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VOLUME 15 **NO. 2** **JULY - DECEMBER 2016**

IMPACT OF NOISE POLLUTION AT WORKPLACE: A CASE STUDY OF LOCO RUNNING SHED AND SHOP, PAKISTAN RAILWAYS KARACHI

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ABSTRACT

Railway is one of the most important means of transportation for public and goods. However, its engines make unwanted noise, which is unpleasant to the general public and workers. The purpose of this study was to determine the noise level at locoshed, shop, fuel filling station and load test section of Pakistan Railways Karachi. The noise levels of the selected locations were measured with the help of CR-262A, Sound Level Meter after calibration with an acoustic calibrator. The workers were personally interviewed and a questionnaire was also distributed, filled up and collected for the determination of noise impact on workers' performance. An analytical hierarchy process model was used for the analysis of noise impact with different alternatives namely locoshed, shop, load test and fuel filling station. The maximum average and peak noise level at locoshed, locoshop and load test sections was found to be exceeding 1.3 to 1.5 times from World Health Organization standards. It was discovered from the model results that there were inconsistency of 0.45. The study revealed that the noise level was more than standards at the selected locations and performance of the employees and workers were seriously affected due to the critical conditions at and near the workplace.

Keywords: Noise level, analytical hierarchy process model, railway engine noise, workers' performance

1. INTRODUCTION

Development of science and technology not only brought numerous conveniences, easiness and comfort for human beings but also created global problems [1]. High level of noise degrades the quality of human life in urban areas across the world [2]. The uncontrolled growth, urbanization, industrialization and transportation system are responsible for this unsustainable environment [3]. Urban environmental pollutants are mostly emerged from modern modes of heavy transportations, like highways, railways, and air traffic [4]. Railway transportation is the most important source for the development of country economy with basic principle to provide transport facility to the public and goods [5]. However, it creates the major air and noise pollutions in urban areas, especially near railway stations, yards, and their maintenance places.

Karachi is one of the biggest, industrialized and dynamic mega cities of Pakistan, facing environmental degradation problems including high level of noise [6]. Noise is a universal environmental hazard of the modern world, originating from a wide variety of sources including vehicles, air and railway traffic, and industrial operations [7]. Railway noise emitting sources are broadly classified into two sources i.e. railway line and railway station. Railway line noise includes the whistling noise of locomotives and train operating noises (composed of rolling noise, traction noise and aerodynamic noise), traction motors, radiator fan, turbo charger and locomotive conditions. Railway station noise comprised of the whistling noise of trains in passenger, cargo, and operating stations, engineering and engine workshop as well as loudspeaker broadcasts in the various locations of railway stations [8]. The high level of noise at workplace directly affects the auditory and non-auditory systems of employees and workers [9]. It disturbs the human comfort and decreases the workers performance [10]. It also creates sleep disturbance, annoyance, irritation, headache, conversation, leading to increases in the chances of accidents at work place, hypertension, heart failure, hearing damage [11-13].

The impact of loco engine noise on employees can be gauged with the help of different models. An analytic Hierarchal Process (AHP) model (Expert Choice 11.5) is one of the most employed models for estimation of noise inconsistency and decision of alternative choice [14]. This model can also be used to assess the risk hazard. Complex number of problems could be resolved through this model [15]. The purpose of this study was to determine the railway noise level at the different workplaces of employees and their impact on the workers performance using analytical hierarchy process (AHP) model.

2. MATERIAL AND METHODS

The selected location for this study was within the premises of Pakistan Railway Station Cantonment, Karachi. The selected site is one of the busiest locations of railways due to repairing, maintenances, trip schedules and examining locomotive engines. The noise intensity at locoshed, locoshop, load test, loco foreman office and works manager office, and interior of mechanical store were measured. The noise level was recorded continuously for three months at the interval of three days from morning till evening using CR-262A sound level meter. The data was taken as minimum, maximum, average and peak dB (A). The meter was held 1.3m above from ground surface and 7.5m away from sources as per standards [3, 6, 16]. The calibration of noise meter was performed through acoustic calibrator at 93.7 dB standard after each set of measurement [17]. The flow intensity of fleets was calculated using traditional method from 8 am to 8 pm at the site. A questionnaire was developed for recording the workers and officers perception about impact of noise on their performance. Direct interview was conducted with 200 workers. It may be added that the objectives of the study were explained to each employees before the beginning of interview [18-21]. In addition, an Analytic Hierarchal Process (AHP) model (Expert Choice 11.5) was used to estimate the impact of loco engine noise on employees and calculate the noise inconsistency. Four alternatives e.g. locoshed, shop, load test and fuel filling station with three different criteria namely annoyance, irritation and headache were set for the model as shown in Fig. 1. The significant statistical data was controlled through sensitivity analysis [22, 23].

Fig. 1. AHP Model with Inputs

3. RESULTS AND DISCUSSIONS

The overall noise level in diesel locoshed was recorded and found with a minimum value of 62 dB (A), maximum 119.3 dB (A), average 84.01dB (A) and peak 130 dB (A) during assessment period as shown in Fig. 2. The daily minimum noise value was found 61 dB (A), maximum 96.5 dB (A), average 78.3 dB (A) and peak 113.5 dB (A) at in front of works manager office. The daily average minimum value observed was 66.6 dB (A), maximum 109 dB (A), average 77.9 dB (A) and peak 127 dB (A) at locoshop. The minimum level of locomotive noise near fuel filling station was 63.7 dB (A), maximum 109.9 dB (A), average 75.58 dB (A) and peak 120.7 dB (A). At load test section, the minimum noise level was found as 55.6 dB (A), maximum 110.6 dB (A), average 92.1 dB (A) and peak 127.7 dB (A). The highest recorded maximum noise level was 119.3 dB (A) with the peak value of 130 dB (A) at locoshed, which was more than standard value of 85 dB (A) [24-25].

The noise emitting from the engines at locoshed was directly reached and received at almost same intensity in locoshop because both sections were adjoining, and there was no barrier between both workplaces. In these places there were various sources of noise such as, engine sound, radiator fan, wheel rolling, cast iron brakes, pressure horn, and shunting of engines. Such noise can be reduced through utilization of newest spare parts, proper maintenances and trip schedules.

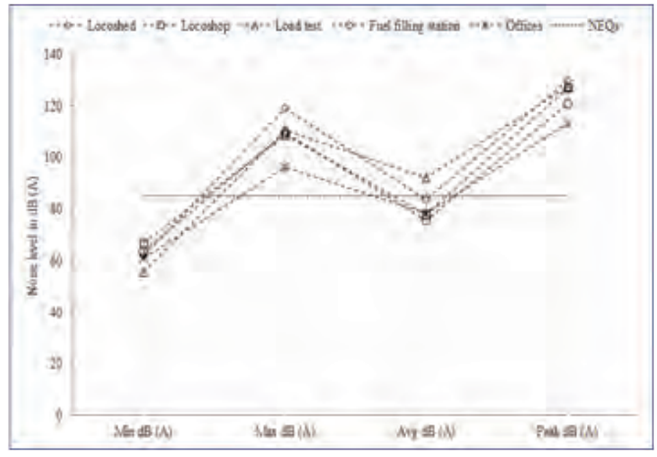

Fig. 2. Comprehensive intensity of noise at selected locations of locoshed and shop Pakistan Railways Karachi

The traditional method was adopted for computing the flow intensity of fleets from morning (8.00 am) to evening (8.00 pm) at the selected locations. The overall flow intensity of loco engines were found 14 at locoshed, 21 at offices, 7 at workshop, 14 at fuel filling station and 4 at load test section as shown in Fig. 3. It was observed that the in front of offices, fuel station and locoshed were found to be noisy locations as compared to shop due to shunting of engines, filling of fuel in locomotive engines, and arrival and departure of passenger fleets from cantonment station.

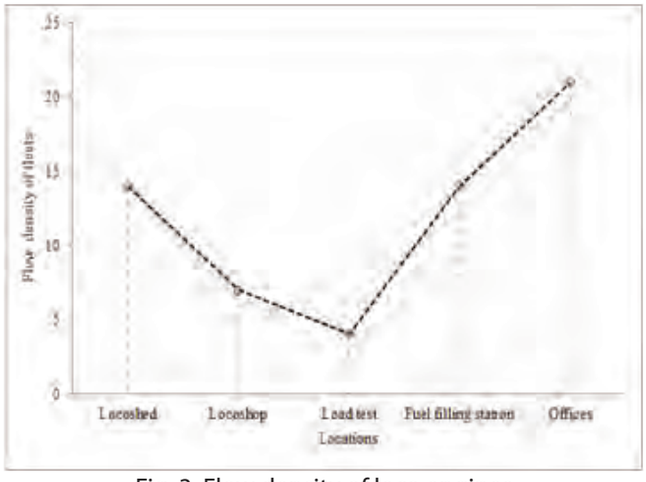

Fig. 3. Flow density of loco engines

The opinion of the workers regarding workplace noise pollution and its impact on their health and performance was collected. The statistical data was controlled through sensitivity analysis. The inconsistency was found to be 0.45 as shown in Fig. 4 and sensitivity is shown in Fig. 5. The analysis showed that the employees of locoshed and shop were at high risk of health and mental stress due to consistent severe noise pollution.

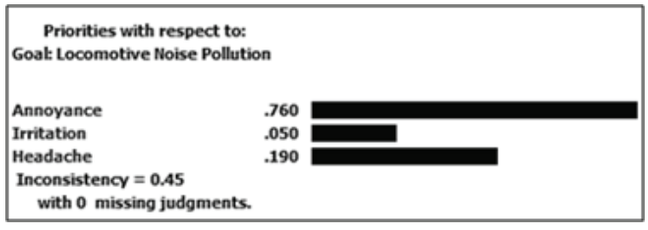

Fig 4. Priorities with respect to goal and Inconsistency

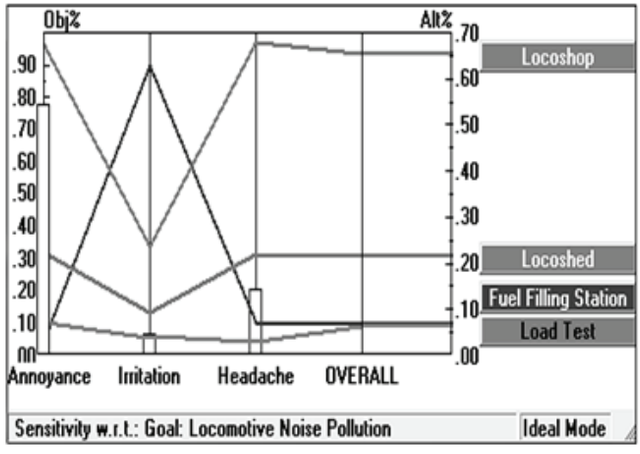

Fig. 5. Sensitivity with respect to goal

4. CONCLUSIONS

The maximum average and peak noise level at locoshed, locoshop and load test sections was found to be exceeding 1.3 to 1.5 times from the standards. The maximum engine flow density was found to be 21 under operation at offices whereas 14 were recorded at diesel locoshed. The severe noise level had adverse impact on the performance of the workers which is responsible for poor health and complications at the workplace. The inconsistency was found 0.45 using Analytical Hierarchy Process model. It is suggested that a noise assessment and management system should be implemented to reduce the impact of noise on the workers. Proper maintenance, trip schedules, sealing of engine doors, usage of bell warning system instead of pressure horn, proficient speeds in yard can minimize the noise exposure. The use of earplugs and muffs and job rotation practice can also decrease the effects of amplified noise on the health of workers.

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PHOTOVOLTAIC CELL MODELLING AND SIMULATION STRATEGIES

Pervez Hameed Shaikh*, Anwar Ali Sahito*, and Aslam Pervaiz Memon**

ABSTRACT

The main focus of this paper is on the modeling of photovoltaic panels or modules that are composed of numerous basic cells. The constituent which impact on the precision of PV simulation is the equivalent circuit modeling primarily encompasses the estimation of the non-linear I-V and P-V characteristics. The assessment, analysis and depiction of PV model will ultimately describe the parameters for the development of maximum power point tracking (MPPT) algorithm along with power conditioners compatibility. This paper intends to collectively organize and assess the mathematical model of the PV cells and to drive the best possible modeling for the continuous varying solar radiation and even under partial shade conditions.

Keywords-Photovoltaic, non-linear, model, solar, simulation

Nomenclature defined in equations as follows:

e : Charge of electron (1.602×10^{-19} C).
k : Boltzmann's constant (1.38×10^{-23} J/K).
I0 : Reverse saturation current for diode.
Iph: Photo-current, a function of junction temperature and irradiation level (5 A).
Ic : Output current of cell, A.
Rs : Series resistance of cell.
Tc : Operating temp. of reference cell (20 °C).
Vc : Output voltage of cell, V.
Ipv,n: Light-generated current in Amperes at the nominal condition (usually 25 °C and 1000W/m^2),
ΔT = T – Tn (being T and Tn the actual and nominal temperatures in Kelvin)
G : Irradiation on the device surfacein [W/m^2],
Gn : Nominal irradiation in [W/m^2].
Eg : Energy band-gap of the semiconductor at normal ambient temperatures.
I_0,n : Nominal saturation current
Ns : Cells connected in Series.
Np : Cells connected in Parallel.
Vt,n : Thermal voltage of Ns (series-connected cells) at the nominal temperature Tn.

1. INTRODUCTION

Solar photovoltaic is a single stage non-conventional energy transformation source which makes electrical energy from light energy. Edmund Becquerel explained in 1839, as the action of falling of light quantum on silver glazed platinum electrode. PV cell is assemble by thin wafers of p-type and n-type material to form a junction. In dark, it has output characteristics similar to a simple diode [1]. The major benefits that PV generators possess, which has resulted in its huge utilization since last two decades, are small lead duration for designing and fixing new systems, matching of output power with peak load burdens, immobile structure, environmental friendly, portable, light weight, high efficiency per unit of weight, noise free, high useful operating life and no moving parts [2].

When PV cell is exposed to light (e.g. sunlight), photons with superior energy band gap of the semiconductor are enthralled thus creating an electron-hole pair. The inner electric fields of pn-junction will cause to be swept across and will produce current proportional to the incident irradiation.

The current flows in the external circuit when PV cell is shorted and shunted internally through intrinsic p-n junction when open circuited. Thus, setup the open circuit voltage exponential characteristics of the cell analogous to that of a diode [3]. PV cells are replicated as a bi-terminal device, which conducts as of a diode in dark and also produce electrical energy when exposed to sunlight.

The constituent which impact on the precision of PV simulation is the equivalent circuit modeling primarily

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encompasses the estimation of the non-linear I-V and P-V characteristics. The assessment, analysis and depiction of PV model will ultimately describe the algorithm parameters for the development of maximum power point tracking (MPPT) algorithm along with power conditioners [4-5].

2. PHOTOVOLTAIC PARAMATRIC EQUIVALENCE

Fig. 1 shows the modest form of equivalent circuit of a solar cell comprises of current source and one or two shunt diodes [5-9]. Current voltage (I-V) characteristivs of cell are determined by the diode [1]. The output of current source is directly proportional to the incident light falling on the cell.

The equivalent circuit models are an appropriate and common approach to pronounce the electrical activities of system devices. In general, an equivalent circuit deals three core benefits:

- Easy to implement with complex electrical systems;
- Permits the system properties depiction in a homogenous and curtailed way in a simple analytical model
- Deliver insights into the multifarious physical progressions which occur within the device/system.

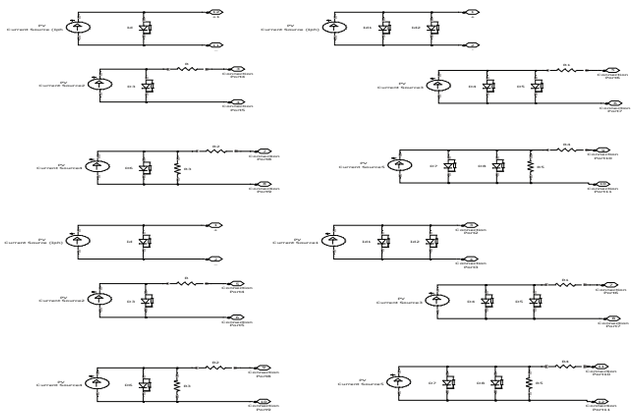

Fig. 1: Ideal Equivalent Circuit Models

a. Ideal Photovoltaic Cell

Electrically, the photovoltaic cell is analogous to a current source in parallel with a non-linear, asymmetric resistive component, i.e., a diode (Fig. 1). Once the cell is brightened, the ideal cell generates photocurrent proportionate to the light concentration. The photocurrent is in quotient amongst the adjustable resistance of non-linear diode and the connected burden, in a ratio which hang on the resistance of connected load and radiance level. It only necessitates three parameters, explicitly; the open circuit voltage (V_{OC}), the short-circuit current (I_{SC}) and the diode ideality factor (A) [10].

b. Realist Photovoltaic Cell Parameters

In a real photovoltaic cell the power extracted from the PV cell depends on several factors which were neglected in the ideal state as defined under:

(i) Parasitic Resistances

In genuine PV cells, the power is dissipated in the resistance of the connections, finite conductivity of neutral regions and also the leakage currents within the sides. These possessions depict electrical equivalence to two parasitic resistances in series R_S (causes the opposition to flow of electrons and holes), its value is so small to withdraw from the circuit [5, 15, 17-19]. Shunt resistance R_{sh} (depicts recombination of electron hole pairs inside the pn junction). Shunt resistance is usually very high and is being neglected for simplification [11-13, 14-18].

(ii) Diode Ideality Factors

The electron hole pair alignment at the junction express the ideality factor of diode meant with 'A'. Its value is generally presumed to be 1 by several authors, referring to P-N junction formation and diffusion of charge carriers across the barrier [20]. In case of two diodes, the second diode is set equal to 2, in accord with the traps notion of recombination [21]. The ideality factor is typically constant at minute currents and ample variation is observed at high currents. This may also vary with temperature [19, 22].

(iii) Thermal Voltage

The diode thermal voltage due to the units of voltage, represented as

$$V_T = k_B \frac{T}{q_e} \qquad (1)$$

where junction temperature (T) is assumed to be controlledor prior known extent, kB is Boltzmann's c onstant, and qe is the elementary electronic charge. Its value is typically around 26 mV at ambient temperature [23].

3. SINGLE DIODE MODEL

Alternatively termed one-diode or single exponential model is the modest and utmost used model for representation of PV cells. Nevertheless unpractical, the simplest PV cell equivalence is single diode model, a current source in parallel to a diode [4, 9, 15, 18, and 19]. This model is enhanced with the insertion of one series resistance, RS [1, 12, 23-26]. In spite of its simplicity to practical approach, the proposed model unveils severe scarcities, with leakage currents within PV cells due to

impurities near the junction and inhomogeneous crystal lattice and also when endangered to temperature deviations. The value of RS is quite small and this parameter is often ignored [22, 26 and 28].

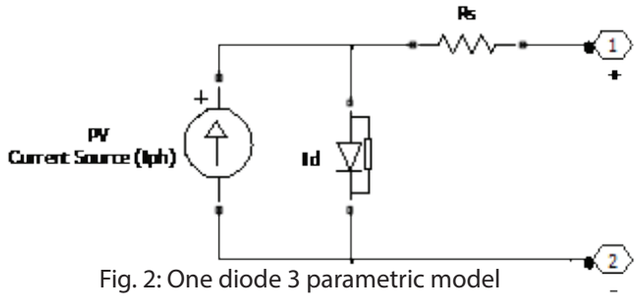

Fig. 2: One diode 3 parametric model

$$I_{pv} = I_{ph} - I_d \left(\exp \left(q \frac{V_{pv} + IR_S}{Akt} \right) \right) \quad (2)$$

A supplementary shunt resistance R_p included in it for leakage currents, non-uniform crystal fabrication structure causes model extension which burdens substantial computational effort, though improvement is achieved in its output power characteristics [20, 21, 29-31]. The value of R_p is generally neglected in [17-19] to simplify the model.

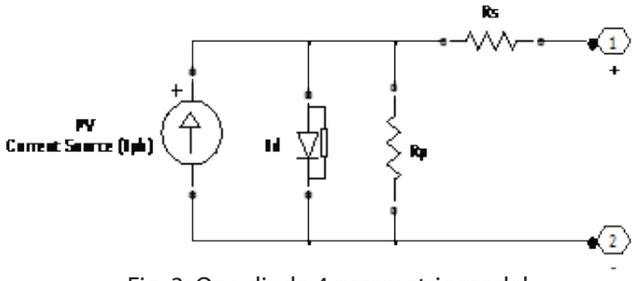

Fig. 3: One diode 4 parametric model

$$I_{pv} = I_{ph} - I_d \left(\exp \left(q \frac{V_{pv} + IR_S}{Akt} \right) \right) \frac{V_{pv} + IR_S}{R_p} \quad (3)$$

This KVL model devises the graphical current-voltage and power-voltage characteristics as shown in Fig. 4, where the three notable points are highlighted i-e open circuited voltage (V_{OC}, 0), short circuited current (0, I_{SC}) and the maximum power point (V_{mp}, I_{mp}). These models are supposed to immune from recombination loss in the depletion region but atlow voltage level, the recombination implies a significant power loss in PV cells. This does not satisfactorily express in the single exponential model. Thus an addition of another shunt diode will comprehensively show this recombination loss.

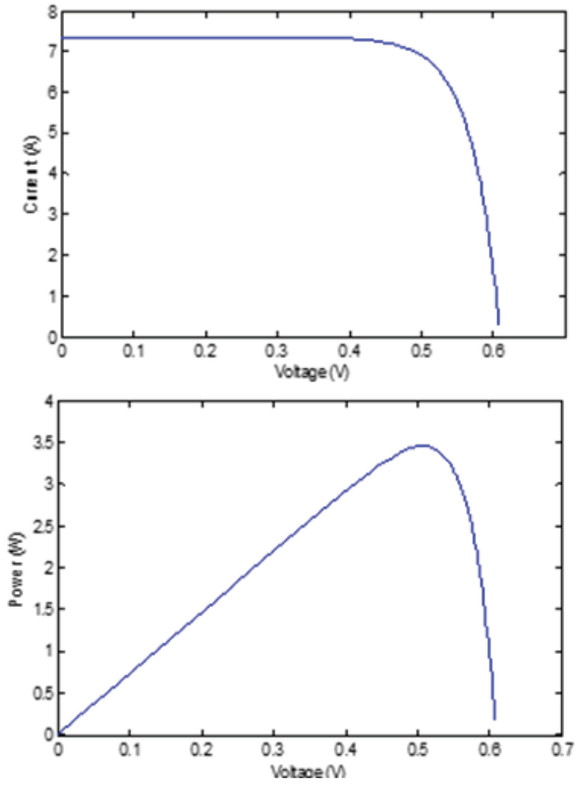

Fig. 4: PV cell characteristics; I-V and P-V (MATLAB ®)

4. TWO-DIODE-MODEL FOR PV CELLS

An even more exact modeling could be achieved by the double-diode or double exponential model with like or unlike diode ideality factors, are joined in parallel. This recombination loss concern in depletion region at low voltage level leads to a more precise model with the addition of another shunt diode for the depiction of the substantial loss [31]. Consideration of this loss leads to a more precise model known as the two-diode model [32]. This model has the benefit of improved precision but has the hindrance of dependency on increased number of parameters. The major impact of the proposed model is temperature variation sensitivity increases as the saturation current is doubled.

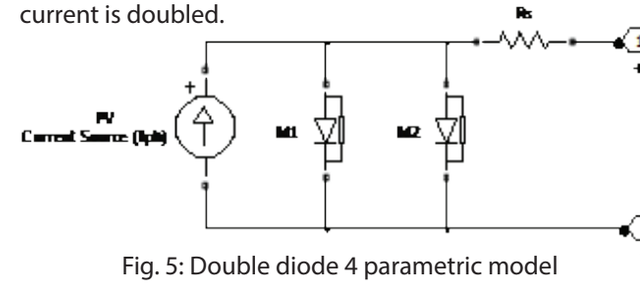

Fig. 5: Double diode 4 parametric model

$$I_{pv} = I_{ph} - I_{d_1} \left(ecp \left(q \frac{V_{pv} + IR_S}{Akt} \right) \right) - I_{d_2} \left(ecp \left(q \frac{V_{pv} + IR_S}{Akt} \right) \right) \quad (4)$$

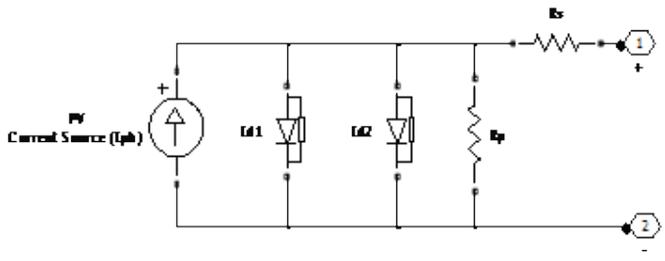

Fig. 6: Double diode 5 parametric model

$$I_{pv} = I_{ph} - I_{d_1}\left(\text{ecp}\left(q\frac{V_{pv}+IR_S}{Akt}\right)\right) - I_{d_2}\left(\text{ecp}\left(q\frac{V_{pv}+IR_S}{Akt}\right)\right) - \left(\frac{V_{pv}+IR_S}{R_p}\right) \quad (5)$$

- Introducing following points to the model will enhance accuracy, complexity and sophistication [4]:

- Temperature dependence of the diode saturation current I0 and the photocurrent I_L.

- A better and accurate shape between the open-circuited voltage and peak power point by a series resistance R_S which represents the internal current flow loss.

- Shunt resistance (R_{Sh}), in parallel with the diode relates to the leakage current to ground probably possess high value or being usually neglected

- Bringing two diodes in parallel with an independent set of saturation currents or letting the Q-F (quality factor) of the diode to have variable parameter insteading of making it fixed at 1 or 2.

- A fair and a common assumption for an ideal cell is $R_S = R_{Sh} = 0$, [6]. A modest complexity model is used to reach at realistic approach.

The rational simulation time management along with the values of approximation of all of the model parameters is the core challenge. Numerous computational techniques have been already offered [17]-[20] and in all these, additional fresh coefficients are presented, ultimately causes computational effort to increase. In determining initial values of parameters, some empirical solutions are pursued. Whereas, scrutinizing its physical features such as the electron coefficient diffusion, lifespan of marginal carriers, intrinsic carrier concentration and other semiconductor parameters [21]-[24] describing the physical conduct of a cell. Since the data about semiconductor is not always accessible in PV datasheets commercially.

Different simulation software are available in market for analyzing mathematical models of the PV cell, Some of the commonly used software are PVsyst, PVcad, SolarPro, PV-DesignPro and PV-Spice. These software packages are costly and rarely have provision of power converters to be interfaced with PV arrays [25].

5. DIODE MODEL JUSTIFICATION

Numerous model variants are established in collected works Watson (1960) [1, 4] offered a two-diode model with identical exponents for crystalline-Si PV cell. Wolf and Rauschenbach (1963) [4] focused the effects of dispersed series resistance PV cells, and resulting the analogous mathematical model [4], but they overlooked the loss caused by shunt current due to the high shunt resistance (RP=13.8 kΩ) consideration in their tentative 2-cm2 mono-crystalline Si cell. Müllejans et al. (2004) [5] used 5-parameter model, supposing prior diode ideality factors n1=1 and n2=2. They stated shunt resistance RP values of practical (large-area) poly-Si cells is as low as 6.6 Ω. In [6, 8, and 13] have also implemented the similar 5-parameter version with the consideration of recombination diode insignificant. Coors and Böhm (1997) [7] have initiated IEC-891 superior 7-parameter variant and Blaesser's technique in I-V curves improvement [7].
Ouennoughi and Chegaar (1999) [13] single-diode estimate have been used and applied the classical equation to a PV module, providing option for number of series cells portraying their ideality factor. This approach thus creates the assessment of p-n junction parameters for cells and modules less straight-forward. Lo Brano et al. (2010) [14] ideality factor of diode using dimensions Volts/Kelvin integrating the fundamental charge and Boltzmann's constant. Thus, stripping qe and k_B, classical (dimensionless) ideality factors of 0.87 and 0.73 achieved, which are not physical. The 3D effects in PV cell are investigated at [4] and also evaluating current flow configuration in distributed series resistance thus becomes too modest and precise model the output from a PV cell. Since, at-least an extra diode and an additional resistor be added for understanding localized loss mechanisms, includes partial resistance enriched recombination [15], for the PV modules tested here, we assume that none of their cells requires such complicated modeling when illuminated outdoors.

6. PARAMETER EXTRACTION APPROACH

(i) Non-linear Fitting

The shunt resistance of a PV cell can be found near short circuit with linear fitting. Since this method each time may not for modules, as bypass diodes get activated at decreased voltage levels. The approximate equivalence of photo-current and short circuit current is assumed for only crystalline cells and the saturation currents in that are smaller in magnitude of several order and also the series resistance is much smaller than the shunt one. Non-linear fitting is preferred for estimation of parameters [39, 43-48]

most of them assume the fixed values of ideality diode factor 1 and 2, while selecting other parameters with fixtures. This technique requires the initial values for non-linear fitting approaches resulting satisfactory curve fits. The non-linear curve fittings are complicated in modeling and even in computer coding. Care must be taken for representative values, with less complexity observations. [47, 50 and 51]

(ii) Semi-log Partial Linear Fitting

To analyze data of p-n junction [45, 52-54] and to discriminate linear part of semi-logarithmic plot, this dominates the two exponential terms. The linear region slope is q_e/nkVT (q_e/NSnkVT for modules) is used to extract diode ideality and current intercept for linear fit provides reverse saturation current. In [45, 53] diode ideality is temperature dependent and series resistance compensation effects the linear deviations at increased voltages. Since physically consistent parameters may not be extracted from tangents to semi logarithmic curve, as there might be conduction and recombination prevailing [55]. The series-resistance effect (R_S is normally not known prior) hence, compensated and the unfavorable effects acquire place at modest voltages, thus interfering with R_S. These all detrimental mechanisms (shunting, recombination or resistive losses) lead to slight rise in the local ideality factor at enhanced voltage level.

(iii) Multiple Quad Dark Analyses

The above two methodologies reviewed may also be pertinent to dark characteristics of PV cells, used in arrangement with irradiated cells to explore certain parameters. An intrinsic difficulty of this technique is imprecise result for R_S caused by altered current drift patterns (e.g. current crowding) in brightened versus dark cells [56, 43]. Reverse current vs. voltage features are also used to find individual parameters.
Dark and multiple-quadrant methods are out of scope yet; we have focused on illuminated forward bias and partial shade data.

7. CONCLUSION

The exploration of PV solar cell has been augmented in last decade to confront the world energy need and improved cell/module performance features at cheaper rates. A PV cell is presumed as a large area forward bias diode p-n junction with a photo voltage, thus created from electron disorder with incident photons at junction. Most of the factors which affect the output of PV cell must be taken into consideration along with the quality issues as ripple generation and the dynamic modeling of PV cell. Since, not only the output of solar cell is reduced but also the I-V charactеristics of PV array or module are affected by the constant partial shading. The problem is further aggravated by the reverse-biasing of the shaded cells, making it a diode with high resistance, that gets over-heated when the illumination difference is fairly large. Thus, there is need for the development of appropriate model that offer benign, amiable and a comprehensive photovoltaic solar system operating under continuous partial shading conditions and changing sun position for static or BIPV systems.

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ON BIOMETRIC MODALITIES: A DETAILED REVIEW OF THE BIOMETRIC TECHNIQUES FOR SECURITY AND AUTHENTICATION

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ABSTRACT

Reliable identification is the need of the modern networked society to grant access to different resources to genuine personnel. The lacunae of traditional identification systems paved the way to find alternatives. As an alternative, biometrics, which is the science of establishing human identity, based on the physical or behavioral characteristics offer several advantages. A number of biometric characteristics have been identified and tested during recent decades. This paper provides an in-depth analysis of the existing biometric systems along with their advantages and limitations. Besides, we also discuss soft biometrics and multi-modal biometric systems in detail and identify the scenarios and metrics which play pivotal role in the successful implementation and accuracy of biometrics technology. For comparative analysis of biometrics modalities, we identify two different sets of features and provide a qualitative comparison of different modalities.

Index terms - biometrics, modalities, authentication, verification

I. INTRODUCTION

Numerous attacks on public, government and private properties portrayed a chaotic scenario and questioned the effectiveness of surveillance systems. In order to cope with the existence of ever increasing number of these systems, a wide variety of approaches have been utilized. The existing security systems usually rely on the cryptographic methods requiring the masses to remember a secret text (password) or keep something with them (token, card) or a combination of both to prove their identity. As a result, the individuals are flooded with passwords and tokens to prove their identity to these systems in order to gain access to different resources such as access control, computer logins, checking e-mails, making bank transactions, border control, welfare disbursements, etc. However, the following problems challenge the authenticity of such systems: (i) forgetting the password/token, (ii) losing card, (iii) divulging the password to an unauthorized person, (iv) number of passwords to be remembered, (v) number of cards to carry, and (vi) ascertaining the identify of a user by the machine. As an alternative solution, the researchers have proposed the idea of human recognition with their physiological or behavioral attributes known as "Biometrics". In general, biometrics refers to the statistical analysis of biological data [1].However, in computer science, it refers to the automatic human recognition through their unique physiological (e.g., fingerprint, face, iris, etc.) or behavioral attributes (e.g., voice, signature, gait, etc.) [2][3][4][5]. Although, not the perfect solution, biometric recognition offers attempts to address many of the aforementioned challenges in the way that these attributes are part of the human body and represent the remarkable capability of humans to recognize each other. Eventually, this idea motivated French anthropologist Alphonse Bertillon to develop the first ever recognition system based on the scientific measurements of an individual's bony parts such as left middle finger, skull width, trunk, cubit, foot length along with eye color, hair color, side and front view photographs. However, the efficacy of the system was seriously challenged when the populated readings showed the identical measurements amongst several individuals. Despite its failure, the system proved a motivating and inspiring factor for Sir Galton to develop an elementary fingerprint recognition system based on the findings of HenryFaulds and William James describing the uniqueness and permanence of fingerprints in 1880. Subsequently, New York State Prison Department inaugurated the system in 1913 and it was adopted as the first fingerprint recognition system in United States.

Any physical or behavioral attribute can qualify for being a biometric trait unless it satisfies the following seven factors
i) Universality: possessed by all humans,
ii) Distinctiveness:distinguishable amongst the population,
iii) Permanence:invariance over a period of time,
iv) Collectability:easily collectible in terms of acquisition, digitization and feature extraction with convenience,
v) Performance: imposed constraints to collection must be realistic and guarantee higher accuracy as well as availability of resources to collect that attribute,
vi) Acceptability:the willingness of population to submit

that attribute to the recognition system, and vii) Circumvention: hard to imitate or mimicked incase of fraudulent attack against the recognition system [3]. Several distinctive characteristics have been identified and tested for recognition. Figure 1 shows the up-to-date nomenclature of these characteristic.

This paper provides an in-depth, critical analysis of the biometric technology along with the merits and demerits of each biometric technique used till date. We highlight the set of features which serve as the criteria for successful implementation and usability of a biometric technique.

The paper is structured as follows. Section I provides basic information consisting of composition, classification, operational scenarios, errors and certain tradeoffs related to biometric systems. In section II, we discuss different biometric modalities along with their salient points, feature sets, matching techniques, advantages and limitations. In addition, section III sheds light on the limitations of mono-modal biometric systems and the need for multi-modal systems.

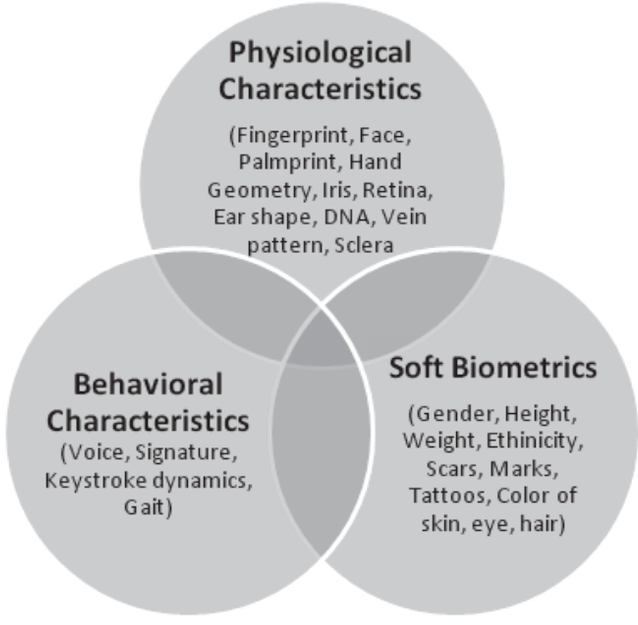

Figure 1: Different Biometric Modalities

Section IV provides a comparative analysis of the biometric modalities with our identified sets of features. Section V concludes the paper.

2. BIOMETRIC SYSTEMS

A biometric system comprises offour modules: i) image acquisition module, (ii) feature extraction module to process the acquired biometric image and to extract the salient or discriminatory features, iii) matcher module to match the features obtained from the probe image with the features of gallery images in order to obtain a match score, (iv) an embedded decision making module to verify or to reject the claimed identification from the user based on the match score, and iv) a database module for storing the digital representation of acquired biometric samples (called templates) during enrolment phase.

The accuracy of a biometric system is heavily data-dependent and influenced by several other factors such as i) quality of biometric trait, ii) composition of target user population, iii) size of the database, iv) time interval, v) variation in the operating environment, and vi) robustness of algorithms. Besides these factors, the following factors also affect the accuracy of a biometric system[9][3][7][8]:(i) False Match Rate (FMR)whichrefers to the percentage measurement of invalid matches, (ii) False Reject Rate (FRR)whichis the measure of times (in percentage) the system recognizes an authorized user as an impostor, and (iii) Equal Error Rate (ERR)whichrefers to the point where FMR and FRR are equal and refers to a trade-off between the false accepts and rejects rates.

3. BIOMETRIC MODALITIES

This section discusses various physical and behavioral biometric modalities in terms of operation, feature extraction and matching algorithms.

3.1. Fingerprints

The unique texture of ridges and valleys present on the fingertips is believed to be unique for every human being even for identical twins and its consistency over entire life time. This makes fingerprint texture a suitable choice for human identification [3][5][8]. A fingerprint image contains the ridge bifurcations (minutiae points) used for recognition purpose and the ridge flow which helps in classifying fingerprints into one of the five categories, namely arch, tented arch, left loop, right loop and whorl [7][11]. A typical fingerprint image may contain 30-40 minutiae points [12]. A fingerprint recognition system may be classified as the one that uses the minutiae points for feature matching or the one that uses the pattern matching techniques [5][14]. High recognition rate, higher acceptability, low cost and portable sensors are the major objectives to design a fingerprint recognition system. On the contrary, the accuracy of these systems is affected by distorted images, physical contact with the sensors, natural image contaminants such as dead cells of finger, scars, cuts, wet and dry skin [3][5][7][8].

3.2. Face Recognition Systems

Amongst all the biometric modalities, face is the most

natural trait that provides the basis for automated face recognition systems [8]. However, the nonlinear structure of human face makes it a complex pattern recognition problem and an active area of research in computer vision [16]. The automated face recognition consists of image acquisition, feature extraction and feature matching phases. An automated face recognition system may employone of two approaches:(i) a feature based approach which computes the geometrical relationships amongst various key features from certain region of face such as distance between the eyes, mouth, side of the nose [17][18], or (ii) a holistic approach which uses the entire face image for performing the recognition task [19]. Categorically, automated face recognition systems can be divided in 2D or 3D systems. A 3D system based on the modeling of facial features as local and global curvatures presents more detailed information of facial geometry as compared to 2D system [16][17]. The most prominent 2D face recognition techniques include Principal Component Analysis (PCA), Fisher Discriminant Analysis (FDA), Self Organizing Map and Convolutional Network, Template Matching, Line Edge Maps (LEMs), Elastic Bunch Graph Matching (EBGM), Directional Corner Point (DCP) and Local Binary Patterns (LBP) [16] [17]. Although, none of these algorithms can guarantee a high recognition rate in a 2D system as the their performance may be drastically affected by illumination variations, pose variations, age variations, and occlusions [16][17]. In contrast, 3D face recognition approaches offer more robustness against the illumination and pose variations [16][20]. Some of the 3D face recognition techniques include Iterative Closest Point (ICP), Curvature based Segmentation approaches, and viewpoint-invariant technique [16].

3.3. Retina Recognition

The blood vessel pattern present on retina of human eye is unique [23]. In addition, the vasculature pattern of retina is the most secure biometric signature for two reasons; one that the retina is well protected and the other that forging the retinal vascular pattern is almost impossible [24]. A retina based identification system acquires the retinal vascular image through projecting an infrared light on the surface of retina due to the faster absorption of infrared light by the blood vessels as compared to the surrounding tissues. Subsequently, the acquired image is further processed and matched with the already enrolled pattern to establish the identity [25]. The feature extraction and matching techniques are based either on landmarks or on circular region of interest [23]. The landmark-based approaches consider the position and bifurcations of blood vessels [26]. Whereas, the area of reference based approaches consider the position of a reference point such as an optic disk [27] or fovea [28]. The features like uniqueness, permanence, highly secure and impossible to forge makes retina based recognition a highly accurate biometric. However, this technique is limited by the intrusiveness of image acquisition, physical contact with the acquisition device, full cooperation demands from the users, requirement of skilled operators, and high cost. These challenges limit the use of retina scanners for civilian purposes.

3.4. Iris Recognition

The complex texture pattern of an iris consists of furrows, crypts, corona and freckles [30]. The iris texture begins to form during the second month of gestation and completes by the eighth month [31]. The factors like clear visibility, uniqueness, lifetime stability, well protectiveness, difficult to forge and easy image acquisition makes iris a highly reliable biometric signature that can be used for verification as well as recognition. The recognition system acquires an iris image by subjecting it to a near-infrared light, extracts the features and finally performs the recognition task based on the iris texture. The works presented in [30][31][32][33] provide an extensive survey of iris recognition technology. Currently, most of the iris recognition systems are based on the pioneering algorithm developed by John Daugman [31]. The highly accurate recognition rate and matching speed motivates the integration of iris recognition systems in large-scale personal identification scenarios such as border crossings [8]. In addition, several efforts have been made to perform the recognition task in visible light [34][35][36] and at a distance [35][37]. However, the illumination changes, non-cooperative subjects, off angled iris images and reflections from ambient light sources including iris itself are some of the challenges to the technology in visible spectrum [38].

3.5. Scelra Vasculature

Sclera is the white and opaque portion of the human eye which contains a unique vein pattern with lifetime stability and hence can be used as a biometric identifier [39]. As evaluated in [40], the sclera vein pattern fulfills all the necessary conditions described in [3] for any physiological or behavioral characteristic to qualify for being a biometric identifier. Nevertheless, a few studies have been conducted to establish the authenticity of sclera vasculature to be used as a biometric characteristic [39][40][41], thereby conformity requires large-scale studies. Nevertheless, all the feature extraction and matching techniques are based on the analysis of the RGB channels of the acquired sclera vein pattern and off-axis iris images [39][40][41][42].

3.6. Palm Print

The palmprint technology identifies an individual based on the unique texture of principal lines and secondary creases

present on the human palmar region. . The unique texture of principal lines and secondary creases develop between the third and fifth month of fetal development [44]. An automated palmprint recognition system acquires both the low and high quality palm images through an optical scanner. From the high quality palm images ridges, singular and minutiae points are extracted as features.Whereas, from the low quality images principal lines, wrinkles and palm texture are extracted as feature set using bi-sector based, tangent based and finger based approaches [45][46]. Normally, three different approaches are used for identification purpose such as i) line based approaches in which the principal lines are extracted and are used as feature vectors [47][48], ii) sub-space based approaches: where the Principal Component Analysis (PCA), Local Discriminant Analysis (LDA) and Independent Component Analysis (IDA) are applied directly on the palm images and the coefficients of sub-space are calculated and used as features [49][50], and iii) statistical approachesconsisting of local and global approaches. The local statistical approaches after transforming the image into a different domain, divides the image into small regions thereby the means and variances from these small regions constitute the feature set [51][52]. On the contrary, the global statistical approaches use the global features such as moments, center of gravity and density as their feature set [53][54]. The potential advantage of this technique is the large size of palm since it provides more detailed information as compared to fingerprints. In contrast, more user cooperation, bulky sensors, physical contact with the sensor and lower order of discrimination are some of the challenges associated with the technology.

3.7. Hand Geometry

The shape of human hand is also an important biometric modality having characteristics of variance and stability [55]. A hand geometry system uses a camera or a scanner to acquire the 2D or 3D image of human hand [55]. The feature extraction techniques are categorized as hand geometry based, hand contour based or palmprint based. Usually, the hand geometry based recognition systems use 2D features of hand such as length and width of fingers, aspect ratio of fingers or palm, length, thickness and area of hand [58].Whereas, the 3D hand recognition systems use skin folds and crease patterns of hand as features [59]. In addition, any of the distance measures such as correlation coefficient, absolute distance, Mahalanobis distance and Euclidean distance or their combination can be used as matching measures [57]. The advantages of this technology include higher user convenience, low cost of sensors, small template size and easy integration with existing fingerprint and palmprint systems. In contrast, the accuracy of this technology is limited by therecognition inability, presence of artifacts such as jewelry, and diseases pertaining to human hand such as arthritis, etc.

3.8. Facial Thermograms

A facial thermogram system captures the unique heat radiation patterns of human face with the help of an infrared camerawhich can be used as a biometric signature. Usually, a facial thermogramis obtained from the vasculature structure present beneath the skin of human face;hence, it is almost impossible to forge that pattern [60]. In comparison to other face recognition techniques, facial thermogram not only reveals the detailed anatomical features of the face, but also shows strong invariance to facial expressions and other artifacts such as application of cosmetics and plastic surgery. As a result, face detection, localization and segmentation becomes easier than the facial images acquired in visible wavelength of light [61]. Several studies have proved the efficacy of infrared facial images over visible light facial images [61][62]. The advantages of this technique include non-invasiveness, representation of more detailed features of face, robustness to heterogeneous lighting conditions and pose variations. In contrast, view dependence, skilled operator requirements, ambient physiological or psychological conditions are some of the challenges associated with this technology.

3.9. Vein Pattern

The network of blood carrying veins beneath the human skin is unique even in identical twins,and this invariant characteristic helps in declaring it a biometric modality [63]. This recognition system acquires the image of human hand by exposing it to near-infrared light. The deoxidized hemoglobin present in the veins absorbs the infrared light by reducing the reflection and causing the veins to appear black [63]. In terms of features, a typical vein recognition system uses minutiae points such as vein bifurcations and endings [63]. Eventually, adaptive thresholding [64], morphological gradient operator [65], Principal Component Analysis (PCA) [66] or Linear Discriminant Analysis (LDA) [67] are used for feature extraction and matching. Although, the non-intrusiveness, difficult to counterfeit and stability of vein pattern makes thistechnology a strong member of biometric signatures. However, it suffers from a number of challenges including higher user cooperation, physical contact with the imaging sensor, shrinkage of vasculature pattern due to diseases such as diabetes, hypertension, metabolic disorders, tumors and lack of large scale investigations on uniqueness of vein pattern [8][63].

3.10. Deoxyribonucleic Acid (Dna)

DNA is unique to individuals and remains stable throughout the life with the exceptions of identical twins [68][69]. Interestingly, 99.7% of DNA code is shared, while 0.3% of the code is inherited and thus varies from person to person. As a matter of fact, this 0.3% of DNA code obtained from small varying region termed as short tandems is used for recognition purpose [70]. In comparison to the traditional method of acquiring the DNA code from blood samples, several alternatives are also proposed such as human hair, ear wax, dental floss, fingernail clippings etc. Nevertheless, the requirement of physical samples to collect the DNA code makes it different from other biometrics which requires either the impression or image for recognition. Furthermore, the DNA matching cannot be performed in real time and the process is not automated [72]. Although, it is a highly reliable and stable biometric identifier, it also suffers from certain drawbacks such as long processing time, requirement of human expertise, high cost and determination of hereditary diseases from the DNA code.

3.11. Ear Shape

The shape of human ear is unique andremains invariant throughout the life. Hence, it can be used as a biometric signature [73]. An ear recognition system acquires the image of human ear through different techniques such as i) taking the photograph of ear, ii) pushing the ear against a flat surface to get an earmark, iii) taking the thermogram of ear [73][75][76], and iv) measuring the acoustic transfer function of a sound wave projected on ear [77]. Ear recognition techniques can be categorized as i) local feature based approacheswhich use the geometrical features of ear for recognition [78], and ii) holistic approaches which use statistical measures to perform the recognition task [79]. However, 2D ear recognitions techniques are sensitive to illumination conditions, pose variations, imaging conditions and presence of partial and full occlusions due to jewelry and ear muffles [80]. To overcome these challenges, the researchcommunity has proposed the idea of 3D ear recognition thereby getting the image with a range of sensor which provide the range color and range image pair information for recognition.

3.12. Body Odor

Due to the presence of unique combination of organic compounds, human body emits a particular odor which can be used as a biometric signature [82]. This technology acquires the human odor through an array of chemical sensors, where each sensor is sensitive to a particular aromatic compound [3]. However, such type of sensors is not robust enough to perform the task of human recognition. In addition, identification of individuals based on body odor suffers from a number of privacy issues such as the possibility of diagnosing the diseases or the activities carried out during last hours.

3.13. Keystroke Dynamics

It is a behavioral biometric based on the technique used by telegraph operators to identify each other by recognizing the "fist of the sender" [85]. This recognition system identifies an individual based on the typing rhythm, which is unique for every individual based on the combination of duration and interval length between the keystrokes [86]. The system measures the characteristics such as duration of a keystroke, hold time, keystroke latency, typing errors, speed and pressure for recognition. Since the mentioned features are statistical in nature, therefore the recognition methods are the averages and standard deviations [87]. Although, the ability to perform continuous monitoring and user acceptability are some of the advantages associated with this technique, but the information regarding individual's potential ratability and work effectiveness are considered as challenges to keystroke dynamics [68].

3.14. Signature Recognition

This is a behavioral biometric that identifies an individual based on the measurements of signature dynamics. Such systems are categorized as either static or dynamic [88]. A static verification system requires the users to produce the signatures on a piece of paper, which is then digitized and produced to the system for identification [89][90]. In contrast, a dynamic signature verification system acquires the signatures through digitizing pad and measures the attributes like pen position, pen pressure, direction, acceleration, length of strokes, tangential acceleration, curvature radius and azimuth for authentication [88]. The dynamic signature verification system offers better accuracy as compared to the static system. The merits of this technique include high social acceptance, ease of changing the signatures any time and inclusion of handwriting methods in mobile devices. On the contrary, muscular illness of the subjects, physical and emotional states, and the possibility of signature change over time are some of the challenges associated with this technology.

3.15. Voice Recognition

Human voice is characterized by some physiological and behavioral characteristics such as shape and size of vocal tract, lips, nasal cavities, mouth, and behavioral attributes such as movement of lips, jaws, tongue, velum and larynx, pitch and volume. These characteristics are unique for every individual [91]. A speaker verification system lies in

one of the two categories such as i) text-dependent, which performs the identification task based on the utterance of a fixed phrase by the user, and ii) text-independent, which imposes no fixed vocabulary constraints on the user [92]. Although more complex and difficult to develop, the later type of the system provides better accuracy and robustness against the spoof attacks. In terms of feature matching, vector quantization, hidden Markov model and Gaussian mixture model provide better accuracy as compared to other approaches such as dynamic time warping and artificial neural networks [93]. Apart from its advantagesincluding less hardwarerequirements, several factors contribute to the low accuracy rate of these systems such as similarity of voice due to health conditions, aging, emotional states and presence of extraneous noise and poor quality of acquisition devices. Consequently, the technology is limited to verification tasks only.

3.16. GAIT

A behavioral biometric based on the analogy that the walking pattern of an individual can be used as a biometric identifier. A gait based recognition system obtains the shape and dynamics information for recognition process. The most common recognition techniques include i) temporal aligned basedtechniques, which analyze the time series features such as the full subject silhouette, ii) static parameter based approaches, which analyze the gait dynamic features such as stride, length, cadence and speed, and iii) silhouette shape based approaches,which emphasize on the similarity of silhouette shape instead of the temporal information [95]. Although, the gait offers the advantage of recognition at a distance over other biometrics [96][97], but it does not provide sufficient discriminatory information which limits its ability to perform only the verification task. In addition, the walking speed, walking surface dynamics are some of the other potential challenges lead to high false rejection rates.

3.17. SOFT BIOMETRICS

This term refers to the attributes that are most common amongst the humans such as gender, ethnicity, height, weight, color of skin, color of eye, color of hair and SMT (scars, marks and tattoos), etc. These attributes provide broad information about a person, but are not sufficient to perform the recognition task [99]. However, their combination with hard biometrics (face, iris, fingerprints, etc.) produces better solutions to classification problems by narrowing down the search space and produces better accuracy rates in verification and identification [98][100] [101][102].

4. MULTI-MODAL BIOMETRICS

Although, the biometric technology based on the measurements of a single trait is mature enough, but none of the systems guarantee 100% recognition accuracy. This is because several factors affect the recognition accuracy of a mono-modal biometric system, e.g., noisy data, intra-class variations, distinctiveness, non-universality, and spoof attacks[5][103]. In order to overcome these challenges, many researchers have proposed the idea of multi-modal biometric systems. A multi-modal biometric system fuses the information from either single or different biometric modalities to perform a decision. In terms of performance, a multi-modal biometric system offers higher recognition accuracy due to the fusion of multiple independent evidences of biometric information [104].

4.1. MODES OF OPERATION:

Operationally, a multi-modal biometric system functions in one of the following three modes [5][7].

(i) Serial / cascaded mode: Itpertains to the processing of acquired multiple biometric modalities one after another. The output of one biometric trait serves as input to the processing of next biometric trait. The first trait serves as an indexing scheme to narrow down the search space before the next biometric trait is used, which in turn results in the reduction of recognition time. Typical serial arrangement is illustrated in Figure 2.

Figure 2: Serial arrangement of multi-modal biometric system

(ii) Parallel mode: In this mode, all the acquired biometric traits are processed simultaneously and the results are combined to get a match score. Although, the architecture provides better results but requires more time to establish an identity. Figure 3 illustrates the parallel architecture.

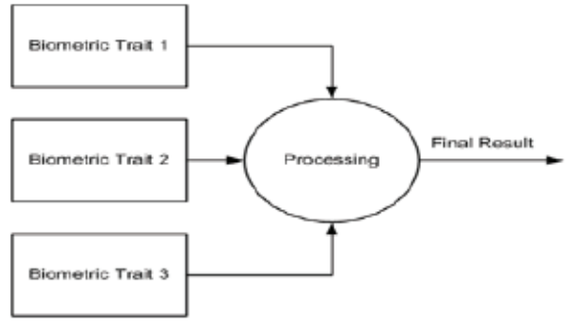

Figure 3: Parallel arrangement of multi-modal biometric system

(iii) Hierarchical mode: In this mode, all the independent classifiers are combined in a tree shape.

4.2. SOURCES OF INFORMATION

Since a multi-modal biometric system performs the recognition based on the presence of multiple biometric samples, these systems can be classified into the following categories according to the source of information [5][7][103][104].

(i) Multi-sensor systems: This pertains to the usage of multiple sensors to acquire a particular biometric trait. The multiple sensors provide detailed and complementary information regarding the measured trait, which helps enhancing the recognition accuracy. Although, the scheme overcomes the problems of poor quality or distorted biometric samples,but may suffer from increased cost of sensors and the constraint of high user cooperation.

(ii) Multi-algorithm systems: Such systems use different feature extraction or matching algorithms on a single biometric trait acquired through a single sensor. Finally, the individual results produced by different algorithms are combined to obtain a decision level, which results in achieving enhanced recognition accuracy.

(iii) Multi-instance systems: These systems capture multiple instances of a single biometric trait to be measured by using a single imaging sensor which produces a complete representation of the trait being used.

(iv) Multi-sample systems: Such systems measure the variations of the same biometric trait, thereby acquiring the underlying biometric trait through a single imaging sensor. However, the attention must be paid to the determination of number of samples in advance given that the acquired samples must show variance and typicality of the particular trait.

(v) Multi-modal systems: These systems perform the recognition task based on the measurements of uncorrelated biometric signatures acquired through different imaging sensors. Although, these systems offer better level of accuracy due to the fusion of increasing number of different biometric traits, but require more effective dimensionality reduction methods. Moreover, the requirements of new sensors and appropriate user interfaces make their deployment costly.

(vi) Hybrid systems: Such systems use different combinations of the above-mentioned scenarios; for example; a system comprising of the multiple imaging sensors and multiple feature extraction or matching algorithms.

4.3. FUSION LEVELS

Exploiting any of the sources of information, the acquired evidences can be combined together at different levels described as follows [5][7][104].

(i) Sensor level: This results in the integration and formation of new data set which is normally used for feature extraction from the raw data acquired through different sensors. As an example, 2D texture information and 3D range (depth) information of human ear acquired through different sensors can be integrated to get the 3D image of human ear.

(ii) Feature level: This refers to the fusion of feature sets obtained from different biometric modalities to form a new feature set with higher dimensionality, given that the feature sets are independent and lie within the same measuring scale. Concatenating the feature sets of face and iris is a typical fusion example. Although, the researchers achieved better recognition accuracy at this level, however, it requires the proper solutions to deal with the factors like compatibility, high dimensionality, computational overhead and requirement of complex classifiers. Feature 4 depicts feature level fusion.

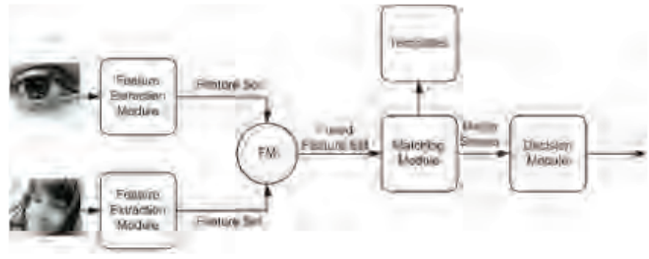

Figure 4: Feature level fusion

(i) Matching score level: This refers to the verification of the claimed identity by matching the obtained feature vectors independently with the pre-stored templates through different classifiers. The outputs are then fused together and finally the decision module makes the decision based onthe composite match score. A match score level fusion is illustrated in Figure 5.

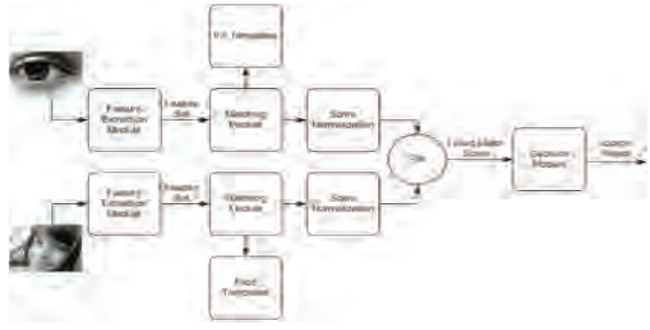

Figure 5: Match Score level fusion

(ii) Decision level fusion: Using this approach, each matcher classifies the observed biometric modality independently.Subsequently, the decisions from different matchers are fused together to make the final decision through the techniques such as majority voting. However, this fusion mode is not considered to be much effective due to the fact that the final classification decision takes longer to arrive. Figure 6 illustrates the decision level fusion.

5. IMPLEMENTATION STAGES OF BIOMETRIC SYSTEMS

The implementation stages of a generic biometric system are shown in Figure 7. The process starts with collecting appropriate samples from different sources. The scenarios considered during the data collection step greatly influence the performance of a biometric system. The collected data is analyzed for missing parts and extraction of appropriate features. It is then split into two parts: one used for learning the inherent patterns, and the other used for evaluation. The pre-processing of the training data follows selection of right features, scaling and rejecting the redundant or unnecessary features from the dataset. The later step finds the inherent relationship between the selected features and builds a classification/prediction model based on the observed patterns. The evaluation of the classification/prediction model is performed with respect to the performance metrics of accuracy, precision and recall. The training data generated during the pre-processing step is used for evaluating the performance of the biometric system.

6. EMERGING BIOMETRIC TECHNOLOGIE

Besides the aforementioned longest serving biometric technologies, several new modalities are striving to find their way to be included in main stream. These include finger knuckle print, periocular skin and heart sound. However, their conformity needs large scale analysis.

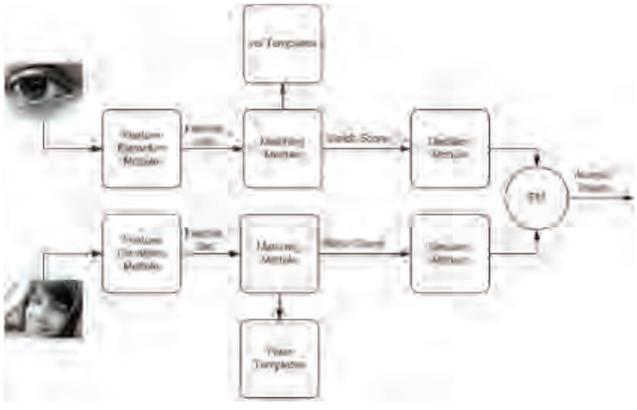

Figure 6: Decision level fusion

7. COMPARATIVE ANALYSIS

We identify a number of features which can be used for the comparative analysis of different biometric modalities. We divide this set of features into two sub-sets, i.e., (i) the set determining the level of universality, uniqueness, permanence, collectability, performance, acceptability, circumvention, and (ii) the set determining imaging procedure, imaging sensor and environmental challenges. Our comparative analysis with respect to these two sets is shown in Table 1 and Table 2.

8. CONCLUSION

Reliable identification is the crucial requirement in a wide variety of systems and different scenarios. Traditional cryptographic methods do not offer reliable identification since they require the users to remember something or to possess something. Besides, several factors affect the efficacyof such systems and their reliability has been challenged from time to time. As an alternative, reliable identification based on the distinctive physiological or behavioral characteristics provides better solutions to high security demands of the present day. Moreover, these distinctive characteristics are sole property of an individual. Hence, the individuals are not required to memorize the large cryptographic words as the passwords. In addition, these features cannot be stolen or

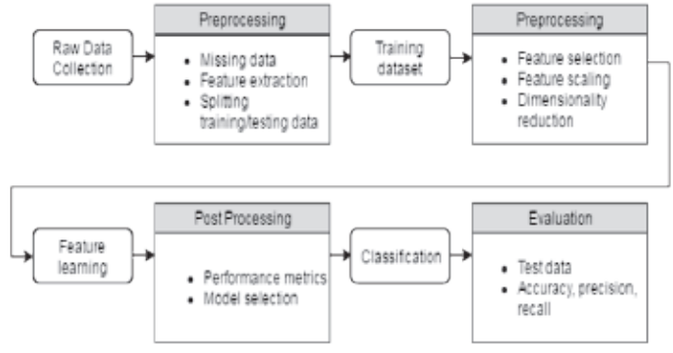

Figure 7: Implementation stages of biometric systems

forgotten and require the genuine user to be present on the spot for identification.

In this paper, we have provided an overview of the existing biometric technologies along with the composition, classification and performance evaluation indicators. Moreover, we discuss different biometric attributes along with their potential advantages and disadvantages. Besides, we also discuss the necessity of multi-modal biometric systems along with their architecture and different levels of information fusion.

Table 1: Comparative analysis of different biometric modalities

Biometric attribute	Universality	Uniqueness	Permanence	Collectability	Performance	Acceptability	Circumvention
Finger print	Medium	High	High	Medium	High	Medium	High
Face	High	Low	Medium	High	Low	High	Low
Hand Geometry	Medium	Medium	Medium	High	Medium	Medium	Medium
Iris	High	High	High	Medium	High	Low	High
Voice	Medium	Low	Low	Medium	Low	High	Low
Ear shape	Medium	Medium	High	Medium	Medium	High	Medium
Palm print	Medium	High	Medium	High	High	Medium	Low
Finger knuckle print	Medium	Medium	Low	High	Medium	Low	Low
Keystroke dynamics	Low	Low	Low	Medium	Low	Medium	Medium
Signature	Low	Low	Low	High	Low	High	High
Gait	Medium	Low	Low	High	Low	High	Medium

Table 2: Comparison between different biometric modalities

Modality	Imaging procedure	Imaging sensor required	Environment challenges
Finger print	Intrusive	Fingerprint scanner	Dirty / oily surface of sensor, temperature conditions, wet / dry skin
Face	Non-intrusive	Camera	Illumination changes, pose variation, expressions
Hand Geometry	Non-intrusive	Camera	Reflections, health conditions
Palm print	Non-intrusive	Camera	Reflections, health conditions
Finger knuckle print	Non-intrusive	Camera	Reflections, health conditions
Ear shape	Non-intrusive	Camera	Illumination changes, pose variations, presence of jewelry and ear muffles
Iris	Non-intrusive	Camera	Illumination changes, diffuse and specular reflections
Voice	Non-intrusive	Microphone	Background noise, channel distortions, emotional and health condition
Signature	Non-intrusive	Phone screen	Health conditions, emotional states
Gait	Non-intrusive	Accelerometer	Walking surface dynamics, emotional, health and dietary conditions
Keystroke dynamics	Non-intrusive	Keypad	Health conditions, emotional states
Heart sound	Intrusive	Electrodes	Physical contact, needs extra sensors

Although biometric technology does not offer solutions to all the applications and security scenarios, yet the recent interest and inclusion of biometric solutions to a number of identity management systems in government as well as private sectors promise a bright future to the science of biometrics.

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A LEXICON BASED MECHANISM FOR IDENTIFYING AND MONITORING SECURITY THREATS ON ROADS

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ABSTRACT

Given the booming expansion of social media, it is not surprising that the field of sentiment analysis has seen advancements rapidly in recent years. Nevertheless, the use of sentiment analysis is quite limited in the field of transportation to assess the safety of an area. This research paper propose the sentiment analysis of traffic or crime information as a new way to handle this problem. To achieve this, we have used one of the user generated contents i.e. Twitter as our source of information. Twitter has emerged as an essential new tool to make social measurements. Millions of tweeps express their thoughts and sentiments about any topic imaginable on daily basis voluntarily. This heap of data is quite significant from both research and business perspectives. Thus, we intend to design an application through our research with which the categorization of data publically available at Twitter can be done, so that the users can have access to the customized and useful information related to the areas they are planning to visit. To carry out this research practically, data from Twitter was collected for a particular source and destination and sentiment analysis was performed using SentiWordNet. The result yielded in overall polarity of the tweets informing users about the safety of all the available routes. This study will help greatly in the development of intelligent transportation systems and our experimental results demonstrate the effectiveness of the system.

Keywords—sentiment; polarity; safety; lexicon

1. INTRODUCTION

Many researches in Europe and America have been conducted in the field of route planning and transportation that focuses entirely on providing traffic information, which unfortunately, is not critical and of utmost importance in our society. In Middle East (Asia specifically), the main concern is the safety of a road user. In improving well-being in human mobility, one can think of other criteria that could be meaningful, such as the friendliest, most scenic, safest, most enjoyable, or matching one's interest the best [2]. There has been an alarming rise in street crimes during last few years and countries are once again in the grip of suchcrimes, thus creating a sense of insecurity among the road dwellers. The crux of our idea is whether real-time, geo-tagged social media streams can be used to enhance everyday experience in the way we interact with places, for instance by avoiding crime-prone areas.

There exists a lot of useful information regarding incidents that might possess risk while travelling from one place to another such as mobile snatching, firing or abduction etc. However, a mechanism is needed to retrieve and categorize the information before presenting it to the user in a useful manner. Thus, the objective of this study is to use public opinions and sentiments to help people to decide about the route they are planning to take when travelling from one place to another.

The remaining paper is organized as: the related work is discussed in Section-II. The implementation methodology is discussed in Section-III. Results has been discussed in Section-IV and the paper is concluded in Section-V along with the recommendations about future work in Section-VI.

2. LITERATURE

Sentiment analysis and opinion mining is the field of study that analyzes people's opinions, sentiments, evaluations, attitudes, and emotions from written language. It is one of the most active research areas in natural language processing and is also widely studied in data mining, Web mining, and text mining [1]. In other words, it is a measure of opinion and subjectivity in textual data [15].

Sentiment analysis systems are being applied in almost every business and social domain because opinions are central to almost all human activities and are key influencers of our behaviors. Our beliefs and perceptions of reality, and the choices we make, are largely conditioned on how others see and evaluate the world. For this reason, when we need to make a decision we often seek out the opinions of others [1]. Different researches have conducted in the last few years that attempt to employ the concept of

Sentiment Analysis in different aspects. As we know that with the rapid rise and popularity of social media, sentiment analysis has developed quite speedily in recent years [3] because of its ability to find emerging trends and topics. In the field of sentiment analysis, many people have worked in this aspect using different techniques and algorithms. Every project has its own importance and significance in its own way and perspective.One can find number of projects and research work done on this topic.

3. IMPLEMENTATION METHODOLOGY

Typically, the methodologies for lexicon based sentiment analysis are based on the fact that he overall polarity of the textual data can be calculated by the polarity of the individual words which compose it [9].

Fig. 1. Illustrates the architecture of our Android application; the architecture is based on a number of stages which includes: a) collection of data from Twitter, b)segmentation of sentences(tweets), c)extraction of sentiment polarities, d) sentiment calculation, and e) evaluation of results.

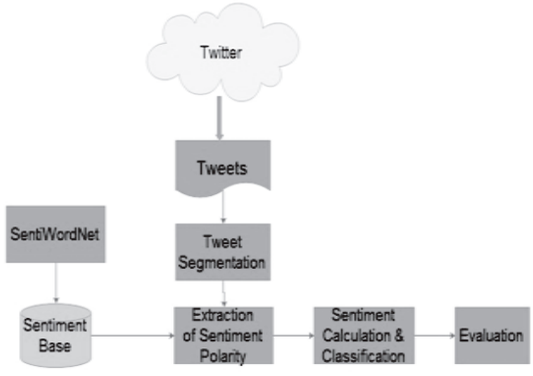

Fig. 1. Architecture of the system.

a) Data Collection:

To ensure that conclusions are purely public opinion based, we have gathered all the data from Twitter (represented by upper block in Fig. 1. We have used Twitter4j library to get data from Twitter.

b) Segmentation of Sentences:

Sentence segmentation is further sub divided into two phases:

i. Tokenization that decomposes the sentences into small tokens such as words, numbers of symbols of varying types.

ii. Process of speech tagging that assigns a part of speech tag on every symbol or word.

c) Extraction of Sentiment Polarities

The polarity of the words can be extracted from sentiment base. However, the sentiment base needs to be updated from time to time since words and topics discussed on internet changes quickly.

d) Sentiment Calculation:

The process of sentiment analysis is then performed on the extracted data. Individual score of each sentence is calculated first which serves as an input to calculate total score of the data.

e) Evaluation:

The final evaluation of the collected score is carried out in this step and one of the ratings shown in Table 1 is then assigned based on the total score to the area that the user is planning to travel.

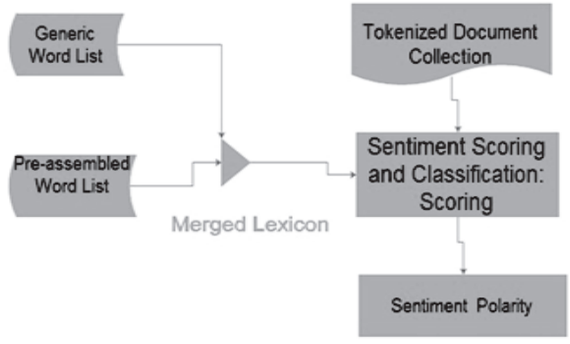

Fig. 2. Sentiment Classification Process

f) Setiment Base:

The process of sentiment analysis consists of two linked segments, i.e. , sentiment lexicon and the sentiment polarity of those words. Since our major task is to focus on information about crime andtraffic conditions, we have developedasentiment base that consists of keywords related to our desired domain and are extracted from SentiWordNet. SentiWordNet is an extension of WordNet and is available freely for research purposes. SentiWordNet[7] is a lexical resource used in the field of opinion mining. SentiWordNet assigns to each Sysnet of WordNet[8] three sentiment scores namely objectivity, positivity and negativity, showing how Objective, Positive or Negative the words are. The score of these sentiments ranges from 0.0 to 0.1

and their overall sum is 1.0 for each sysnet. These words are arranged as a set of synonyms[13]. As we are only interested in knowing how safe or dangerous the routes are, therefore, we have considered only positive and negative scores of the words as shown in Fig. 3. The words taken from SentiWordNet are stored in "Preassembled word list" whereas general words such as very, totally, completely etc are stored "Generic Word List" as shown in Fig. . These two lists are merged to form ou crime and traffic lexicon to which tokenized document set is passed as an input and the process of classification is carried out as shown in Fig. 2.

```
# POSID PosScore        NegScore        SynsetTerms
Gloss
a       00064787        0.625   0       good#5
beneficial#1    promoting or enhancing well-being; "an
arms limitation agreement beneficial to all countries";
"the beneficial effects of a temperate climate"; "the
experience was good for her"
a       00106020        0       0       good#2 full#6
having the normally expected amount; "gives full measure";
"gives good measure"; "a good mile from here"
a       00231252        0       0.75    worse#1
(comparative of `bad') inferior to another in quality or
condition or desirability; "this road is worse than the
first one we took"; "the road is in worse shape than it
was"; "she was accused of worse things than cheating and
lying"
a       00478311        0       0.75    tough#6 bad#3
feeling physical discomfort or pain (`tough' is
occasionally used colloquially for `bad'); "my throat
feels bad"; "she felt bad all over"; "he was feeling tough
```

Fig. 3. Fragment of SentiWordNet

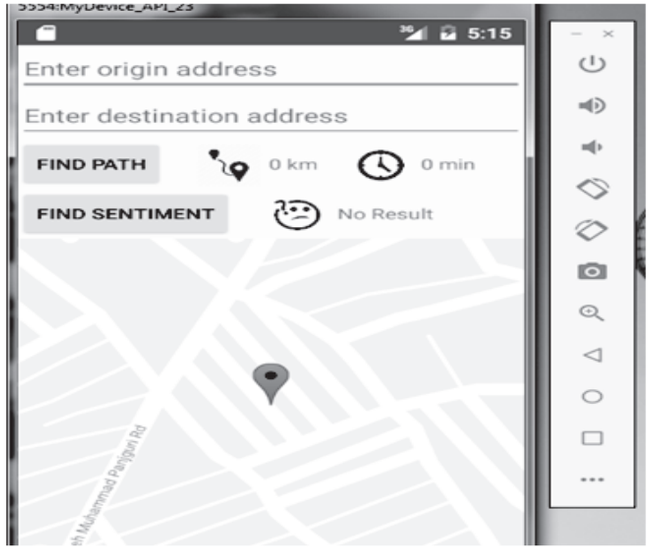

Fig. 4. Final interface of application.

- Table 1. Classification of Sentiment

	Range	Sentiment
Total Score	>=0.75	Strong Positive
Total Score	> 0.25 AND <= 0.5	Positive
Total Score	> 0 AND <=0.25	Weak Positive
Total Score	< 0 AND >= -0.25	Weak Negative
Total Score	< -0.25 AND >= -0.5	Negative
Total Score	<= -0.75	Strong Negative
Total Score	0	Neutral

4. RESULTS:

Fig. 4 shows the final interface of our application. We have tested the application and it works well in predicting the sentiment of routes. When the find path button is clicked, all the possible routes will be drawn between source and destination provided by user on Google Map using Google Map Direction API as shown in Fig. 5. The brighter shade of green shows the path as being safer rather than the darker one. The screen also shows the distance and time needed to travel between the two points. On clicking the 'Find Sentiment' button, the rating of each individual path (from source to destination) is calculated as shown in the Fig. 5 that helps user in making decision about choosing he route. The term 'Neutral' is only for the main route. The sentiment for alternate routes is only shown through lines Google map. Fig 6 shows two paths, one safe and the other unsafe, from Lyari to Sohrab Goth. The path that passes through Nazimabad had negative tweets about target killing and other incidents that is why it is unsafe and is shown by pink line. Fig. 7 shows the tweets extracted by the application having information about source and destination entered by user.

```
.googlemapdemo I/System.out: Move back to Chicago for school or stay in Florida ..
.googlemapdemo I/System.out: Nothing like booking a spur of the moment Chicago trip to fit nicely in between the Florida & Colorado
.googlemapdemo I/System.out: Chicago feels like winter time in Florida
.googlemapdemo I/System.out: I have cousins on snap from all over the U.S so i know what's going down in Cali,Chicago,New York, Flori
.googlemapdemo I/System.out: Massive Shootings: Sandy Hook, Charleston S.C, Boston, Aurora, Dallas, Florida, Oregon, San Bernardino,
.googlemapdemo I/System.out: #SlingTV move to Florida from Chicago. If you actually let me watch Chicago programming I would actuall
.googlemapdemo I/System.out: Another friend ex friend was in airport in Florida getting ready to board plane for Chicago. Lived that
.googlemapdemo I/System.out: 6:30 in Florida which means it's 5:30 in Chicago...debating getting payback and waking up @CoreyHollis
.googlemapdemo I/System.out: Folks from, Boston, New Jersey, Ohio, Florida,Chicago Mexico, Missouri, Illinois, india, Tenneessee. Wo
.googlemapdemo I/System.out: Chicago then Pensacola Florida gon be a highlight
.googlemapdemo I/System.out: Only time I've been out of Texas was when I went to chicago and that was like 3 years ago so you know I'
.googlemapdemo I/System.out: KJRI = General Consulate of Republic of Indonesia Office..in the US such as in LA,SF,Houston (handle als
.googlemapdemo I/System.out: The Chicago Bears were defending Super Bowl champs, the last time #Kentucky beat #Florida. □ □ #UK
.googlemapdemo I/System.out: Professional Interstate Movers from Chicago to Florida
.googlemapdemo I/System.out: Florida / Kentucky game on CBS in Chicago □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
.googlemapdemo I/System.out: Florida is not close to being as cool as chicago, and will never ever be.
.googlemapdemo I/System.out: I wanna go to chicago and cali and florida and vegas again but w friends this time
.googlemapdemo I/System.out: Like to Chicago , California , st.louis , Colorado , Arizona , Florida plus more  all just for soccer □
.googlemapdemo I/System.out: One more full day in Florida tomorrow, fly to providence on Monday, fly to Chicago on Tuesday, home on
.googlemapdemo I/System.out: In chicago you have people crossing the roads and protesting. In Florida you have iguanas crossing the
.googlemapdemo I/System.out: Hey Chicago Wildcats! Join your fellow #BBN'ers at @PonyInnChicago for UK vs Florida. Free pizza and st
.googlemapdemo I/System.out: My Florida followers; look into the Chicago scene, you'll definitely find someone you would want to bri
.googlemapdemo I/System.out: Chicago; do the same
```

Fig. 7. Tweets extracted using Twitter4j

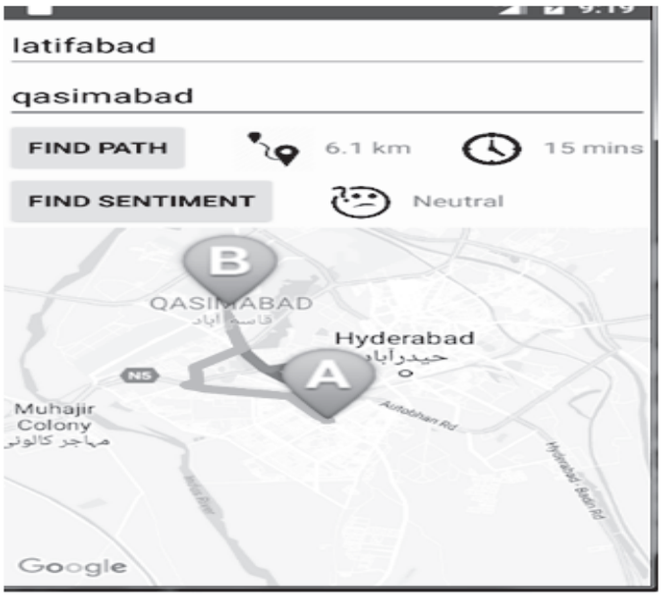

Fig.5. All possible routes from A to B

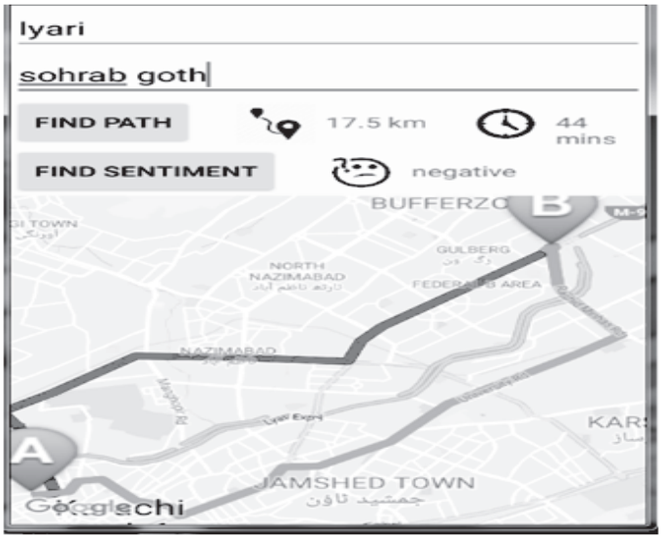

Fig. 6. Safe and unsafe route between source and destination.

5. CONCLUSION

To our best knowledge this is the first attempt to use sentiment analysis to gather the data about criminal activities as well as traffic unlike old experiments that completely focused on collecting information related to transportation. Twitter serves as the fast and real time source of information as compared to news articles thus providing users with the access to timely updates about the situation of crime and transportation in different areas. However, the reliability of data collected from Twitter is low. This project has potential applications in developing intelligent transportation system. It can be used to accommodate traveler's best interest along with ensuring his safety.

6. FUTURE WORK

Though our application seem to work properly, still there are some aspects and areas that needs to be worked on for further enhancement.

Firstly, our project focus on gathering information about routes using manually saved waypoints.. This can be improvised by taking points of interest or landmarks in to account rather than waypoints. The application will look for all the possible routes automatically that exists between source and destination, perform sentiment analysis on each of them individually and suggest the route that is safest of them all .The results would be more accurate and beneficiary then.

Secondly, we have used Twitter4j library for the extraction of tweets from Twitter that returns only newest data available on the website. In order to get all the previous information available on Twitter about a particular area, we can use Streaming API along with Twitter4j.

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AN ONTOLOGY-DRIVEN VEGETATION CLASSIFICATION FOR SEMANTIC-BASED IMAGE RETRIEVAL OF AERIAL PHOTOGRAPHY

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ABSTRACT

The retrieval of images using semantic concepts is challenging and essential issue in watchword based search. The focus has been shifted from low-level feature extraction to human semantics in order to enhance the precision of content based image recovery framework. It is done to decrease the semantic gap between visual components and affluence of human semantics. This research provides an ontology-driven approach to train the system by modeling the human cognition that also conquers the constraints of a label based retrieval. In the proposed work, a properly characterised philosophy framework is used to drive image annotations that enable semantic retrieval of aerial photography. The concept of image semantics is exploited for the classification of vegetation and also to determine the qualitative semantics by using Allen's qualitative relations. Psychophysical evaluation is used to assess the effectiveness of the proposed approach. The outcomes of the different experiments are relatively favorable in terms of accuracy of relevant image retrieval.

Keywords: Semantic Image Retrieval, Vegetation Classification, Aerial Photography, Qualitative Semantics

1. INTRODUCTION

Image recovery is the field of study concerned with looking the perusing computerized image form distinctive database gathering. Gathering images into (semantically) significant classes, utilising low-level visual components or features is still a testing and critical issue in substance based image recovery. A tremendous measure of data is out there. On the other hand, we cannot get or utilise the data unless it is sorted to permit productive browsing, beholding, and recovery. In the light of these groupings, for an image database, viable records can be manufactured [1, 2]. Human cognition focuses on how humans process information, by looking at the way people treat information that comes to them and their treatment that leads to responses. The main theme of this research is to build this cognition into a machine which can behave similarly to human behaviour. The system perceives like human cognition works.

Appropriately defined domain ontology provides the vocabulary for the annotation drives the extraction of automatically produced annotations and provides the conceptualization utilized in retrieval [14]. In the sequel, a comprehensive review of the relevant background in semantic image annotation and retrieval is presented. It is followed by a detailed description of the proposed ontology infrastructure, the ontology-based semantic analysis, and retrieval components. Experimental results in the domain of aerial images against both plain content-based and keyword-based retrieval will illustrate the contribution of this approach.

This area of study is very active in research since the 1970s [3]. Due to the availability of such digital content in abundance, image retrieval pulls in enthusiasm from specialists in the fields of image handling, mixed media, computerized libraries, remote detecting, space science, database applications and other related disciplines. Viable and quick recovery of an image was not simple, particularly, when the accumulations developed into terabytes. A viable image recovery framework needs to work on the gathering of image to recover the important image in view of the client question image which adjusts as nearly as would be prudent to human discernment and comprehension the inquiry image.

2. LITERATURE REVIEW

Low-level visual features such as color, texture, and shape, as well as higher-abstraction structural information, formed the content annotation metadata. Indexing was performed using the automatically extracted numerical descriptors, and retrieval was based on similarity measures that try to

match the way humans perceive visual similarity. Four broad categories can be identified depending on the chosen content and indexing paradigm: query by example, iconic, textual and hybrid, respectively. The literature considers a huge number of diverse approaches for a variety of application domains.

An expert Bayesian network was presented by Mukashema et al. that implements as a novel object-based classification technique to extract coffee fields from very high resolution (VHR) imagery [4]. Theme is to disdeveloped and tested for ten agricultural zones of Rwanda using aerial orthophotos. A high resolution coffee map of Rwanda was produced by applying the automated method on 198 orthophotos and one Quick Bird image. At the startup, the spectral separatability was assessed between coffee and other major land cover classes. Then, the expert Bayesian network model is developed for one site and tested in other nine sites. Finally, the model parameters are implemented to all aerial orthophotos at national level and assessed using field and census validation data sets. A Bayesian system is just as helpful as this former information is dependable. Either an unnecessarily idealistic or skeptical desire of the nature of these earlier convictions will misshape the whole system and negate the outcomes. Another strategy for immediate features based image recovery was proposed by Bhattacharyya et al. [5]. The author developed an image database with low-level texture features from Gray Level Co-Occurrence Matrix. For testing the images, the decision tree is framed in the training stage.

Sohail S et al. presents an ontology-based image retrieval system from a corpus of characteristic scene images by conferring human cognition in the retrieval procedure, to address the issues of keyword-based image retrieval and substance based image retrieval through the utilization of subjective spatial representations over semantic image annotations [6]. The performance evaluation of the suggested framework has been carried out by comparing the semantically retrieved images, in view of queries and descriptions provided by users. A much-known approach in evaluating such systems is the "Psychophysical". Data has been collected to manoeuvre the proposed approach, which consists of manually classified 300 aerial images of vegetation. The Psychophysical was carried out by dividing 300 images into different groups and given to different users from various domains including IT Experts, Farmers, Agrarians, Students. Hence, every user was given a set of 30 images and had five images in each belonging to every category. Each one of these images was represented using 10 concepts.

Cristina S et al. proposed a measured framework that permitted us to offer distinctive arrangements in the Image CLEF 2013Plant Identification task [7]. An adaptable, particular framework is proposed which permits us to investigate and consolidate the outcomes in the wake of applying techniques, for example, image retrieval utilizing (LIRe), metadata grouping and innocent Bayes classification. Training gathering is very broad, covering an extensive number of animal varieties, keeping in mind the end goal to acquire precise results with this photograph annotation calculation. Henning S. et al. performed a study with multi temporal simultaneous C- and L-band polarimetric SAR data to assess the crop classification accuracy for different modes [8]. Kadir A. developed a method for leaf classification. This method incorporates shape, vein, colour, and texture like features and uses PNN as a classifier [9]. Fourier descriptors, slimness ratio, roundness ratio, and dispersion are used to speak to shape highlights. Shading minutes that comprise of mean, standard deviation, and sticks are utilised to speak to shading. Twelve composition elements are separated from lacunary. Larranaga A. et al. has assessed, from an operational viewpoint, regardless of whether the consolidation of spring SAR perceptions into an order plan in light of one multispectral summer scene gave upgraded crop characterization [10]. Effective procurement of information is significantly more probable from SAR sensors than from optical sensors due to a couple of chances for without cloud optical acquisitions. This is the essential reason for the utilization of SAR images to characterize diverse products . The outcomes showed an increment in exactness when SAR information was incorporated into a multispectral order plan. Enhancements were slight, and the incorporation of two SAR scenes did not give extra advantages. In all the cases, correctness acquired utilizing just SAR information was lower than those who utilised the optical images, failing to reach more than 75%.

Isabel L. et al. investigated five different classification methods and their precision: (i) Parallelepiped (ii) Minimum Distance (iii) Mahalanob is Classifier Distance (iv) Spectral Angle Mapper (v) Maximum Likelihood using Quick Bird imagery [11]. This technique identifies whether remote identification provides the ability to perceive products adequately and agro-processing measures in a standard agricultural based district depicted by dry weather conditions. The minimum information was taken from the division of the satellite data for portrayal in order to survey pixel-article and pixel-item information. The results exhibited that challenge and pixel-article based examinations unmistakably manoeuvred pixel-based examinations, resulting in the exactness more than 85% in an extensive segment of the requests and highlighting the more likelihood of exact classifier.

All the techniques /approaches discussed used the

low-level concept of the images to classify the vegetation in the image. They do not consider the high-level concepts of images except Sohail, S. [6], where image retrieval is based on the high-level semantics of the image and uses spatial relationships. The research framework provided details about semantic similarity and its different methods to compute similarity among different concepts. They were not applied in their work for image categorization and retrieval, but the relative effectiveness of their approach in regards to image segmentation and labeling can be used to retrieve an image on keyword-based retrieval method.

The classification of vegetation, based on different objects has been performed on high-resolution satellite images [12, 13]. However, the objects always have certain semantic relationships among them. In this research, these relationships are exploited and a knowledge-driven framework, using ontologies as the means for knowledge representation, is investigated for aerial image semantic retrieval for vegetation classification.

3. PROPOSED FRAMEWORK

An Ontology-Based Image Retrieval framework has been proposed to search in digital repositories.

3.1. SEMANTIC IMAGE DESCRIPTION

Keeping in view the goal of searching of the images in advanced vaults, we propose an Ontology-Based Image Retrieval Approach utilising Qualitative Semantic Image Descriptions, to enhance the accuracy of pursuit. Coordinating of RDF triples has been utilised rather than watchwords keeping in mind the end goal to focus on the setting of the hunting term.

3.2. PROPOSED FRAMEWORK

The proposed system is in parts: User Interface, Domain Ontology, and Images vault. In the framework shown in Figure 1, a user submits the RDF query through a user interface that expands the query's search. These questions have been sent to metaphysics, to perform the semantic coordinating on the inquiry looking terms. The inquiry result will be the images reference, originating from the cosmology. The real images will go to the ranker in the wake of contrasting and the images reference. The ranker figures out the priority among the images and positions them as per their significance scores. The resulting segments depict the points of interest of every part of the system.Figure 2 represents the proposed ontology-based image retrieval framework. The proposed methodology to perform semantic matching and searching in digital repositories is also provided. Finally, a dry run of the proposed methodology is provided by carrying out different experiments.

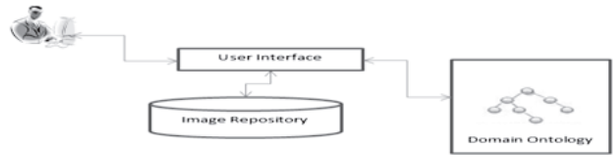

Figure 1: Generic Ontology-based Image Retrieval Process

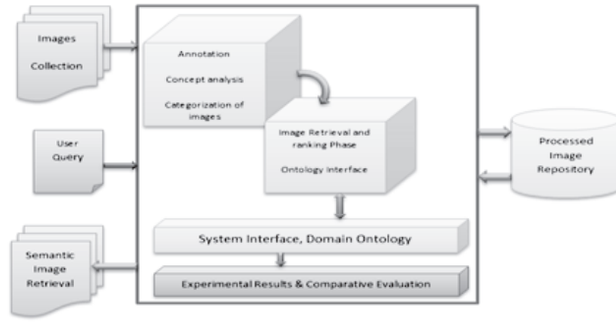

Figure 2: Proposed Ontology-based Image Retrieval Framework using Image Semantics

3.3. IMAGE ANNOTATION

An example of annotated aerial image is presented in Figure 3, which contains the concepts present in an image that is being used to measure the frequency of each concept. The whole annotation process is performed manually by using psychophysical evaluation, in which the objects and their relationships are identified for more comprehensive analysis of the image semantics. In result of this evaluation, we annotated the image in a better way that ultimately leads to a more accurate classification of vegetation images.

3.4 ONTOLOGY FORMULATION

An ontology-based image retrieval framework to carry out searching is proposed. In the framework, thematic similarity approach is used in order to capture the context-aware meanings of the concepts.

The ontology model is formulated using the open source Protégé (version 4.3) as RDF Triple. The concepts, identified through annotation in the previous step, were implemented through 10 classes (Barren Land, Road, Vegetation, Terraces, Tree, Rock, Crop, Building, Forest, and Water) as objects & subjects and their relationships were mapped as the predicates. We employ searching on metadata (in the form of triples) instead of keywords to concentrate on concepts and their relationships together in the following SPARQL query.

4. RESULTS AND DISCUSSION

The user interface of the prototype system and the workflow of the end-user are described. Users are able to specify queries by selecting the triples from the UI. The system should be simple and easy to use, so the user interface of the prototype system is designed similar to the Google search engine. In addition, results should be ranked according to the degree of relevance to the user query to enable users to focus on the top ranked, more relevant results to the query rather than on the less relevant results.

Figure 4 shows the psychophysical evaluation where the x-axis represents the concepts and a y-axis represents the frequency of occurrence of each concept. In order to assess the statistical relationship, the T-test is applied, presented in Figure 5 and Figure 6. It is distributed on a curve based on the number of degrees of freedom (df). It confirmed the hypothesis. A significant difference between psychophysical evaluations and semantic image retrieval is found. By applying T-test, it is seen that the hypothesis is correct.

```
PREFIX ns: <http://www.semanticweb.org/ontologie/Ontologyaerial.owl#>
SELECT  ?img ?catag
        where
{?image ns:hasCatogeory ?catag.}
```

Figure 3: An example of annotated aerial image representing concepts and their respective frequencies

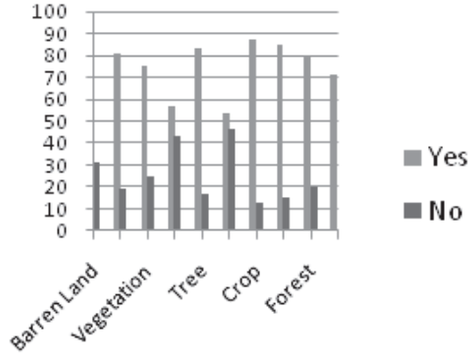

Figure 4 (a): psychophysical analysis

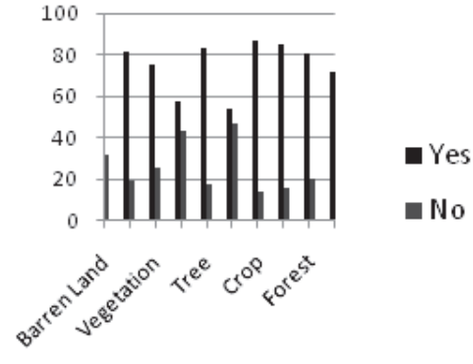

Figure 4 (b): SPARQL Query results

	A	B	C
1	t-Test: Paired Two Sample for Means		
2			
3		*Variable 1*	*Variable 2*
4	Mean	73.875	94.375
5	Variance	162.125	4.839286
6	Observations	8	8
7	Pearson Correlation	0.675138	
8	Hypothesized Mean Difference	0	
9	df	7	
10	t Stat	-5.10227	
11	P(T<=t) one-tail	0.000698	
12	t Critical one-tail	1.894579	
13	P(T<=t) two-tail	0.001396	
14	t Critical two-tail	2.364624	
15			

Figure 5: T-test on analysis

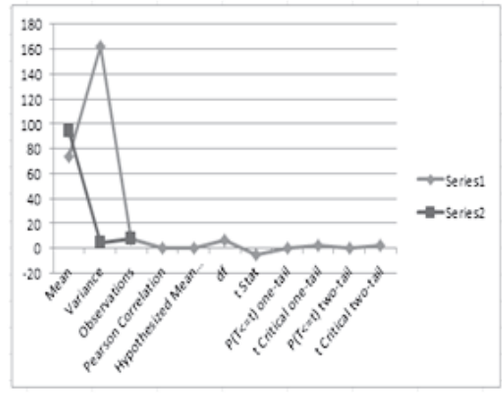

Figure 6: Graph for T-test

5. CONCLUSION

The image retrieval is based on high-level features and descriptive characteristics of an image. In this research, both semantic and qualitative semantic relations are exploited to model the human cognition for vegetation classification of aerial photography. The image annotations are used to understand the image semantics clearly.. For this purpose, concepts, categories, and auxiliary characteristics have extracted via human cognition. Further, these characteristics are validated by presenting a framework based on psychophysical evaluation to retrieve the relevant images, accurately. However, the presented framework does not consider incomplete RDF triples that can also contain useful information which may enhance the accuracy of the retrieved images.

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IDENTIFYING AMBIGUOUS QUERIES METHOD BASED ON SPATIAL INFORMATION FOR IMPROVING WEB INFORMATION RETRIEVAL

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ABSTRACT

In Web Searching, users are needed to give queries in order to get back the response accordingly. Generally, users get bulk of irrelevant information associated with given input and it needs to be filtered with respect to user requirements about searched contents. Commonly, it is observed that most of queries are unable to describe its purpose, hence known as ambiguous queries. These ambiguous queries establish a noteworthy portion and results in challenging the users' intents towards web search. Therefore, many locations based as well as time based features have been engrossed to deal with such problem in order to achieve information effectiveness in terms of accuracy and relevancy. This paper presents Identifying Ambiguous Queries Method (IAQM) based on Spatial Information, a new method to classify the ambiguous queries based on post search results. In order to originate spatial information from the search results, the ambiguous queries from two different datasets Ambient and Moresque are processed separately by developing a Java-based prototype. The proposed IAQM has achieved improved performance in terms of accuracy as 82% and 78% independently that leads to the motivation of development of small scale search engine in future.

Keywords:Ambiguous, spatial information, disambiguation, information retrieval

1. INTRODUCTION

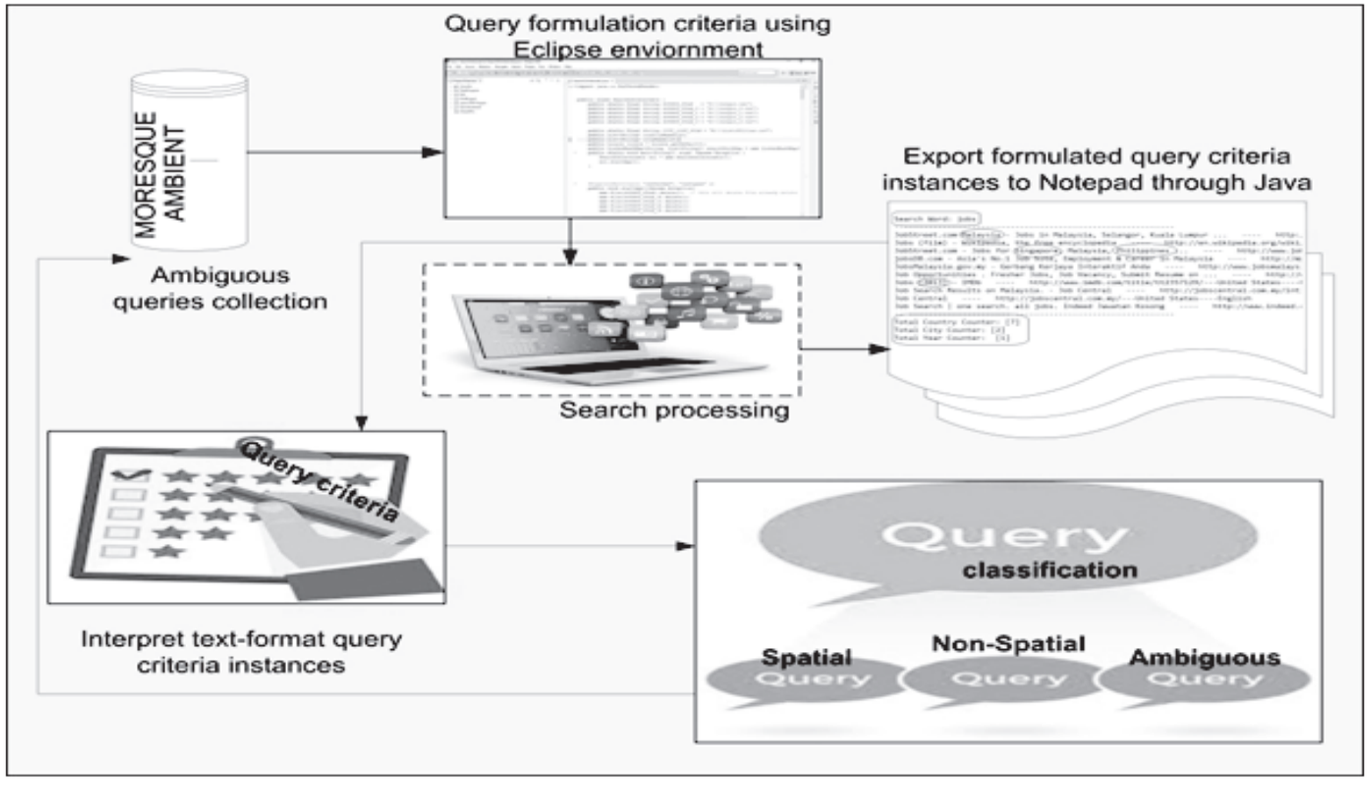
In the field of web search, the essential objective of research is associated with performance enhancement, which is mainly dependent on disambiguation of queries given by the users to find information. For example, when a user gives queries, he/she gets back thousands of results in response of the query which he/she needs to analyze according to requirements. In this process, he/she hold relevant information and disposes off irrelevant one. But however, this process in unviable because time restrictions. Hence it results into finding of the quick way to find relevant information. This situation cause accuracy problem to occur. Lack of domain knowledge leads natural language limitations in the state when users are unable to state their needs effectively [1]. This unclear expression of user requirements creates problem of ambiguity that results in misunderstanding of the queries and their linked results. Such queries are called logically ambiguous and mostly contains short terms i.e., one to three terms only [2]. By locating domain knowledge and initiating refinement process, ambiguity can be resolved by using some features of type spatial or temporal. This process of introducing additional spatial or temporal features leads to spatial search [3-5] along with temporal search [6-8]. Henceforth in this paper, we propose a method named as Identifying Ambiguous Queries Method (IAQM) based on Spatial Information dealing with ambiguous queries to make them clear so as to get accurate search results in response.

The remaining contents of the paper are organized as follow; Section 2 is about description of previous related work. Section 3 elaborates the proposed method and then Section 4 is to give description about. Finally, concluding remarks along with future directions are penned out in Section 5.

2. LITERATURE REVIEW

By using search engines, the purpose of web search is to enhance the process in order to get precise information needed by users. But however, it is becoming challenging because of rapid growth in size and complexity of Internet. To retrieve information, search engines are in need of input queries to be processed upon. These queries are observed as ambiguous[9]; and cause renouncing of performance of search engines in terms of accuracy. Additionally, identification of these ambiguous queries is considered as

thorny task. Hence, the process disambiguation is meant to deal with retrieving relevant information and also identifying the ambiguous queries as well [10]. For this purpose, different disambiguation techniques [8-11] were introduced in past with features of identifying those ambiguous queries. Ricardo, et al. used temporal features in terms of year to process text queries for disambiguation [3]. Clustering approach was utilized to form clusters on the basis of temporal features. However, that approach was lack of accuracy because of solely relying on temporal features as it was argued by many researchers in support of other features like spatial. And also it was contrary to the principle of traditional IR system that doesn't use these features in retrieved documents until they exist in variety [12]. Long ago, in multi-computer applications the concept of spatial information has been introduced by targeting different research areas like user modeling, and information retrieval[13-15]. The spatial information is defined as the information, which is used to illustrate nearby applications with the situation [15]. Then after, the problem of query disambiguation has been researched by [8] utilizing spatial information. Our proposed method IAQM is distinguished with authors in use of spatial information in the form of location being found in results retrieved back in response of user queries. However, our work is differentiated with the authors in terms of using spatial information representing any location in search results produced in response of the queries rather than using separately. Even though, numerous approaches, the determinations need progressing with respect to particular case of using spatial information for query disambiguation.



FigureError! No text of specified style in document.. 1: Work diagram of the proposed method

3. PROPOSED WORK

Our proposed methodology is grounded on hybrid approach and is focused upon primarily on identification of ambiguous queries and then developing a method for disambiguating the contents accordingly. The proposed IAQM is executed to deal with ambiguous queries so as to make them unambiguous such that to retrieve accurate information according to user needs.

In proposed method, we process explicit queries consisting of spatial information in receptive results for refinement procedure. The ambiguous queries are being input from two different datasets; AMBIENT and MORESQUE separately. Furtherance in investigating categories of the queries, we use spatial feature i.e., consisting of information about any place (See Figure 1). In next step, these queries are classified into spatial, non-spatial, or ambiguous based on results with respect to spatial information presence. The spatial category represents information about any place; Non-spatial is representing temporal information in the form of year, while ambiguous ones represent none of

either spatial or temporal information. Thereafter analyzing the receptive contents, queries are being classified and then datasets are updated to be processed in future by other researchers. In order to implement IAQM, the Eclipse IDE on top of a Windows 10 pro (64-bit Operating System) with 4GB RAM and 2.30 GHz Core ™ i5-4200U CPU @ 1.60 GHz are used.

4. RESULTS AND DISCUSSION

In order to assess IAQM, AMBIENT (Ambiguous Entries), [16] and MORESQUE (MORE Sense-tagged QUEries) [17]are used to evaluate its efficacy. The prior dataset comprised of 44 queries and subsequent consists of 114 ambiguous queries. The information about number of queries being processed in our method is presented in the table 1 given below.

Table 1: Information about ambiguous Queries in datasets

Sr.	Dataset	Number of Ambiguous Queries
1	AMBIENT	44
2	MORESQUE	114

Keeping in focus of ambiguity of the queries, our disambiguation approach [18] classify these queries as spatial, non-spatial, and ambiguous. We used search results in order to get executed our method. Upon retrieving 10 search results in form of web snippets, we analyzed one by one to find spatial information such that classification can be made. Figure 2 presents the execution and the analyzing process.

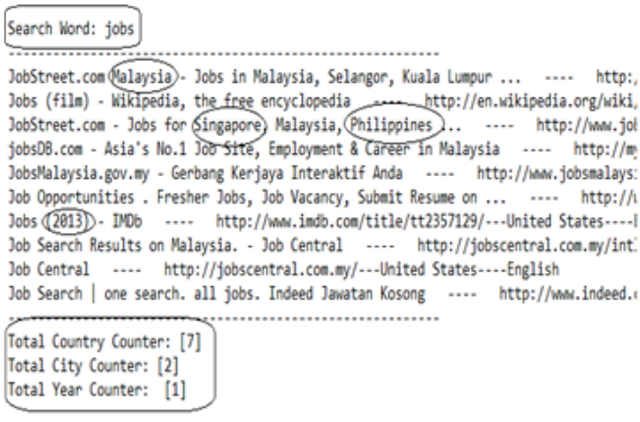


Figure 2: Execution and analysis process

In the above Figure 2, we set "country" and "city" counters for the spatial information so as to target place, while "year" counter variable is used to search out temporal information. The table 2 below presents in first row total number of ambiguous queries being processed. The second row shows the number 23 and 21 as spatial queries based on values retrieved against each variable, 13 and 68 are classified as non-spatial , so as to make total of 36 and 89 clear queries as whole in each dataset. After final results, we come to conclusion that our criteria to classify queries as spatial or non-spatial performed well and hence at last only a small portion of 8 and 25 are left as an ambiguous to be processed in future with the introduction of new features.

Table 2: Results summary after execution of IAQbSIM

Processed queries / DATASET	AMBIENT	MORESQUE
Ambiguous queries	44	114
Spatial queries	23	21
Non-spatial queries	13	68
Total Cleared Queries	36	89
Leftovers ambiguous queries	8	25
Performance achieved	**82%**	**78%**

The figure 3 presents the queries being processed in our proposed IAQM based on the information being presented above in table 2. The blue colored bar shows the values obtained from AMBIENT data set while red colored bar shows values that are obtained after use of queries of MORESQUE dataset.

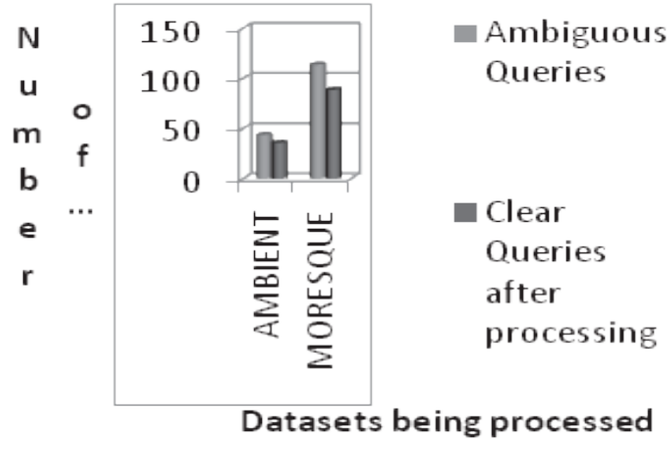


Figure 3: Results after processing datasets

While in figure 4 the query classification information is being shown for the transparent understanding.

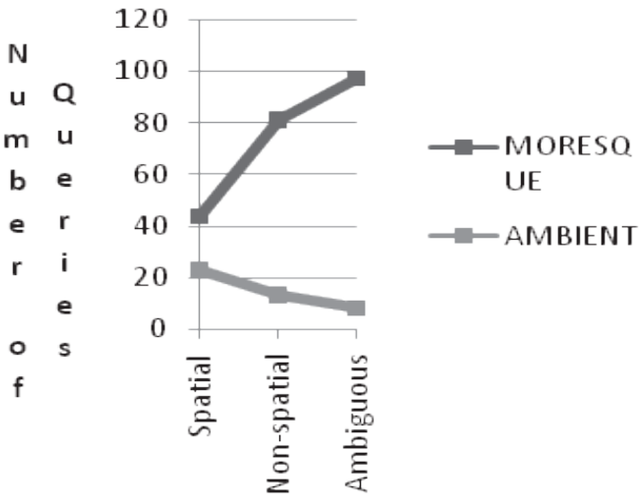


Figure 4: Queries classification chart

The performane of our proposed method IAQM according to defined criteria is depicted in figure 5. The the outcomes of our proposed method IAQM are showed in blue-colored bar while red-colored bar is to show the leftover ambiguous queries, that need to be treated in future.

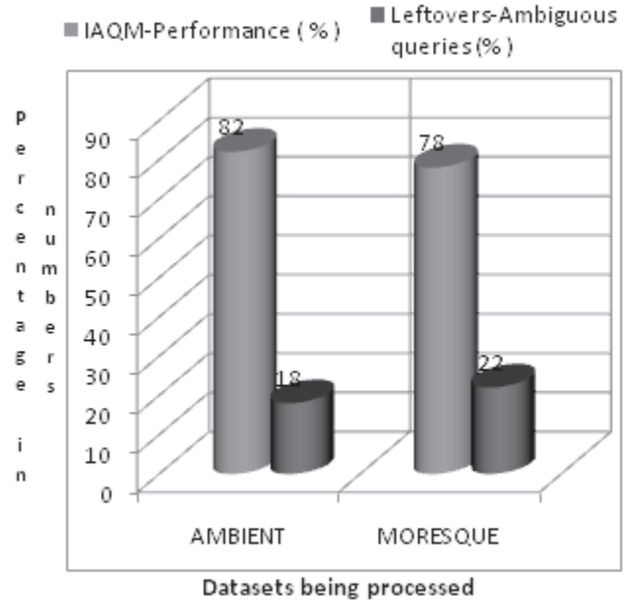


Figure .5: Results come out from different datasets

Furtherance in description of figure 5, IAQM performance and leftover ambiguous queries are shown by two legends respectively in blue-colored and red-colored bars. The X-axis represents the altered datasets that we used for the investigation while Y-axis is demonstrating the percentage that have been symbolized as numbers. Among the results it has been observed that our method IAQM significantly contributed to make the ambiguous queries as clear, while the leftover ambiguous queries i.e., 18% and 22% in the datasets AMBIENT and MORESQUE respectively need to be processed and analyzed by the researchers in future by introducing new features.

5. CONCLUSION

In this paper, we underlined the problems of identifying ambiguous queries input for the purpose of finding relevant information from a majority of the retrieved queries; which is then difficult to examine by users in response of ambiguous queries. In this paper, we recycled a total of 158 ambiguous queries from two different datasets separately with the purpose of making them vibrant so as to enhance the accuracy of the retrieved information. We carried out the process by using spatial features being present in post search results. Our proposed method titled IAQM achieved better performance and filtered 82% and 78% of clear queries in the datasets distinctly, that were known to be ambiguous in past. We also have objectives to test our method by using divergent datasets in order to verify its robustness. In addition, we also have future plan to execute a full-text analysis by combining spatial features with time-based features so as to develop a small scale search engine.

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EVALUATION AND SELECTION OF SUPPLIERS IN ELECTRONICS INDUSTRY OF PAKISTAN USING ANALYTICAL HIERARCHY PROCESS

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ABSTRACT

Suppliers are always the business drivers of any manufacturing organization. Their evaluation has assumed a strategic role in deciding the future of an organization. Supplier selection is a difficult process for the management. An organization usually has to select a supplier among several available choices on the basis of different criteria. A number of researches have been devoted to cope with this problem in different industries but less work has been done in electronic industry of Pakistan. There is a need to find an effective and precise method for suppliers' selection in electronics industry. The specific objectives of research study are to select suppliers in electronic industry, to explore factors affecting supplier's evaluation and selection and to apply Multi Criteria Decision Making (MCDM) technique for supplier selection. In this paper a model based on Analytic Hierarchy Process (AHP) is used to address the problem of supplier selection in electronics industry of Pakistan. In this study six suppliers have been evaluated on given criteria. Through the study it has been identified that "Quality" is most important criteria followed by "Cost" and "Reciprocal Arrangements" in supplier evaluation in this specific scenario. In addition to that sensitivity of criteria is also discussed. This study will help the decision makers of electronics industry in selecting best supplier for their organization.

KEYWORDS: AHP, Multi Criteria Decision Making, Supplier Selection, Electronics Industry

1. INTRODUCTION

Usually industries are integrated with different segments through their supply chain systems. These segments play important role in success of industry. Every industry requires resources and raw material. Management has to select suppliers for the supply of raw material. Supplier selection process is sensitive, ambiguous and complex. It is more sensitive when the finished products solely depend on quality of raw materials provided by supplier. Sometimes it is ambiguous and complex when there is very less margin in quality, cost, delivery and other features required by an organization. Therefore deciding about appropriate supplier is very crucial and difficult for decision makers because inappropriate selection can lead to a loss not only terms of money but quality, time and sometimes perception of organization also.

Operations of production line of most of the electronics industries essentially depend on several minor and major components being provided by the different suppliers. So the selection of supplier is considered important while making decisions about them. It has been a proven fact that the quality of equipment provided by supplier will be reflected in the original equipment being manufactured by an organization. Several factors have been identified which play an important role in deciding the best possible alternative depending on quality, reliability, delivery, performance background, guaranties, price, technical capability and financial worth of the supplier. Dikson (1966) recognized twenty three different criteria for supplier selection. According to him supplier selection is categorized in two aspects. In one way, only a single supplier meets all requirements of buyers (Single Sourcing) while in other way, a single supplier cannot meet all of the requirements of an organization (Multi Sourcing) [1]. Several techniques have been developed to cater single and multiple sourcing issues in the literature [1]. In the literature, few researchers have considered this issues as an optimization problem, and suggestions have been made to formulate an objective function to solve this issue effectively [2]. From the surveyed literature, it is evident that there different researcher has applied various techniques for supplier selection. These included mathematical modeling , cluster analysis, statistical models, case based reasoning systems, decision support systems, analytic hierarchy process, data envelopment analysis, artificial intelligence and mathematical modeling [3-5]. These methods exhibit several similarities and dissimilarities. Efforts have been made to identify the easy and least complex method in evaluating the suppliers in electronics industry [6]. This has been achieved by

comparing similarities between the methods and secondly contradiction rate between the alternatives [7]. Tangible and intangible factors for supplier selection have been examined using ANP and MOMILP which revealed the relationship of maximizing the total value of purchasing and minimizing the budget [5]. Using benefits, opportunity, cost and risks, AHP model has been utilized to evaluate the suppliers which is found to be a good choice as this method focuses on these factors from buyer perspective [4]. Selection of supplier for electronic industry is done by using FPP which resulted in minimization of uncertainty [8]. In German electronic industry an AHP decision model has been employed to evaluate the suppliers [9]. Neural network model proposed to be a new method of data collection which has been applied for wide range of multi-attribute decision making problems [10]. Due to globalization challenges and the need for fast development of the products new criteria and sub criteria have been evolved and identified by the researchers which have to be considered as the most important for supplier selection. The major factors are quality, service, cost, delivery, flexibility, reputation, technical strengths, facility and responsiveness. These criteria are employed through fuzzy Delphi, fuzzy AHP, SIR.VIKOR in the available literature [11]. Heuristic approach has also been identified as for optimized selection of supplier in MCDM [12]. These MCDM techniques have also been employed for purchasing of computers and printers by using AHP [12].

Supplier selection is a challenge for decision makers and electronics industry of Pakistan is also facing such problems. It has been discovered thorough review of literature that there is little work done in this field in Pakistan and there is a need to provide some easy and logical understanding about this problem. AHP is least complex technique; it is being used for decades for decision making. The applications of AHP are numerous in the field of CAD/CAM engineering, simulation software selection and in academia [13-14]. In all cases AHP proved to be one of the best candidates for MCDM and can easily be used to resolve such problems.

In this article a case of an electronics industry of Pakistan has been considered to derive the multi-criteria decision making model. The company designs and fabricates different electronic circuits on a large scale. The famous products of the organization are Radio Jammers, Radio Wireless Sets and Electronic Control System of Locomotives. This company requires various parts such as Printed Circuit Boards, Transistors, Resistors, Capacitors, and Inductors on a large scale. Any interruption in the supply of the parts can lead to inefficiency in the organization.

2. RESEARCH METHODOLOGY

The research methodology adopted involves the following steps;

First step involves the identification of criteria (literature review and experts' interview). In the second step questionnaire was prepared on the basis of identified criteria. In the third step questionnaires were floated to relevant audience and data was collected. In the fourth step AHP was applied on the collected data. Fifth step relates the discussion and results obtained after implementation of AHP. In the lasts step conclusion and recommendation are made.

3. MODEL FORMULATION BY AHP METHODOLOGY

In Analytical Hierarchy Process (AHP), overall hierarchy is formulated for decision problem. The hierarchy is structured from the top to the bottom level of the problem. In the highest hierarchy the overall goal of the problem is determined, then in the intermediate level, criteria and sub criteria are identified and at the end (bottom) several available alternatives are evaluated. Each criterion in the lower level of hierarchy is compared with respect to the criteria in the upper level of hierarchy. The criteria in the same level are compared using pair wise comparison. Figure-1 describes the hierarchy of a general decision making problem.

The hierarchy is constructed taking all the criteria, sub-criteria and alternatives specific to the research problem. The hierarchy is structured from the top (performance evaluation of suppliers) through the intermediate levels (main and sub-criteria on which subsequent levels depend) to the bottom level (the list of suppliers).

To determine important criteria and their relationship with the decision variables is a crucial step. This step is crucial because the selected criteria and sub-criteria can influence the final choice. Here in this study, the criteria and sub-criteria are selected based on the literature review and through expert's opinion.

The construction of pairwise comparison matrix for each level in hierarchy is the next logical step in AHP. A nominal evaluation scale is used during pairwise comparison. The scale used is a discrete scale from 1 to 9 [15]. The value 1 for equally important, 3 for moderately more important, 5 for strongly more important, 7 for very strongly more important, 9 for extremely more important and 2,4,6,8 are used for intermediate responses.

Matrix X is a pairwise comparison matrix constructed after comparing criteria pairwise. The element x_{ij} of matrix X is importance of ith criterion relative to the jth criterion at the same level of hierarchy. As the relation $x_{ij} = \frac{1}{x_{ji}}$ exists so X is a positive reciprocal matrix. Refer to" (1)".

$$X = (x_{ij})_{m\times n} = \begin{bmatrix} 1 & x_{12} & \cdots & x_{1m} \\ \frac{1}{x_{12}} & 1 & \cdots & \vdots \\ \vdots & \vdots & \cdots & \vdots \\ \frac{1}{x_{1m}} & \frac{1}{x_{2m}} & \cdots & 1 \end{bmatrix} \quad (1)$$

A prioritization technique such as the Fuzzy Programming method, the Goal Programming method, Eigenvector analysis and the Logarithmic Least Squares method, [18] may be applied on pairwise comparison matrix to get the values of weights w_i of the criteria.

At the last step, relative weights are calculated by normalizing each matrix. The relative weights are given by the right eigenvector (U) corresponding to the largest eigenvalue (λ_{max}) as:

$$X_U = \lambda_{max} U \quad (0)$$

If the pairwise comparisons are completely consistent, the matrix X has rank 1 and λ_max= m. In this case, weights can be obtained by normalizing any of rows or columns of X.

The alternatives' rating scores Rij are obtained from the comparison matrix for each ith criterion relative to alternative in lower level.

Relative priorities of alternatives and criteria implied by comparison matrix are found in the last step. Relative priorities are obtained by Eigen vector theory. Consistency index is checked at selection stage. Consistency index (CI) and Random consistency Index (RI) are required to evaluate consistency. For determining CI and RI values a Matrix size M×M approach is used. Weights are calculated from the comparison matrices. The first step is placing the values in each cell of the matrix and summing columns' value. Then the result of summations would be equated, and then the weights of the criteria/ factors are found by dividing the each column summation by the total sum of the columns.

$$CI = \frac{\lambda_{max}-1}{n-1} \quad (3)$$

Where "λ_{max}" is the maximum eigenvalue and "n" is the size of the pairwise comparison matrix. The random consistency index (RI) is computed as,

$$RI = 1.98\frac{n-2}{n} \quad (4)$$

Thus the consistency ratio (CR) is obtained using,

$$CR = \frac{CI}{RI} \quad (5)$$

The computed result of CR is recommended to be consistent if CR value is less than or equal to 0.1 or 10%. In the final step, weights are multiplied with criteria to get preference matrix and addition of results gives composite score of criteria.

4. APPLICATION OF AHP FOR SUPPLIER SELECTION

In this study, electronic industry of Pakistan has been chosen as a case study. Data for six suppliers have been collected from the case company for specific demand of LM324 (general purpose transistor). On the basis of collected data and expert opinion, AHP technique has been selected for resolving this problem. In the current study, the "Goal" is evaluation and selection of suppliers in electronic industry of Pakistan. Goal is placed at zero level of hierarchy. Main Criteria are placed at the first level below the goal. Sub-Criteria are placed below main-criteria at level two. At the last and third level alternatives have been placed which are supplier 1 to supplier 6 in this specific case. The alternatives taken are suppliers dealing in electronic components internationally.

After the construction of hierarchy the main and sub criteria have been determined. The main and sub criteria are defined through expert opinion of decision makers dealing in procurement of electronic components. These criteria were also validated through review of research survey as explained in table-1

Quality of products to be supplied, delivery of orders, cost of components and handling cost, financial stability and worth of a supplier are the key criteria mentioned in literature [15-20]. While purchasing electronics components, the pre-shipment inspection and testing is not easy as compared to mechanical components therefore the issues of reliability, warranty and after sale services are very important. Therefore researchers have considered services as a major factor for consideration of supplier. Similarly, perception and customer relationship management has also been selected as one of the important criteria for selection of the vendor [20]. Last three criteria in above table-1 have been included from expert opinion of practitioners associated with this area.

The next step is pair wise comparison of criteria and sub-criteria. At this stage level of importance of each main and sub criteria is defined. Relative judgments of criteria have been tabulated in table-2 . The judgments are based on expert opinion of practitioners of this specific area.

To minimize the computational efforts Excel Sheets® and Expert Choice® software have been incorporated. After pairwise comparison weights of criteria have been calculated by right eigenvector analysis method. In the next step, rating score of suppliers have been calculated

from pairwise comparison matrix for each criterion. In the last step, decision has been made on the basis of priorities of criteria and alternatives.

5. RESULTS AND DISCUSSIONS

In this paper three aspects have been studied by using AHP. First of all, Priorities of alternatives have been assessed, second it has revealed performance of criteria by decision maker and at the last best from all of available supplier is selected. In this study, AHP has been used to evaluate importance and priorities of factor for supplier selection in electronic industry. The case has been evaluated by considering ten main criteria and seventeen sub-criteria as shown in Table 1. In the each of six suppliers has also been assessed by considering the same criteria Fig 3 presents the evaluation of each supplier against specific criteria. Comparison matrix every xij position corresponds to geometric mean of experts opinions' involved in decision making processes. In this case, to access the judgment of decision makers, each of them has been inquired about the importance of criteria over other. Assessment of judgment of decision makers resulted "Quality" as the highest importance with a weight of 0.120. "Cost" is lagging "Quality" with a weight of 0.118. "Reciprocal Arrangements" was rated at number third with a weight of 1.11. Figure 2 presents the graphical representation of criteria according to the level of importance and weights.

As "Quality", "Cost" and "Reciprocal arrangements" are prior of all criteria so their importance is higher than all other factors. Evaluation of suppliers strongly depend on these criteria. Supplier 3 is good in "Quality", "Cost" and "Reciprocal arrangements" than other suppliers. Supplier 3 has been rated marginally higher than 1, 2, 4, 5 and 6. Priorities of criteria directly affect the decision. Change in priorities of criteria changes the final results. Fig 4 and 5 presents the changed results due to variation in priorities of criteria.

Suppliers' evaluation is sensitive to weights of criteria. A minor change in priority of criteria changes the result. Supplier 3 is on top, supplier 4 and 6 are substantially closer when "Quality" is prior to all other criteria as shown in Fig 3. However supplier 3 is replaced by supplier 1, when quality is slightly compromised. The gap between both suppliers 4 and 6 marginally increased when "Delivery" and "Impression" is prior to all other criteria as shown in Fig 4. Similarly the gap between supplier 1 and 3 marginally decreased when "Cost" is prior to all other criteria. There is a difference in stated preferences and revealed preferences of criteria by decision maker. AHP has highlighted this difference. In the stated preference of the decision maker, the more importance has been given to "Quality", "Cost" and "Delivery". In stated preference "Delivery" has third top priority by decision maker but in revealed preference it has not such importance. It is only 8.1% important. The AHP method determined the supplier 3 as the best supplier. The overall inconsistency is 0.06 which is within the boundary 0.1 with tolerance ±10%. Fig 6 presents the final result of the selection of suppliers

The components provided by supplier 3 have good quality relative to other suppliers. It offers comparatively less cost. It is good in reciprocal arrangements and service. It is flexible in lead time and negotiations. It is relatively good in delivering the product on right time and right place. Specifically in this case "quality", "Cost", "reciprocal Arrangements" and "Service" has more weight, supplier 3 is good in these criteria so it is the best choice. Quality of components provided by supplier 1 is slightly lower than the quality of components provided by supplier3. Supplier 2 offers comparatively high cost, it is good in delivering products than all other suppliers, so supplier two is third choice, similarly supplier 4,5 and 6 are ranked on same criteria.

6. CONCLUSIONS

Through literature review and expert opinion, it emerges that selecting a supplier is difficult and complex multi-criteria decision making problem. Decision made on alternatives depends on different criteria. Supplier evaluation is sensitive to priorities of criteria. Frequently, these evaluation criteria support or oppose each other. This specific problem is resolved by using comparable scales of criteria values. This study presents a structure that can be used to formalize the process of evaluating the suppliers in electronic industry. "Quality". Similarly "Delivery" has second highest importance but AHP resulted "Cost" as third highest importance but AHP, resulted "Reciprocal Arrangements" as third high important criterion. Firstly, difference is due to inconsistencies in judgments, made by experts during assigning weights of preferences. Secondly, continuously changing human behavior, human mode, working environment and thoughts affects the human decisions. AHP proved to be the best candidate for multi-criteria decision making and human error can be eliminated or reduced by AHP effectively in decision making

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APPENDIX

TABLES

Table.1 Selection of Criteria and Sub Criteria

Main criteria	Sub-criteria	Reference
Delivery	Lead time	Shyur and Shih [15]; Wang, Huang, and Dismukes [17]; Hua, Gong, and Xu [18]
	Order delays	
Quality	Product quality	Liu and Hai [19]; Shyur and Shih [15]; Jharkharia and Shankar [20];
	Customer complaint rate	
Cost	Price	Shyur and Shih [15]; Jharkharia and Shankar [20]; Wang, Huang, and Dismukes [17];
	Exchange rate	
	Transport cost	
	Unit cost	
Financials	Financial position	Liu and Hai [19], Shyur and Shih [15], Wang, Huang, and Dismukes [17];
	Profitability	
Flexible	Short lead times	Liu and Hai [19], Shyur and Shih [15], Stevenson [16]
	Solve conflict	
Services	Warranties & claim policies	Hua, Gong, and Xu [18].
Relationship	Long-term relational development	Shyur and Shih [15], Liu and Hai [19], Jharkharia and Shankar [20].
	Open communication	
	Reputation	
	Mutual trust	
Impression		Expert Decision Makers
Packaging ability		Expert Decision Makers
Reciprocal arrangements		Expert Decision Makers

Table 2: Pairwise Comparison of main criteria

	Delivery	Quality	Cost	Financials	Flexible	Service	Relationship	Impression	Packaging	Reciprocal A
Delivery	1	1/4	1/2	2	1	1/2	1	1	1	1
Quality	4	1	1	1/2	1	1	1	1	1	2
Cost	2	1	1	3	1	1	2	1	1	1/2
Financials	1/2	2	1/3	1	1	1	1	1	1	1
Flexible	1	1	1	1	1	1	1	1	1/2	1/3
Service	2	1	1	1	1	1	1	1	2	1
Relationship	1	1	1/2	1	1	1	1	1	1	1
Impression	1	1	1	1	1	1	1	1	2	1
Packaging Ability	1	1	1	1	2	1/2	1	1/2	1	2
Reciprocal Arrangements	1	1/2	2	1	3	1	1	1	1/2	1

FIGURES

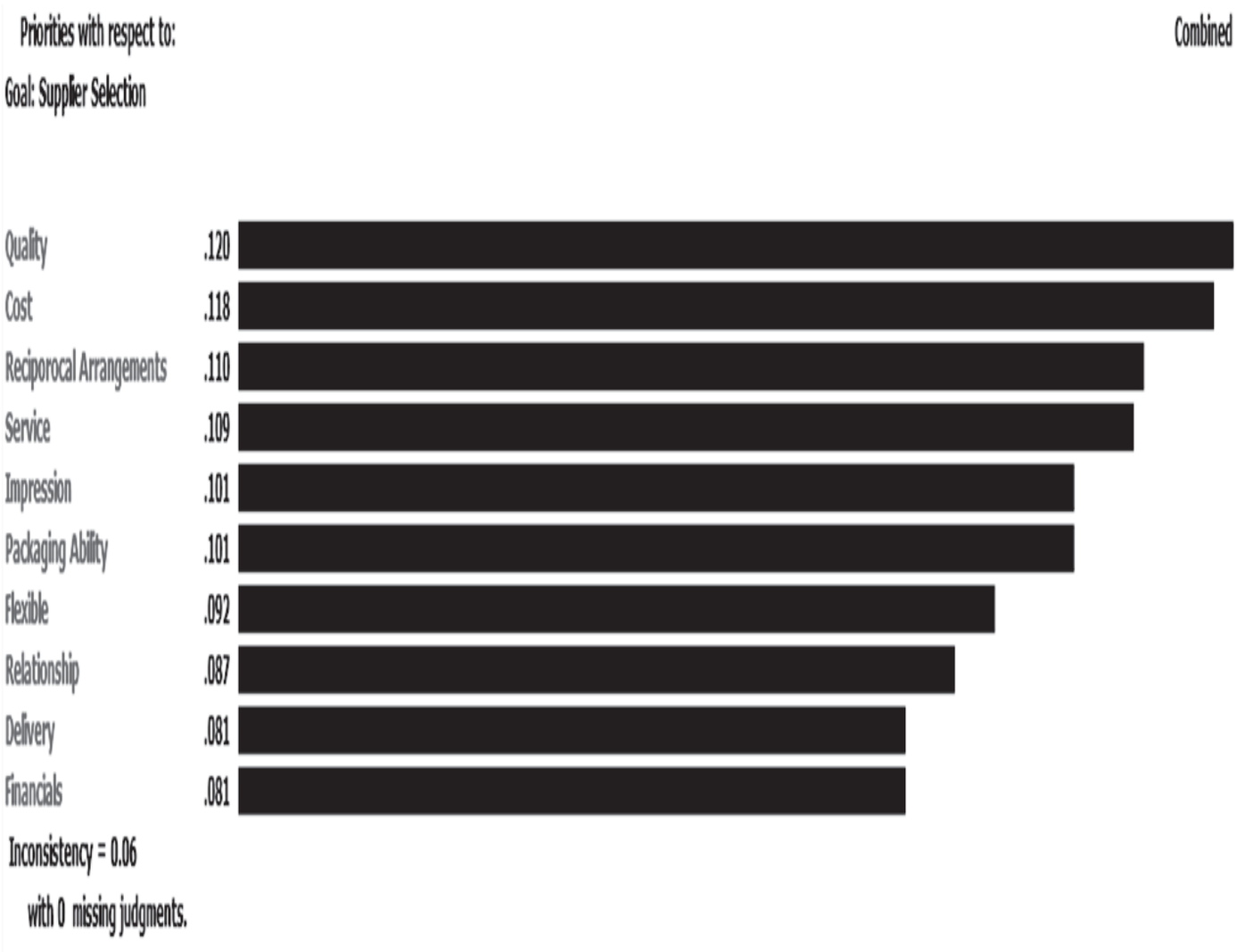


Fig 1-General Hierarchy for evaluation of problem

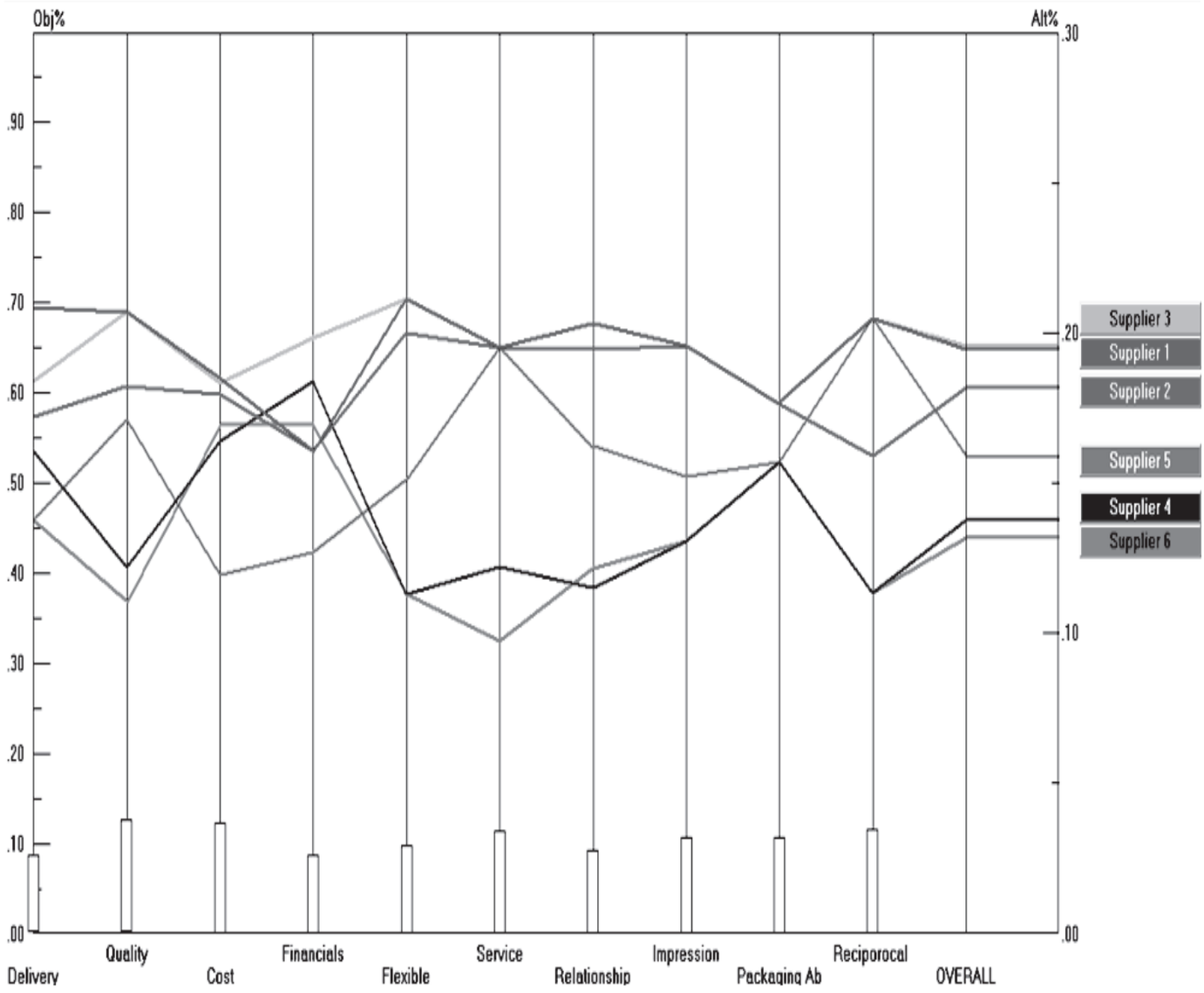


Fig 2 Priorities of criteria with respect to goal

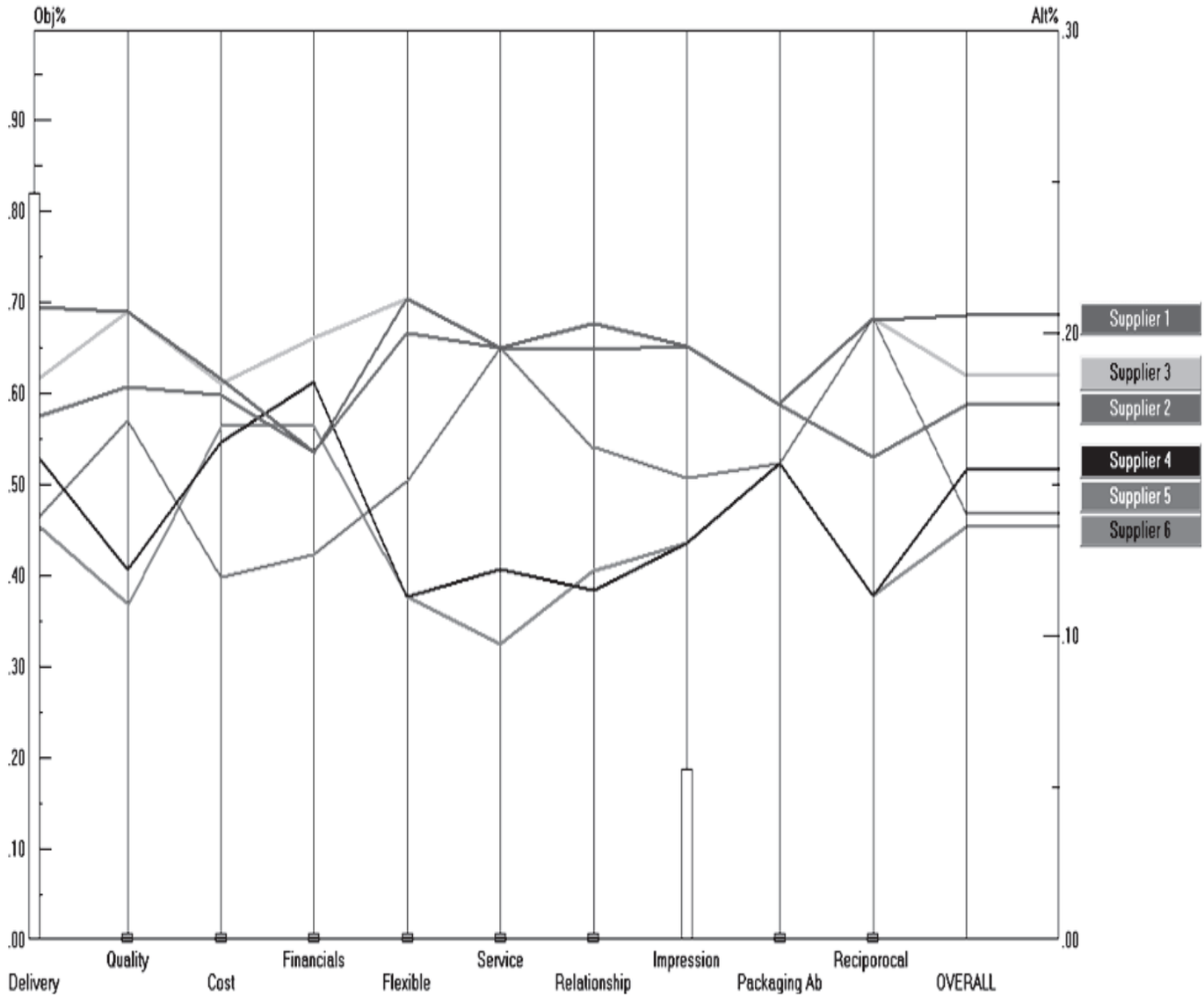


Fig 3 Sensitivity Curve for supplier rating

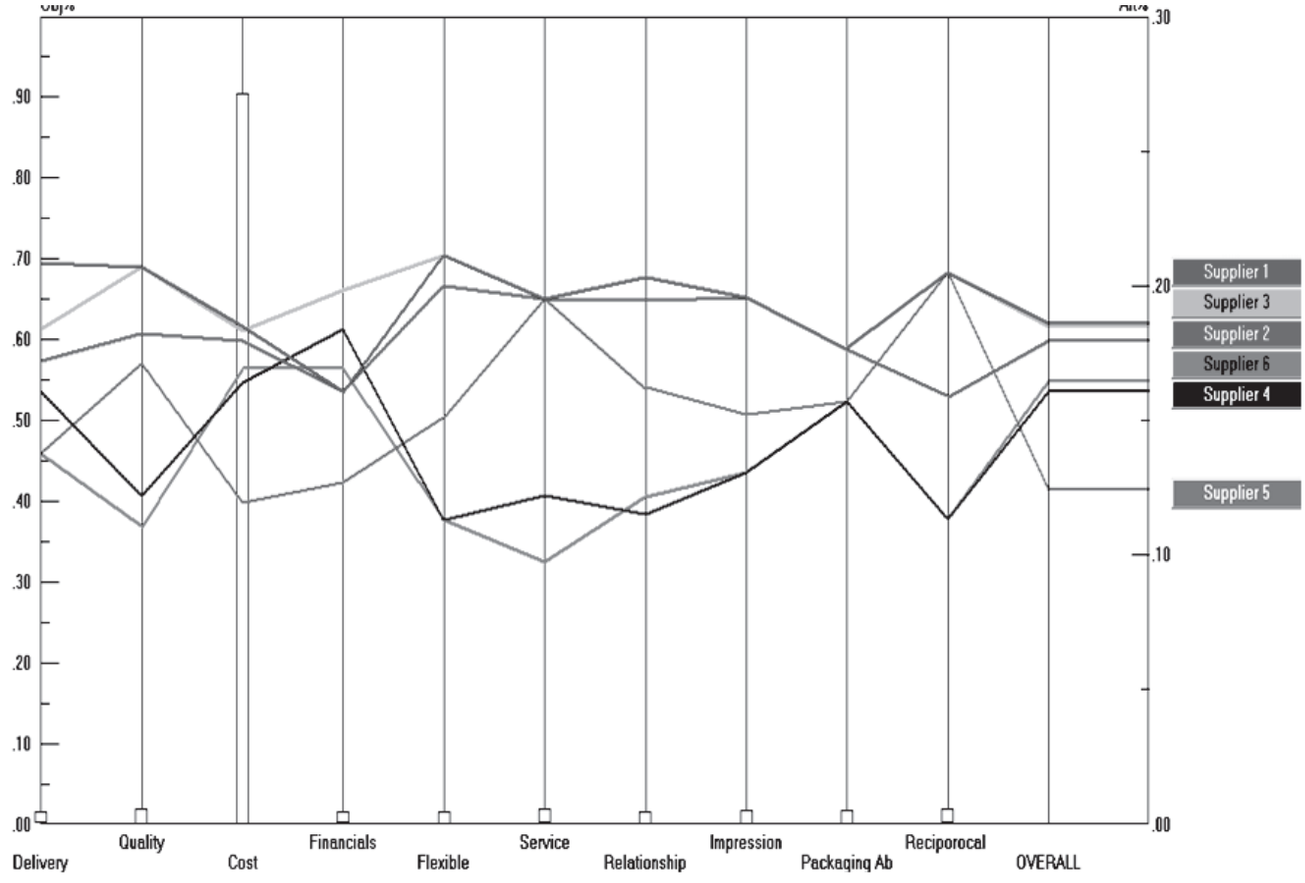
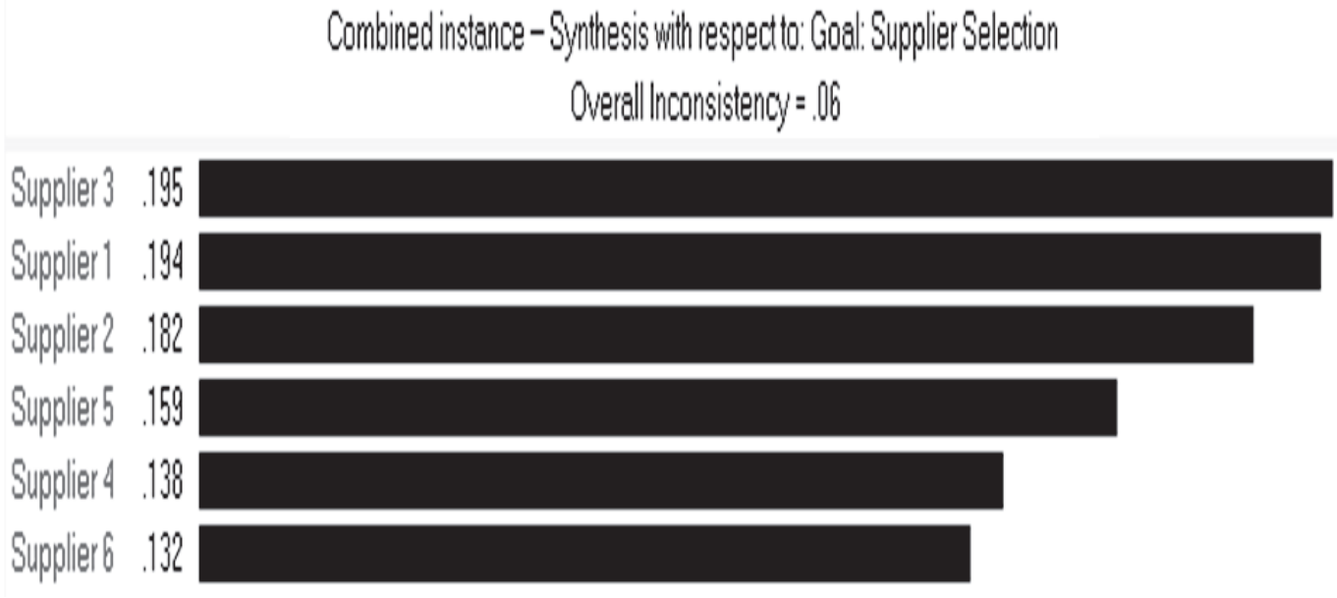


Fig 4 Priorities of criteria with respect to goal



Fiq 5 Sensitivity curve after further changing the criteria priorities

FUTURE INFRASTRUCTURE OF IOT: LARGE SCALE DEPLOYMENTS OF IOT COMPONENTS

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ABSTRACT

Non PC devices and gadgets are increasing day by day, due to this increase and all the time connectivity of the devices to the Internet raised many challenges; such as memory shortage, IP configuration space, energy consumption and security issues. Current infrastructure of internet of things (IoT) is still not mature enough to handle all of these changes. Although, many attempts have been made to address these challenges in the context of IoT, but the proposed solutions either address the specific issue or are very generalized. Thus there is a need to look at the proposed approaches and solutions from a holistic perspective to uncover future benefits and increase applicability and integration of the solutions proposed in literature for IoT. Hence, in this paper and attempt have been made to gather and analyze all the existing and proposed solutions in the literature based on different parameters. Looking at the literature this survey helps in developing the understanding of the existing IoT infrastructures and provide insights about future infrastructure for IoT components and/or devices. The given future directions are based on the focused survey of many research papers.

Keywords:Future Internet; Infrastructure of (IoT); Networks; Smart objects; heterogeneous devices; Cloud computing; Internet of Things.

1. INTRODUCTION

The term Internet of things (IoT) was first used in 1999 by Kevin Ashton [1] in the context of supply chain management. But now it is used in a broader perspective. Hence, the connected devices not only access information from the internet but are following the protocols the internet uses to store information. Due to use of modern technology like Wi-Fi and Bluetooth there has been a very rapid increase in data utilization and exchange. The size of data related to users has become so big that managing it became a challenge. In communication the deices use common grounds to make communication easy between the users. Thus the use of Radio-Frequency Identification (RFID), tags, sensors, mobile phones, etc. is increased. RFID is usually interacting through a unique addressing scheme [2]. Ubiquitous computing became an emerging technology now a day. It uses resources which can be made available anywhere at any time. Cloud computing has become well-known lately because of its provision of making resources on the network available for shared use. Cloud helps users to save their money on processing resources, software and infrastructure and it is easy to use. In cloud the available resources on the network are utilized to perform the assigned task. The data are handled in third party data centers. Cloud is a joint pool of resources which is provided on claim/demand. Cloud computing has

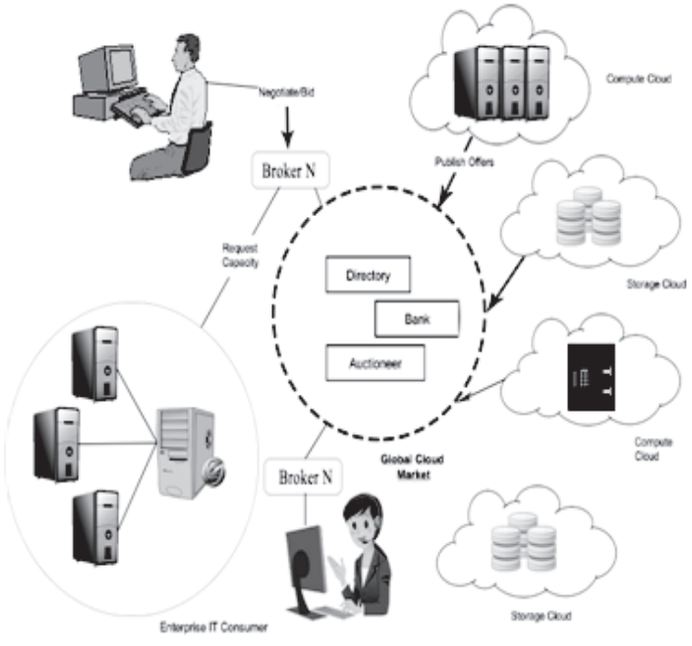


Figure 1. Global Cloud exchange infrastructure for trading services.

become a highly demanded service or convenience due to the advantages of high computing power, low cost of facilities, high performance, scalability, low-priced software, ease of access as well as availability. Cloud dealers are facing progress rates of 60% per year, but as this is a new field in its beginning, cloud computing still has flaws that need proper attention and there is a need to make working on these systems more users friendly.

The devices connect to the clouds and remain on the network for accessing resources or data are called smart objects, i.e., any hard ware on network is a smart object. An object is considered a smart objects [4] that have the following features:

- It is hardware and have features like ability to process and store data.
- It can be discovered on a network and can communicate back.
- It has a unique ID, physical address and a name.
- It can process physical data with the help of actuators.

From Figure 1. we can easily understand how cloud computing infrastructure works and how data break down and travel into different communication mediums. In cloud computing infrastructure, data are stored into central location and on demand every device can access the data. In future it has to be figured out that how huge amount of data could be managed and how future infrastructure will be able to handle large number of IoT devices requesting connections and data access.

2. PROPOSED SOLUTIONS

In this section we will go through all the solution that are proposed in recent years and we will also see their advantages and limitations. In next section we will discuss some of the practical implementations, after that we will compare all the discussed technologies to see which ones can be practically implemented and which ones are not and what are the possible reasons that make those approaches impractical. In the last section we will discuss some open issues and conclude the paper.

(I) NGSON/SON

IP traffic in the global level is increasing and in near future the challenging situation will arise [9] because most of the IoT objects or devices are non-PC. So for the increase in both IoT devices and IP traffic expect some new requirements from the existing infrastructure, such as support for reliable and scalable content distribution, IP traffic management, privacy, security, trust, mobility etc.
However, the current infrastructure of Internet was never designed for fulfilling those requirements [9]. Some organizations are currently working in these issues and they have introduced new concepts and designs that are to be helpful in above mentioned situations. For example, NGSON (Next Generation Service Overlay Network [6]) Standardized by IEEE that are providing more efficient services like video streaming over a Service Overlay Network(SON) based on custom user context. Besides this a network infrastructure for IoT is proposed in [5]. This infrastructure has following characteristics:

- Infrastructure is context-aware
- It supports edge diversity
- It uses virtual network instance as a service
- It is evolvable network infrastructure

There is a drawback in this infrastructure and that in its context manager or context-aware feature the context support is lacking because there is no support for user-center services

(ii) Daidalos/ SWIFT

As discussed above there is a large increase in IoT devices and mostly these devices are non-PC devices the next problem we will have to face in such a situation is security and privacy issues in communication and end devices. There are many methods available to overcome this problem like pop-ups and warnings about certificate mismatches. The EU projects name Daidalos [10] and SWIFT [11] are addressing the same problem and there are several solutions presented in these projects.

In this context [12] proposed a new infrastructure for IoT. There are two major directions in which this infrastructure can handle security and privacy in near future, one is Identinet, in which identities are at the end point where all the communication takes place these identities may classify all the entities like persons, software and devices. Second direction is digital shadow. Digital shadow takes data as entities using services and nodes in special meaning that help users to interact with the multiple entry points to access the real world data without interrupting the actual view on the data. There are two minor issues with this approach. First, that it is only applicable in SWIFT[11] and the second one is that there arises uncertainty when the environments become dynamic and collaborative.

(iii) IPv6 Mapping Scheme

IoT concept is very vast, every physical device that has some unique id and some memory storage called smart object [13] like QR(Quick Response) or matrix barcodes, Universal Resource Locators (URLs), Radio Frequency Identification (RFID) these all are connected to some network called internet of things and due to increase in there devices there are problems in identification and assigning address or IPs

so a solution provided by the authors in [13] that is based on Internet Protocol (IPv6) mapping. According to authors everything that can be connected to the IoT becomes extendable through this infrastructure or protocol. By the use of IPv6 mapping scheme [14] we can assign and utilized more addresses than before.

(iv) TR(time-reversal)/5G

As we discussed that in future there will be large number of smart objects and IoT devices will connect with each other then the major challenge that we will be facing would be energy issue. According to [16] a new technique or an infrastructure for IoT is introduced for objects named as TR(time-reversal) It is an ideal paradigm for IoT. According to this technique we can reduce the power consumption as well as interface alleviation. through TR system we can support multiple concurrent users that are active and provide better and efficient battery life. This infrastructure reduces the computational power and complexity and also the cost of devices that are connected to the terminal nodes. TR system also supports the various quality of Service QoS options. The system also provides the additional physical-layer that enhance the security and privacy in IoT for customers. The system also accommodates heterogeneous devices that are located in terminal nodes. Recently the researchers are working on new technology called 5G in mobile telecommunications and that will be more efficient and faster that current 4G standards. According to [15] the major idea in this system is non-orthogonal multiple devices access strategy, where massive IoT devices will be connected According to TR infrastructure for IoT these issues are already resolved and mathematically proven [16].

(v) VM (Virtual Machine)

The concept of smart cities and smart homes are also related to IoT, with the passing time rapid changes are taking place in technology as well as the concept of IoT. In near future when there will be large number of devices and other smart objects connected with each other two major problems can occur. The first one is computational complexity because an ordinary device with limited processing power cannot perform complex calculations and the second is the storage issue or memory limitations in devices so there is a need to design new infrastructures

for these problems. The authors in [17] are addressing the same problems and the solution they proposed is related to "Cloud Computing" and "Cloud storage". Cloud computing is very hot topic in such situations. There are many solutions provided in this paper and the concept of VM (Virtual Machine) is introduced. Cloud is also providing the services all around the world. The proposed system is Market-oriented. According to the proposed system cloud computing will be very helpful in near future for storing and computing complex problems that are impossible for ordinary devices. According to the system virtual machine or device will be assigned to every device that will perform the specific operations according to the needs of that device. The drawback of this system is wastage of energy and security issues may also arise.

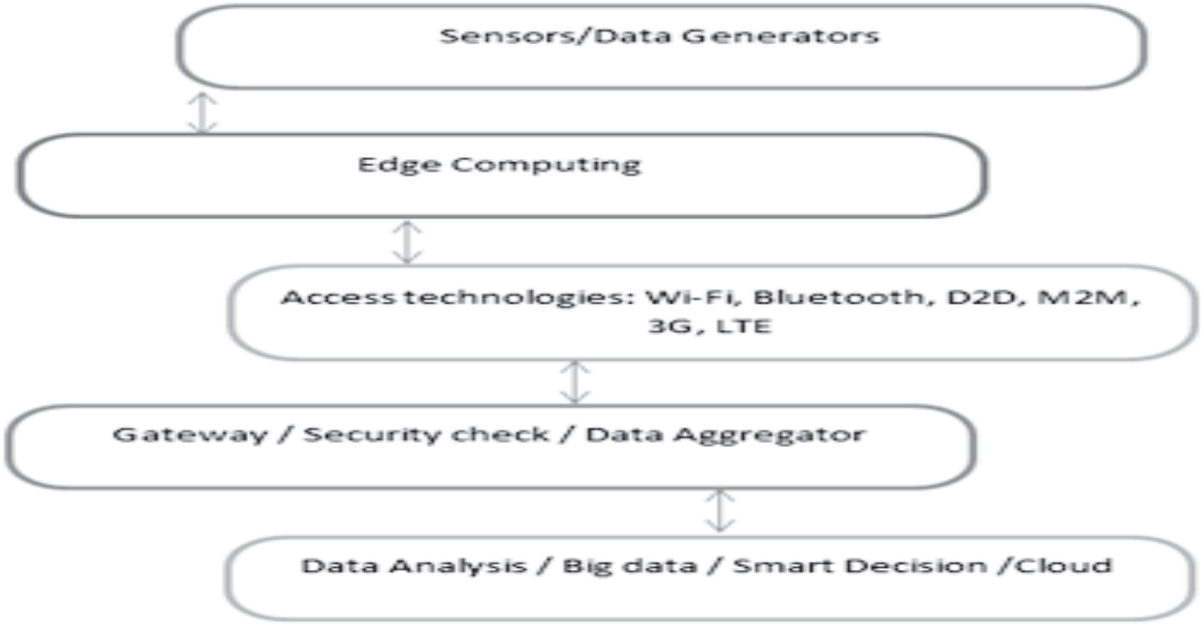


Figure 2. General Hierarchy of Current Technology

(vi). LEONORE

IoT application models work in such a way that IoT devices have some external dependencies and they can only send and receive data at their end terminals nodes. This imply that these models are based on layer architecture whose bottom layer is compatible with IoT objects or devices and the other layers like business and logic layers are involved in some other process. In this way when large scale IoT components and heterogeneous devices are connected at the bottom level then, it becomes very difficult to handle data at this ordinary infrastructure. In the domain of smart cities and large scale developments a new infrastructure has been proposed that is named as LEONORE [19], it is a service oriented infrastructure which provides software package that facilitates the heterogeneous terminal devices. After applying this infrastructure, the devices are able to controls their processors by themselves. The proposed solution is also applicable in pull-based as well as push-based. Pull-based is usually used in configuration management systems so that devices are schedule and provisioning runs to off-peak time, on the other hand push-based solution allow devices to control over the applications that are installed on them also the software updates and security fixes. The proposed system is also tested based on real world scenario and the statistical results prove that this infrastructure is much more efficient and fast in the domain of Smart cities and large scale development of IoT than the ordinary layer architecture. There are some issues at gateway level that still need more research.

General hierarchy of current technology for IoT connectivity and authentication is given in Figure 2.

3. SENSING CHINA (EXPERIMENT)

In the field of IoT many experiments have been carried out. According to [18] smart buildings using IoT can be used to improve efficiency in communication and quality and reduce wastage in terms of time. The "Smart Cities" term has been introduced because those cities use intelligent and efficient technology. According to [18] survey paper, an experiment project was launched named 'Sensing China' in china in June 2010 after the successful completion of the project everything that was involved in this project had identification tags. The benefit of these tags was, that every device can share information and can broadcast the data through some communication medium. People could track information and monitor the data through objects. In near future these projects play the key role in development of IoT. The Authors believe that in future these concepts and designs will become very common.
The main future infrastructure of IoT is shown in Figure 3.

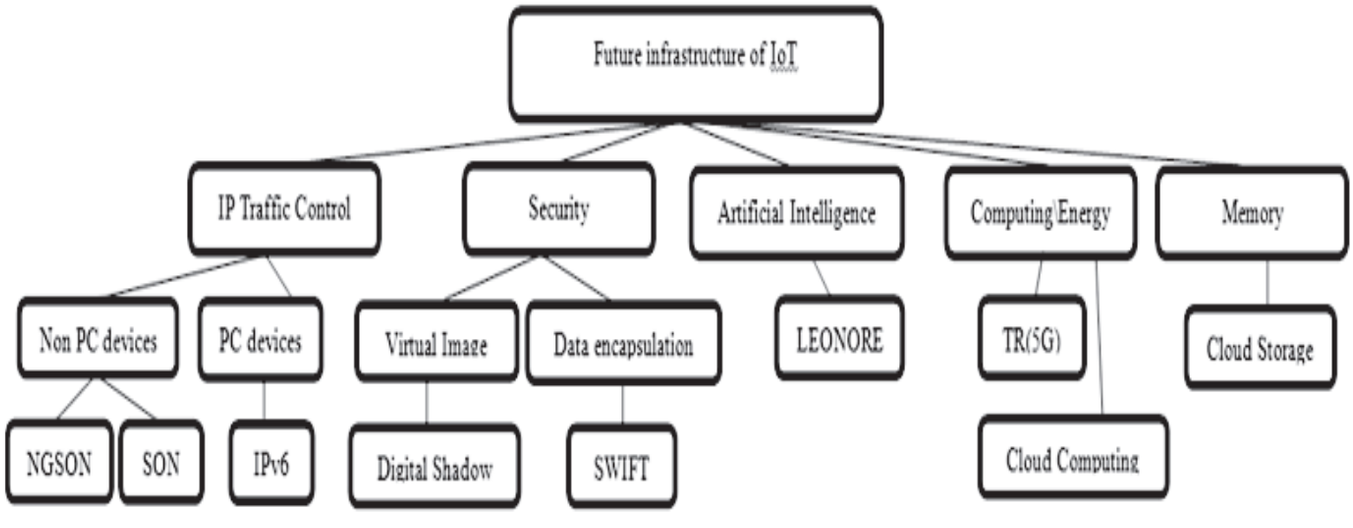


Figure 3. Future IoT Infrastructure

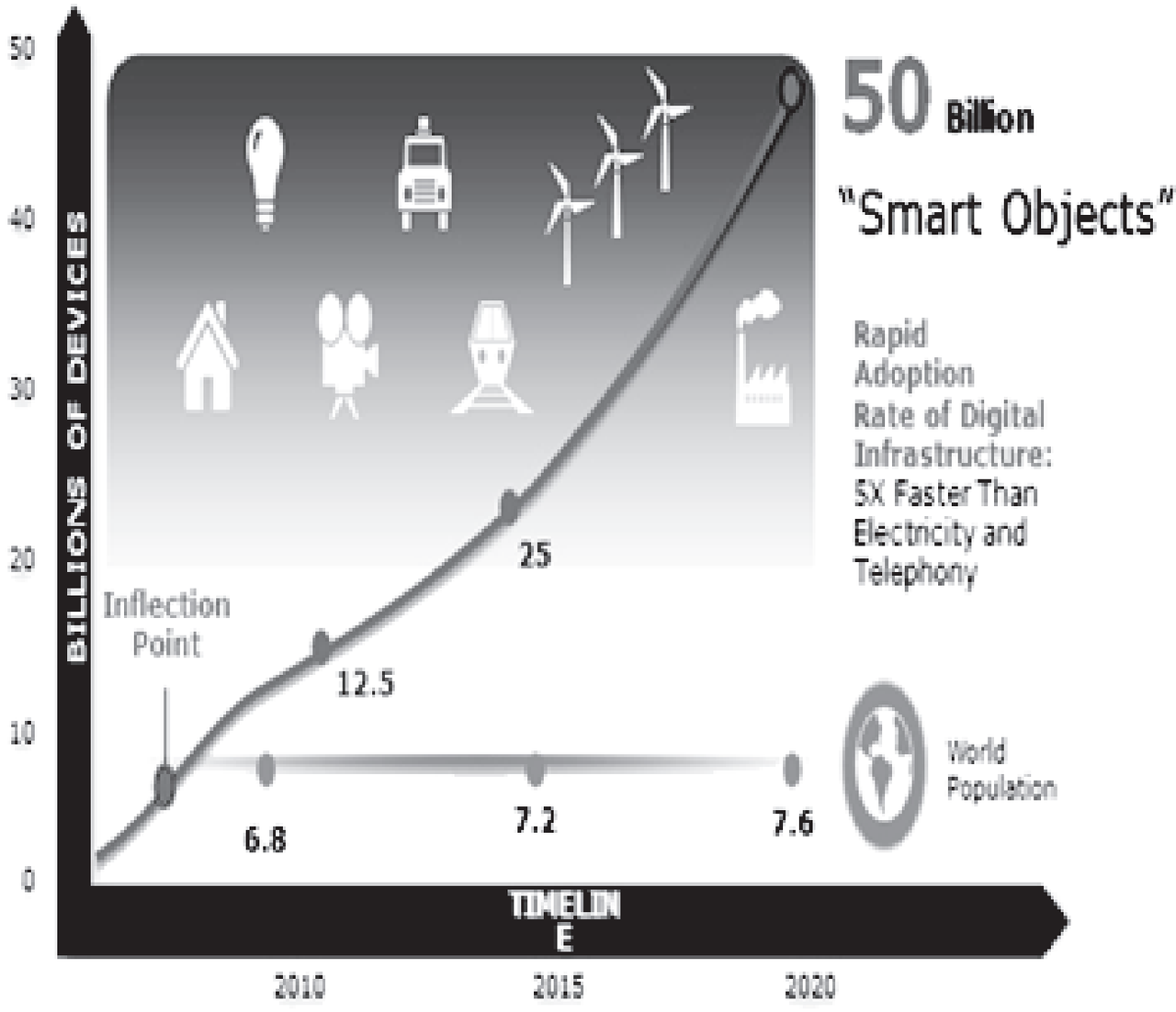
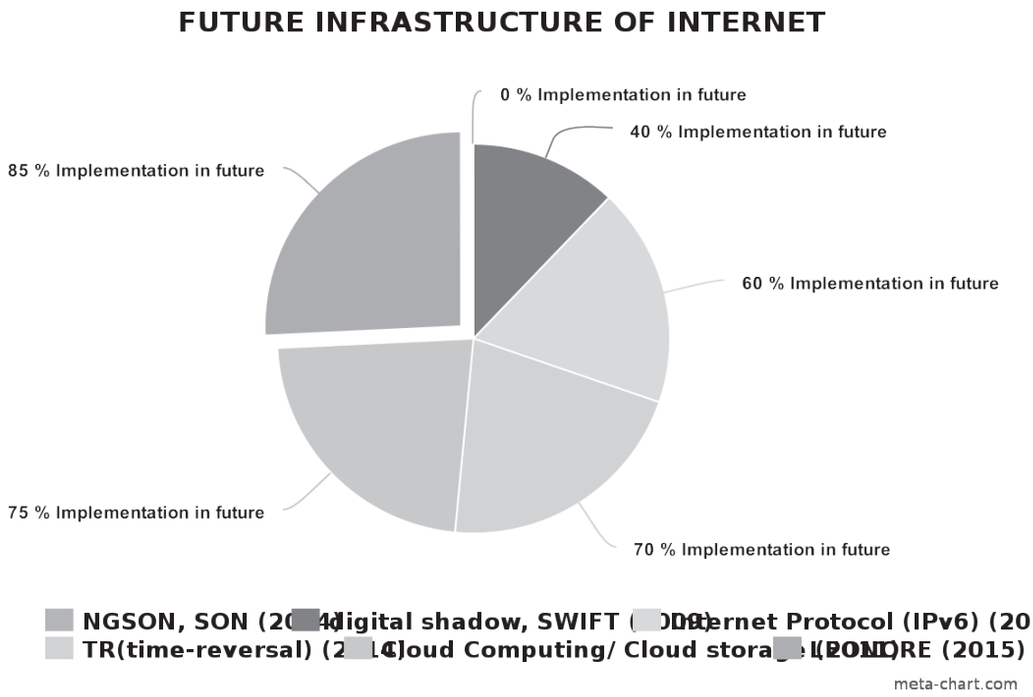


Figure 4. Increase in IoT devices in future.



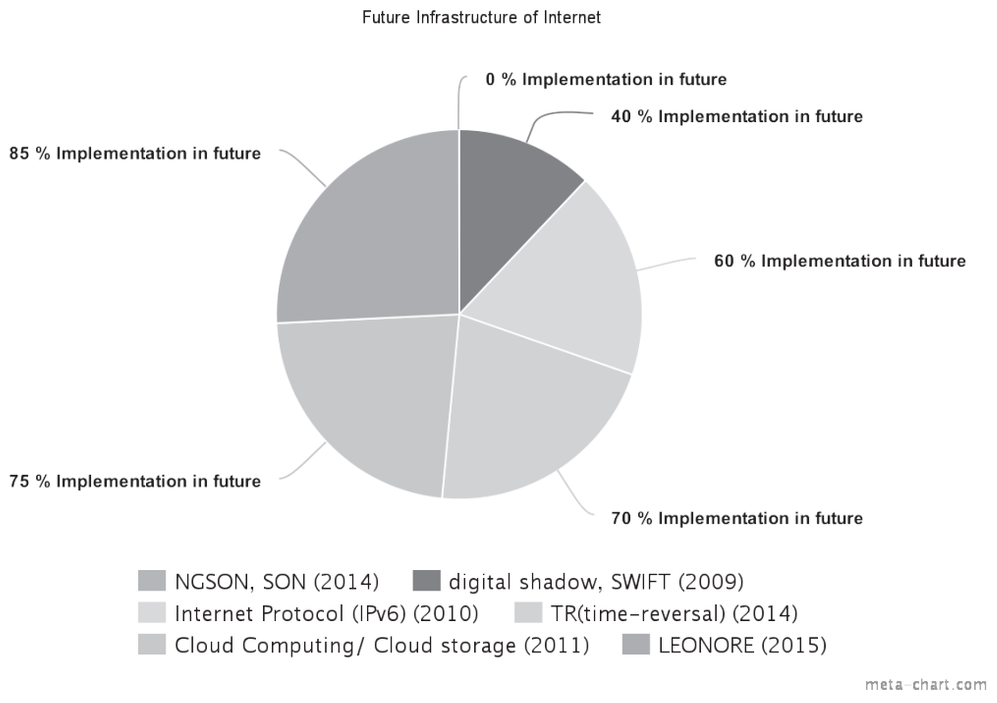


Figure 5 (a)(b) Future infrastructure and technology applicability in IoT

Table 1: Performance Evaluation of IoT Solutions

Infrastructure / Technology	Year of Propose	Practical Implementation	Statistical Result	Details
NGSON , SON [9]	2014	Test phase	nil	To control IP traffic for non PC devices
Digital shadow SWIFT [12]	2009	nil	40%(paper based)	The concept of virtual image or data encapsulation
Internet Protocol (IPv6)[13]	2010	Implemented	60% (current Internet)	A mapping scheme to control IP traffic
TR(time-reversal) [16]	2014	Test phase	70 Expected	The concept of 5G / Efficient computation / Energy Efficient
Cloud Computing/ Cloud storage	2011	Implemented	75%	The concept VM (Virtual Machine)/Storage
LEONORE [19]	2015	Test phase	85% (proven through Experiment results)	AI (Artificial Intelligence) at terminal devices /Software base Solution

(VI) PERFORMANCE EVELUATION & COMPARISON

There are so many IoT devices that are rapidly increasing and connecting to the network, according to the recent study [9]; that 80% devices are non PC devices and in near future it is very difficult to handle the entire infrastructure. We have already discussed different infrastructure and the techniques that are proposed recently. Figure 4. shows state that how much increase in these devices in near future.

In the Figure 4. we can see that as the time passing we should have need to a new infrastructure that will be capable to handle the huge increase.

So according to the given statistical results that are gather form different research papers we can draw a pie chat that is given in Figure 5(a) and (b).

There are many things to be compare like IP traffic control, storage in IoT devices, security, artificial intelligence , data backups , computational complexity etc in all these aspects many infrastructures have been proposed but as compared to all the infrastructure LEONORE[19]is giving the best results according to the researchers this infrastructure is tested in real ground and the experiments prove that in near future this infrastructure can be implemented because according to it when the device has ability to learn and respond accordingly, at that time it will be very easy to manage everything. Moreover, in near future devices will need large memory for that Cloud Computing/ Cloud Storage [17]gives the best results and in near future it is highly likely that everything will be on cloud. In the context of TR(time-reversal) [16] or 5Gthe research shows this infrastructure could be implemented in near future because energy is the main issue increasing day by day so it could be the best solution but in terms of computational resource to cloud computing technology is matchless. According to [14] IPv6 solution could not be helpful in near future due to enormous increase in IoT devices. So in near future we need an infrastructure that will provide all the aspect at the same time like energy, machine learning, security, complex computation solution, high storage capacity etc.

5. OPEN ISSUES

Increase in ubiquitous computing, smart devices, architectures and IoT technology many things are going to face rapid change in near future and there are many emerging technologies and infrastructure that could cope with the emerging challenges. In order to meet the future, challenges these infrastructures need to be designed carefully. Research shows that machine learning and artificial intelligence(AI) based contextual and self-configurable solutions will replace the existing technology. Literatures points out that in future there will be large number of non PC devices hence focus remains on the connectivity, security, data intensive devices and cloud based solutions. Besides, intelligent technology and increased connectivity bring new challenges. Moreover, memory issues and energy issues, are always challenging and lot of work is required there in these field.

6. CONCLUSION

In this paper a survey of the various infrastructures available in literature is presented with the focus on the challenges of the Internet of Things technology. We reviewed the focused literature on various infrastructures recently proposed for IoT in terms of memory needs, processing needs, connectivity. It turned out that various proposed architectures for future IoT technologies have their benefits and limitations and those frameworks suggest diverse approaches and solutions. Thus, this survey provides the initial insights in the rapidly growing field of IoT. Based on the facts in existing literature the emerging trends are highlighted in this paper. In future we aim to explore the real world cases for such technology with the experimental data and results.

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