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## ESTIMATION OF GLOBAL AND DIFFUSE SOLAR RADIATION FOR NAWABSHAH, SINDH, PAKISTAN

Asif Ali Abbasi\*, M. Shahid Qureshi\*\*

### ABSTRACT

The study of solar irradiation has been carried out for the first time over Nawabshah Sindh, Pakistan. In this study twenty two years (1983-2005) of measured data of bright sun shine hour of this region have been used to estimate global and diffuse solar radiation. Regression coefficient a and b have been calculated for the first order Angstrom type correlation for the city using relationship given by Tiwari & Sangeeta. The results obtained via four empirical models (Angstrom 1924, Liu & Jordan 1960, Page 1977, Hawas & Muneer 1980) were compared with values obtained from NASA Satellite based data (Global, diffuse). A good agreement was found between both models. The global irradiation possesses larger value for the months (April –July), for the period of study. The seasonal variation in solar radiation tends to be synchronous with energy demand in Nawabshah as higher magnitude solar radiation in the summer are a major contributor to heat gain in buildings, increased air conditioning loads, and thus peak electrical demand. If solar becomes a significant portion of the energy resource mix then technologies may compensate the increasing energy demands [1].

**Keywords:** Direct and Diffuse Radiation, Angstrom Coefficient

### 1. INTRODUCTION

The radiant energy of sun is the only source of energy that influences the atmospheric motion and can be used as alternate energy resource in view of future depletion of fossil fuel reservoirs. Information about global solar radiation is important for wide variety of application, e.g. solar energy system's design, building's design, crop drying, photosynthesis etc. Solar radiation data is collected in major parts of world but is unavailable in developing countries like Pakistan which can not afford costly instruments [2]. So it is important to develop methods to estimate the solar radiation on the basis of available metrological data. Several formulas have been developed by various authors to estimate the amount of global solar radiation on horizontal surfaces using various parameters, such as sunshine duration, cloud cover, humidity, maximum and minimum temperatures, wind speed etc. Iqbal proposed a linear relationship in terms of clearance index for estimating monthly mean diffuse solar radiation [3]. Hepbasli and Ulgen correlated the ratio of monthly average hourly diffuse solar radiation to monthly average hourly global solar radiation with the monthly average hourly clearness index in form of polynomial relationships for the city of Izmir, Turkey [4]. Recently, Wu et al. 2007 [5] used the metrological data of Nanchang station (China) to predict daily global solar radiation from sunshine hours and dew points. Best result was achieved by model which uses sunshine duration.

Firoz Ahmed studied the prospects of solar energy utilization in Karachi without comparing to measured data [6]. In this study it is attempted to calculate Regression coefficient for the first order Angstrom type correlation as well as to estimate global and diffuse radiation for Nawabshah. The results obtained via four empirical models were compared with values obtained from NASA Satellite based data (Global, diffuse). The Nawabshah city is located at latitude 26.22 N and longitude 68.38 E. The highest temperatures each year in Pakistan, typically rising to above 48 °C, are usually recorded in Nawabshah District from May to August.

### 2. METHODOLOGY

The original Angstrom (1924) equation relates monthly-averaged daily irradiation  $H_0$  to clear day irradiation  $H$  and the number  $n$  of hours of bright sunshine [7].

$$H = H_0 [a + b (n/N)] \quad (1)$$

$H_0$  is the monthly mean daily radiation on a horizontal surface in the absence of atmosphere.  $N$  is the day length obtained by

$$N = [2 \cos^{-1} (\tan LAT \tan DEC) / 15] \quad (2)$$

The angle between the earth-sun vector and the equatorial plane is called the declination abbreviated as DEC. Yallop's algorithm 1992 [8] enables a high precision computation of DEC. The present routine is valid for the period 1980–2050 and has an accuracy of 1 min of arc for DEC. For longer

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period high precession calculation the complete version of VSOP theory [9] may be used. Using such algorithm DEC of sun can be determined that leads computation of H. In order to compute coefficients **a** and **b**, the following relationship given by Tiwari & Sangeeta [10] can be used.

$$a = -0.110 + 0.235 \cos \phi + 0.323(n/N) \quad (3)$$

$$b = 1.449 - 0.553 \cos \phi - 0.694 (n/N) \quad (4)$$

Where  $\phi$  is the latitude of the place and N is same above, the values of  $H_0$ , the radiation received under the absence of any atmosphere may be calculated by [11]:

$$H_0 = (0.024) I_{sc} [1 + 0.033 \cos (360 DN/365) * [\cos LAT \cos DEC \sin W_s + (2\pi W_s / 360) \sin LAT \sin DEC]] \quad (5)$$

### 3. PREDICTION OF DIFFUSE SOLAR RADIATION

A regression between monthly-averaged values of diffuse and global irradiation was first developed by Liu and Jordan (1960) [12] in the form of  $H_d/H$  as function of  $K_T = H/H_0$ , where  $H_d$  is the monthly - averaged daily diffuse radiation incident on horizontal surface.

$$H_d/H = 1.390 - 4.027K_T + 5.53(K_T)^2 - 3.108 (K_T)^3 \quad (6)$$

Hawas and Muneer's work was based on long term measurement undertaken at 13 stations in India for the period 1957-1975 [13]. The model proposed by Hawas and Muneer for the Indian sub-continent is

$$H_d/H = 1.35 - 1.61 K_T \quad (7)$$

For temperate climates and for location close to the tropics, the correlation equation which is widely used is developed by Page (1977) [14] as follows,

$$H_d/H = 1.00 - 1.13 K_T \quad (8)$$

The significance of estimating the averaged daily diffuse radiation on a horizontal surface is that it gives a direct measure of the energy received, say, on a horizontal solar panel. Depending on the altitude and azimuth of the sun at any moment if the solar panel may be adjusted according to the solar angle increases the energy received. Such estimates then lead to obtain estimates of the energy output from any solar installation for energy production depending on the efficiency of the system.

### 4. RESULTS AND DISCUSSIONS

Table 1 gives the data of temperature and mean daily sunshine hours for Nawabshah. The duration of "bright sunshine" is measured through a Campbell- Stokes sunshine recorder [15]. Table 2 gives the input parameters declination

of the Sun (second column), sunshine hour's  $n$  (third column), and day length  $N$  (fourth column), for each month. The day length  $N$  and Angstrom coefficients **a** and **b** were calculated using equations 2, 3 and 4 (above) respectively. Monthly mean daily extraterrestrial radiation  $H_0$  is estimated from equation (5) and values are listed in table 3 (second column). The Angstrom coefficient values are then used to estimate monthly average daily global solar radiation  $H_{est}$  using equation (1) and are given in table 3 (third column). The transparency of the atmosphere is indicated by  $K_T$ , fraction of Extraterrestrial radiation that reaches the earth surface as global solar radiation. It is a measure of the degree of clearness of the sky.  $K_T$  is calculated (fifth column) in table 3 and the values show that sky is very clear almost throughout the year (i.e. 60%). The ratio of the monthly average daily diffuse radiation to the monthly average daily global radiation ( $H_d/H$ ) are calculated using equation 6, 7 and 8 from different diffuse solar radiation models. The values for Liu & Jordan, Page and Hawas & Muneer models are computed and given in (sixth, seventh and eighth column) also in Table 3 respectively.

The values of  $H_0$ ,  $H_{est}$  and  $H_{NASA}$  are plotted over the months as shown in figure 1. There is remarkable agreement between the estimated and measured values for global solar radiation as shown in figure 1. The maximum of direct radiation for the month of June and July is quite appreciable. The values of ( $H_d/H$ ) obtained by Liu & Jordan, Page and Hawas & Muneer models are plotted over months as shown in figure (2). From this figure it is clearly observed that The Liu & Jordan as well as Page method predicts lower values than the Muneer & Hawas correlation.

NASA supported satellite systems and research providing data important to the study of climate and climate processes. These data consists meteorological quantities and surface solar energy fluxes [16]. These satellite and model-based products have also been shown to be accurate enough to provide reliable solar and meteorological resource data over regions where surface measurements are nonexistent, and offer two unique features - the data is global and, in general, contiguous in time. Typically value of the measured parameter  $H_{NASA}$  shown in table 3 (fourth column) is given in a tabular format as a monthly average over the 22-year time span July 1983 - June 2005.

**Table 1:** Climatological information for Nawabshah, Pakistan location of weather station: 26.3 n, 68.4 E, altitude: 38 m

	Data period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean maximum temperature (deg-c)	1983-2005	24.3	27.3	33.3	39.2	43.5	43.2	40.4	38.6	38.4	37.1	31.6	25.5
Mean temperature (deg-c)	1983-2005	15.1	17.8	23.8	29.5	34.1	35.5	34.0	32.5	31.1	27.7	21.9	16.4
Mean minimum temperature (deg-c)	1983-2005	5.9	8.7	14.2	19.7	24.6	27.7	27.6	26.3	23.8	18.2	12.2	7.4
Mean daily sunshine duration (hours)	1983-2005	8.5	8.9	8.8	9.2	10.1	9.4	8.2	8.5	9.3	9.7	9.2	8.5

**Table 2:** Input parameters for estimation of monthly average global solar

Months	Declination (in degrees)	Monthly mean sunshine Hour(n)	Monthly Average Day length(N)	Coefficient "a"	Coefficient "b"
Jan	-19.95	8.5	10.622	0.359	0.375
Feb	-10.63	8.9	11.290	0.355	0.406
Mar	0.15	8.8	11.99	0.337	0.444
Apr	11.78	9.2	12.788	0.333	0.544
May	20.13	10.2	13.39	0.346	0.424
June	23.43	9.4	13.64	0.323	0.475
July	20.13	8.2	13.39	0.298	0.528
Aug	12.18	8.5	12.81	0.315	0.492
Sep	0.78	9.3	12.05	0.349	0.417
Oct	-10.61	9.7	11.29	0.378	0.357
Nov	-19.86	9.2	10.62	0.380	0.352
Dec	-23.43	8.5	10.35	0.367	0.383

**Table 3:** Global solar radiation data

Months	$H_o$ (kW h/m <sup>2</sup> )	$H_{est}$ (kWh/m <sup>2</sup> )	$H_{NASA}$ (kWh/m <sup>2</sup> )	$K_T = H/H_o$	$H_d / H$ LJ	$H_d / H$ MH	$H_d / H$ Page
Jan	6.442	4.26	3.99	0.661	0.243	0.286	0.253
Feb	7.640	5.19	4.71	0.680	0.232	0.255	0.231
Mar	9.041	6.03	5.41	0.667	0.240	0.276	0.247
Apr	10.268	7.49	6.09	0.729	0.189	0.176	0.176
May	10.962	7.36	6.42	0.671	0.238	0.27	0.241
June	11.179	7.27	6.41	0.651	0.254	0.301	0.264
July	11.037	6.84	5.77	0.619	0.279	0.353	0.300
Aug	10.501	6.71	5.60	0.639	0.265	0.321	0.277
Sep	9.452	6.32	5.56	0.668	0.240	0.275	0.245
Oct	8.032	5.48	5.00	0.683	0.228	0.251	0.229
Nov	6.711	4.58	4.21	0.683	0.228	0.251	0.229
Dec	6.089	4.14	3.75	0.680	0.232	0.255	0.231

Table 4: Diffuse Solar Radiation Data

MONTHS	$H_d$ LJ (KW H/M <sup>2</sup> )	$H_d$ MH (KW H/M <sup>2</sup> )	$H_d$ Page (KW H/M <sup>2</sup> )	$H_d$ (NASA) (KW H/M <sup>2</sup> )
JAN	1.035	1.218	1.077	1.02
FEB	1.204	1.323	1.198	1.27
MAR	1.447	1.664	1.489	1.64
APR	1.415	1.318	1.318	1.98
MAY	1.750	2.215	1.773	2.21
JUN	1.846	2.188	1.752	2.32
JUL	1.908	2.414	2.052	2.39
AUG	1.778	2.153	1.858	2.19
SEP	1.516	1.738	1.548	1.78
OCT	1.249	1.375	1.254	1.35
NOV	1.044	1.149	1.048	1.06
DEC	0.960	1.055	0.956	1.68

Table 4 gives the values of diffuse solar radiation. Diffuse solar radiation is not commonly measured in any metrological station of Pakistan [17], M. Akhlaque Ahmed recently estimated global and diffuse solar radiation of Hyderabad [18] and Lahore in recent years [19]. There fore the diffuse solar is estimated by Liu & Jordon, Page, Hawas & Muneer) method using equation (6, 7 and 8). The estimated values of diffuse solar radiation by Liu& Jordon, Page and Hawas & Muneer models are listed in column (1 to 3) respectively of table4. NASA measured values of diffuse solar radiation are also taken into account (fourth column).In figure (3), the estimated values of diffuse solar radiation obtained by different empirical models are compared with the measured NASA satellite data. There is good agreement between the estimated and measured values and the NASA satellite data for diffuse solar radiation was best fitted with the values estimated from Muneer and Hawas model as shown in figure 3.

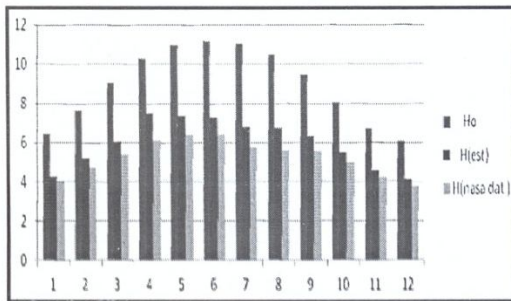


Figure 1: Monthly variation of  $h_0$ ,  $h_{est}$ ,  $h_{NASA}$  for Nawabshah.

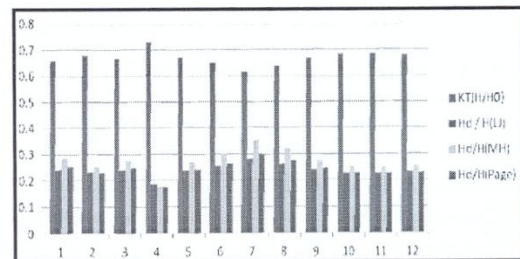


Figure 2: Plot of monthly variation of clearness index  $k, h_d/h$  for  $l_j$  and  $h_d/h_0$  for  $m_h$  and  $h_d/h_{page}$  Nawabshah

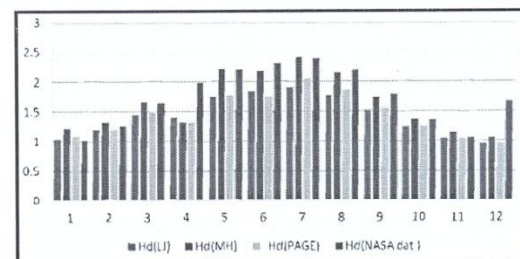


Figure 3: Monthly variation diffuse radiation using different models at Nawabshah

5. CONCLUSIONS

The estimated values of global and diffuse solar radiation suggest that solar radiation can be used as an alternate energy resource for this region. The result obtained shows that the solar energy utilization has bright prospects in Nawabshah, Sindh, Pakistan. The analysis of the estimated and measured values of  $H$  shows that the maximum values of global solar radiation are observed in

June while the minimum values appeared in December. It is further suggested that Hawaas & Muneer model may be best for an estimation of monthly daily diffuse radiation over this region. A more information of the basic solar characteristics allows for the utilization of solar radiation in a broad assortment of thermal, electrical, photo biological and photochemical processes.

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## ISOLATION OF FUNGI IN THE DRINKING WATER DISTRIBUTION SYSTEM OF HYDERABAD (PAKISTAN)

Niaz A. Memon\*

### ABSTRACT

Isolation of Fungi in the distribution systems is receiving high attention of the researcher's neurotic to one of the greatest concerns for the water consumers with respect to the quality of drinking water contaminated with pathogenic microorganisms including various bacteria, viruses and parasites, the well known water contaminants. The occurrence of fungi in drinking water has received much attention in the last decade, accepting it as drinking water contaminant. However, the relevance of waterborne fungi for water quality and human health is poorly understood and still conflicting. The knowledge about the occurrence and diversity of fungi in drinking water of the distribution systems particularly in the developing countries like Pakistan is still having a low base. This paper deals with the isolation of filamentous fungi, together with other critical parameters of drinking water in the distribution system of Hyderabad city. The isolated fungal species are *Aspergillus Flavus* 45%, *Aspergillus Oryzae* 25%, *Aspergillus Fumigatus* 25%, *Aspergillus Niger* 50%, *Aspergillus Nidulans* 6%, *Aspergillus Granulosus* 20%, *Mucor Hiemalis* 3%, *Penicillium Funiculans* 6%, *Absidia Gluca* 3%, *Trichopyton verrucosum* 4%. Out of 40 samples, 36 samples were found positive for fungal isolation at 09 locations out of 10. It is observed that free residual chlorine of 1.28 mg/l and total chlorine of 1.39 mg/l at location 10 can resist the fungi. This is the only location where no significant occurrence of fungi is isolated. No significant correlation-ship was found with the other physiochemical parameters of drinking water of the city.

**Keywords:** Filamentous Fungi, drinking water, distribution systems

### 1. INTRODUCTION

Fungi, including yeasts and filamentous species or molds, are ubiquitously distributed. They may be found wherever nonliving organic matter occurs, although some species are pathogenic and others are parasitic. Because of broad enzymatic capabilities fungi can degrade actively most complex natural substances and certain synthetic compounds therefore they are present in , and have been recovered from , diverse, remote, and extreme aquatic habitats including lakes, ponds, rivers, marine environments, waste water, sludge, rural and urban storm water runoff [1]. Fungi are present in soil and have been recovered from a wide range of aquatic habitats including lakes, streams, distribution systems, drinking water and also on the surface of drinking water reservoirs and distribution pipes, as well as in haemodialysis units [2-3]. The occurrences of fungi in drinking water is now receiving increased attention since last decade and are now generally accepted as a drinking water contaminant, though the relevance of waterborne fungi water quality and human health is yet conflicting [4]. Pathogenic viruses in water are the most common cause of gastrointestinal infections worldwide, and in past, fungi

are not often considered when discussing pathogenic organisms in drinking water, but may be regarded as chronic problem in drinking water distribution systems [4, 5]. Fungi are a diverse group of organisms belonging to the kingdom Eumycota [6, 7]. They are present in soil, organic material and air and anything in contact with air and also can enter drinking water from various locations, although considered as unnatural habitat for them [8]. The issue of fungi in drinking water starts from 1970s identifying cyanobacteria which are known to be able to cause problems in drinking water [9, 10]. The occurrence of potentially pathogenic species of fungi, such as *Aspergillus flavus*, (*A.flavus*), *Aspergillus fumigates* (*A.fumigatus*) in drinking water has led to identify the fact whether the water distribution system serves as a transmission source for fungal infections [11-12].

The purpose of this work is to isolate and identify fungal species at different locations from the distribution system of Hyderabad (Sindh) city to determine the quality of drinking water being supplied to local population. Therefore, in the present study, 10 different locations of the distribution system of the city were sampled and analyzed for the isolation of the species of fungi. The samples were collected according to WHO guidelines

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available on the website [www.who.int](http://www.who.int), (the reference quoted as website address is usually inappropriate and not considered authentic) to make this study representative.

## 2. MATERIALS AND METHODS

### 2.1. SAMPLING

During this study 40 samples from the distribution system of the drinking water of the city of Hyderabad are collected and analyzed. Of these, 36 samples are showing visible growth of species of fungi, while 04 samples appeared sound and free from any growth.

Samples are collected from 10 different locations, including, treatment plants and distribution system in sterile sample bottles (400 ml). All samples are subjected to membrane filtration [1].

Materials (sample bottles, medium containing agar) used in this research were sterilized by autoclaving at 121<sup>0</sup> C

for 15 minutes. For all samples sodium, thiosulfate solution was added to the sample bottles before autoclaving. This was to stop the fungal effect of residual chlorine from acting on any fungi that may be present in water sample. The pH of the samples varied from 7.5 7.7 and the free residual chlorine was found 1.2 mg/l. For the membrane filtration, 100 ml of water sample was filtered through membrane filters with a diameter of 47 mm and a pore size of 0.45 µm. The filtrates were placed in the centre of the agar plates after filtration and incubated at 25<sup>0</sup> C. Fungi colonies were isolated upon formation, stained with lacto phenol and observed under the microscope. Fungi so observed were identified using appropriate taxonomic guides available. However, during collection taps were washed thoroughly and flushed several times and allowed to run for 5 minutes. Sample bottles were then opened and the sample water collected quickly making sure that the bottles did touch taps before, during and after collection. The sampling locations are given in the table 1.

### 2.2 PHYSICOCHEMICAL ANALYSIS

**Table1:** Sampling locations

S. No.	Sampling Location	Title
1	Filtration Gallery of NTP	L1
2	Outlet of New Treatment Plant NTP 30 MGD	L2
3	Inlet of Old Treatment Plant OTP 10 MGD	L3
4	Outlet of Mixing Chamber at OTP	L4
5	Tap water from CNG Pump Gulistan-e –Sajad Gate	L5
6	Tap water Service station opp. Agha Khan Hospital	L6
7	Outlet of I MGD Pumping station op. citizen colony	L7
8	Inlet of LSR Thandi Sark Pumping station	L8
9	Outlet of LSR to Latifabad	L9
10	Outlet of Military Engineering Service (MES) Pumping station	L10

**Table 2:** Fungi species identified in distribution system of drinking water samples

S. No.	Location	Fungi isolated
1	L1	A.flavous, A. fumigatous, A.niger, Mucor,Orzyae
2	L2	A.flavous, A.nidulans, Trichophyton verrucosum
3	L3	A.falvous, A.nidulans, A.fumigatus, A. niger, Penicillium .F
4	L4	A.flavous, A.nidulans, A. niger, Penicillium .F
5	L5	A.flavous,A.fumigatous, A.granular, A.niger.
6	L6	A.fumegatous, A.niger, Mucor
7	L7	A.flavous, A.niger, A. fumigatus, A. granular,Gluca, Penicillium. F
8	L8	A.flavous,A. niger, oryzae, Penicillium.F A.flavous,A. niger, oryzae, Penicillium.F
9	L9	A. niger
10	L10	No isolation

Spectrophotometer DR 2700 (HACH), SensIon Multiparameter Meter (HACH) are used for analyzing the Physicochemical parameters and their correlation-ship. The potable spectrophotometer is digitally auto calibrated; where as the Multiparameter Meter is calibrated according to the manual available with the equipment. For each sampling batch, the probes are calibrated.

### 2.3 FUNGI ISOLATION AND IDENTIFICATION

Fungi species are isolated on Potato Dextrose Agar (PDA) with the incubation of membrane on PDA for 5 days at 25° C, membrane filtration is used.

### 3. RESULTS

The summary of fungi species isolated in the present study is presented in Table 2. The study reveals that the incidence of species from the samples of the drinking water in the distribution system of the city of Hyderabad mostly contained more than one species. It has also been observed that *Aspergillus flavus* (*A. flavus*, *A. fumigatus*, *A. niger*) are the most frequently isolated species. However, at location 1, near new treatment plant (NTP) shows *A. flavus* (45%), *Oryzae* 25%, *A. fumigatus* 25%, *Niger* 50%, *Mucor* 3%. At location 2, *Trichophyton verrucosum* 6%, *A. nidulans* 3% whereas *A. flavus* 20% are identified. At location 3 *Penicillium F* 6%, *A. nidulans* 3%, *A. fumigatus* 7%, *A. flavus* 10% and *A. niger* 5% are identified. At location 4, *A. niger* 10%, *Penicillium* 9%, *A. nidulans* 1%, *A. flavus* 7% is isolated and identified. At location 5, *A. granular* 70%, *A. niger* 17%, *A. flavus* 13% and *A. fumigatus* 5% growth is observed. At location 06, *Mucor* isolated with 12%, *A. fumigatus* 3% and *A. niger* with 1%. At location 7, *A. flavus* 29%, *A. niger* 9%, *Gluca* 2%, *Penicillium* 2%, *A. flavus* 18% and *A. granular* 4% are isolated. This location is the most critical location where almost six species of fungi are identified. IMGD drinking water to two hospitals, jail, and the rest of the population of the vicinity is supplied from this pumping station (location 7). At location 8, *A. flavus* 6%, *A. niger* 2%, *Penicillium* 2% and *A. oryzae* 1% is identified whereas the location 9 is found less affected as 3% of *A. niger* is isolated. The safest location is location 10 where no growth of fungi is found. This location is situated in cantonment area and the availability of free and total chlorine is found which may be a certain reason of no growth of any fungal contamination.

### 4. DISCUSSIONS

The drinking water supplied by Hyderabad Development Authority (HDA) is consumed by almost 80% of the population of the city. The isolation and identification of the species (Table 2) from the distribution system of the city, is an indication that the water is not well treated through the Treatment Plants. Also the use of chlorination as a chief purification procedure has not remained assertive. From the results in section 3, it is observed that the genus *Aspergillus* is the most frequently isolated in this study, therefore the findings of this study are in general agreement with the study carried out by Gunhild et al (2009) and E.C. Okpako (2009) [4, 16], who reveal that fungi are relatively common in water distribution systems but the fungi species are not found evident for any human diseases. However, E.C. Okpako agrees that it is important to be aware of the fact that several of the species which are of clinical concern are present in the drinking water. Since most fungi species survive disinfection and water treatment is not confirmed [16]. This study is in line with the reports from Frankova(1995) [13] reporting the isolation of *penicillium* 30% in drinking water from the wells and reticulated water in Slovakia, the results of present study are also in agreement with the studies of Nagy (1982) [14] reporting *penicillium* (28%), Hinzlin (1985) [15] reporting *penicillium* (23%) in the reticulated water of Nancy and Metz, France. Some fungi species like *Gluca*, *oryzae* found in this study of drinking water of the city are not yet reported in the literature reviewed so far. According to the presented results *A. niger* is the 2nd frequently genus of fungi, (Table 2) and are in line with de Hoog et al (2000) indicating that this genus is known as a common allergen and may cause opportunistic invasive infections in hospitalized immunized patients [17]. The presence of *penicillium* species in the drinking water of the distribution system is also considered as a disease causing agent, being in agreement with the study of Gunhild et al (2009) it is known that *penicillium* is known to cause allergy, asthma and some respiratory problems. Therefore the species isolated in this research may have allergic potentiality for some individuals, which needs further study in this area.

### 5. CONCLUSIONS

It is concluded that this study confirms the presence of different taxa of filamentous fungi in the drinking water

from the distribution system of the city of Hyderabad, and that some of the species found during this study have not yet been reported in the studies according to the best knowledge of the author. Though the study does not confirm any relevancy of human diseases with the species identified, however the fact could not be denied that several species which are of clinical concern are also present in the drinking water supplied to the consumers of the city. It is found that *Aspergillus flavus* is being considered as human pathogen, allergen and mycotoxin producer. The isolation of *A. niger* and the penicillium in this research indicates the possible human health problems which needs confirmation. The fact that the fungal contamination is resistant to the chlorine is not satisfied in this study because of the fact that the availability of free residual chlorine of 1.28 mg/l and total chlorine of 1.39 mg/l at location 10 can resist the isolation of fungi.

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## ANALYSIS OF JPEG AND WAVELET COMPRESSION TECHNIQUES USING TOMOGRAPHIC IMAGES

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### ABSTRACT

The image compression is a hot topic of research during these days. An uncompressed image data requires large amount of storage and high transmission bandwidth and hence requires compression. This project focuses on, the compression of medical images, particularly radiological images. The steps towards digital images in radiology raise the question that how to economically and suitably store, transmit and retrieve the volume of digital images with an acceptable quality for a given clinical application. Many techniques have been proposed for achieving data compression. In this paper two compression techniques JPEG and Wavelet Transform are used for comparison and analysis three types of computed tomography images are taken, based on the sequence of images in TIFF format of chest, brain and kidney. Objective evaluation is done on quality of the compressed images. The results show that Mean Square Error, Peak Signal to Noise Ratio, Compression Ratio and Compression Size are highly satisfactory for the images compressed with wavelet Transform. Thus the results of compression show that wavelet give better result than JPEG.

### 1. INTRODUCTION

For the radiologists and consultants, medical imaging is powerful and useful tool, which helps them to facilitate and improve diagnosis. One of the method in radiology is tomography [1]. It is a non invasive imaging technique allowing for the visualization of the internal structure of an object without the superposition of over and under lying structure [2]. In this process images are sections through the use of waves of energy like computed tomography (CT) slice captures each organ in its actual three-dimensional position [2,3]. The medical image size is around 250-300 MB/ patient/ visit [3]. To handle the total volume of CT image which requires large bandwidth and high speed for communication system in the form of uncompressed raw image data is a big problem.

The transmission speed and storage is improved by the image compression. The compression is technique of packing and storing data in such a manner that it requires minimum space than original file [4]. But medical information can be lost. It spoils common features in most images are neighboring pixels or picture element highly correlated [5]. Some loss of information can tolerated in some application but under particular situation such as diseases diagnostic, the loss of data is intolerable.

Wavelet transform is a better approach for analysis of tomographic image compression. This provides a good representation of the image data by decomposing into

different frequency subbands [6]. Discrete wavelet transform is described through a series of cascaded filters. The decomposition use filters are known as analysis filters, and for the reconstruction of the image filters are known as synthesis filters.  $H_0(Z)$  and  $H_1(Z)$  represent analysis filters, whereas  $G_0(Z)$  and  $G_1(Z)$  represent synthesis filter in Figure 1. In this research work biorthogonal wavelet transform is used. The design of biorthogonal wavelet allows more degree of freedom then orthogonal wavelet. Two wavelets, instead of just one, are introduced [10]: One  $\tilde{\Psi}$  is used in the analysis, and the coefficients of a signal  $S$  are

$$\tilde{c}_{j,k} = \int s(x) \tilde{\Psi}_{j,k}(x) dx \quad (1)$$

The other,  $\Psi$  is used in the synthesis

$$s = \sum_{j,k} \tilde{c}_{j,k} \Psi_{j,k} \quad (2)$$

The functions used in the calculations are easier to build numerically than those used in the usual wavelets .The decomposition levels are 8 and set global threshold 80.01.

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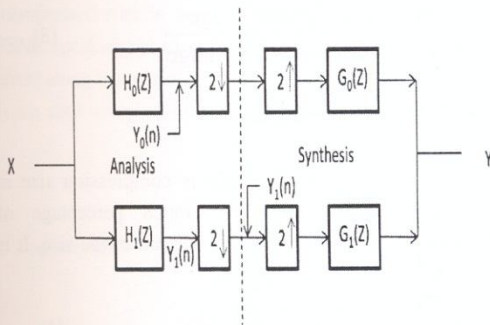


Figure 1: The analysis and synthesis filters

The steps needed to compress an image are as follows:

- Digitize the original image into a signal X, which is a string of numbers. The digitized image can be characterized by its intensity levels, or scales of gray which range from 0 (black) to 255 (white), and its resolution, or how many pixels per square inch.
- Decompose the image into a sequence of wavelet coefficients W. Each row of the 2D matrix is passed through the high-pass and low-pass filters and then down sampled by 2. Each column is passed through a different set of high and low pass filters and again down sampled by 2. The resulting, four matrices are four sub bands of the image, as shown in the figure below.
- Use threshold to modify the wavelet coefficients from W to another sequence W'. The threshold is the number or value below which detail coefficients are set to zero.
- Use quantization to convert W' to a sequence Q. means to multiply each number in W' by a constant k, and then round to the nearest integer.
- Apply entropy coding to compress Q into a sequence E. Entropy coding is designed so that the numbers that are expected to appear the most often in Q, need the least amount of space in E.

Here is the CT scan image of kidney of size (256x256)

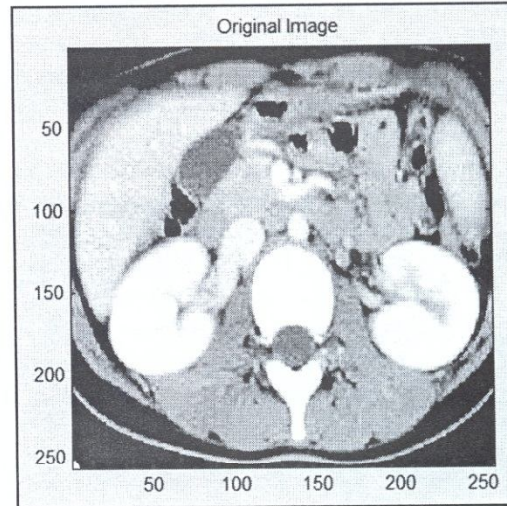


Figure 2: Original CT scan image of kidney

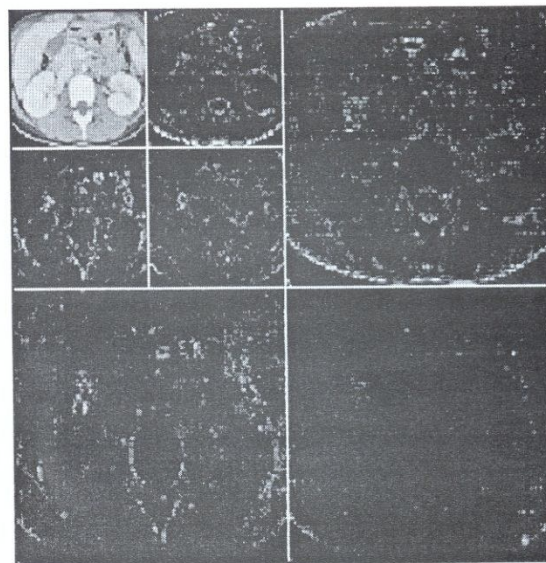


Figure 3: Decomposition of image at 2 levels

This became a up to date compression technology as it can generate remarkably better medical image results compared to the compression results of JPEG[7]. Joint Photographic Expert Group generated by Fourier transform based methods such as the discrete cosine transform (DCT) used. Such algorithms are lossy by nature. We can achieve high compression through DCT algorithms with only some loss of data. In the baseline standard, eight bits per input sample is specified. The

JPEG compression scheme is defined into the following steps [8]

- Transform the image into an optimal color space.
- Down sample chrominance components by averaging groups of pixels together.
- Apply a Discrete Cosine Transform (DCT) to blocks of pixels, thus removing redundant image data.
- Quantize each block of DCT coefficients using weighting functions optimized for the human eye.
- Encode the resulting coefficients (image data) using a Huffman variable word-length algorithm to remove redundancies in the coefficients.

The steps are summarized in the following figure 4.

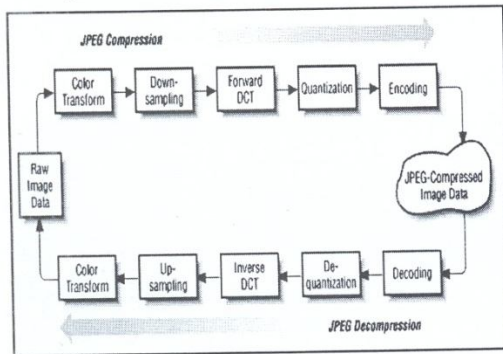


Figure 4: JPEG compression and decompression

This paper provides an overview of the image decomposition technique using wavelet transforms. The aim is to introduce how the wavelet compression techniques are applied in medical image compression in order to enhance the accuracy in medical diagnosis.

## 2. METHOD OF ANALYSIS

In This paper, different CT scan image sequences are used and tested. These images were compressed using wavelet transform and then with JPEG. In evaluation, some statistical parameters are calculated to measure the quality of reconstructed images.

### 2.1. COMPRESSED RATIO (CR)

The quality of compressed image is measured by widely used measure known as compression ratio (CR). It is calculated by dividing original size of the image by compressed size of the image [9,10].

$$CR = \frac{\text{size of original image}}{\text{size of compressed image}} \quad (3)$$

### 2.2 COMPRESSED SIZE (CS)

An other parameter is used that is compression size in percentage. This means how much percentage of compressed size occupied of the original image size. It is denoted CS.

$$CS = \frac{\text{Compressed Size}}{\text{Original size}} \times 100 \quad (4)$$

### 2.3 PEAK SIGNAL TO NOISE RATIO (PSNR)

Peak-signal to noise ratio is the engineering term most commonly used for measuring the quality of reconstructed compress data. Higher PSNR value indicates that the reconstruction is of higher quality. The unit of PSNR is decibels (dB) The formula is given by [9,10].

$$PSNR = 10 \log \left( \frac{(255)^2}{MSE} \right) dB \quad (5)$$

### 2.4 MEAN SQUARE ERROR (MSE)

In statistics Mean Square Error is one of the way to qualify the difference between values implies by an estimator and the true value. It measures the average of the squares of the maximum absolute errors. Lower the values of MSE shows that the result is better [9,10].

$$MSE = \frac{1}{NM} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} \left[ |f(i, j) - f^*(i, j)|^2 \right] \quad (6)$$

In this equation  $f(i,j)$  shows the original image and  $f^*(i,j)$  is reconstructed image.

## 3. COMPRESSION OF TOMOGRAPHIC IMAGE SEQUENCE

Figure 5 shows the five CT images used for experiments and are labeled as Image  $I_1$ , Image  $I_2$  up to  $I_5$ . The upper row shows original images and lower row shows the compressed images, that is through Wavelet Transform. The resultant images or reconstructed images are measured with different parameters using objective evolution. Table 1 shows the values that are calculated through these formulas as CS (%)

(compressed size in percentage), CR (compression ratio), PSNR (peak-signal to noise ratio) and MSE (mean square error) along the original size of the images. The images  $I_1$  to  $I_5$  are also compressed with JPEG compression technique

and quality measures are also calculated for images compressed with JPEG techniques. The images are shown in Figure 6 and calculations are shown in Table 2.

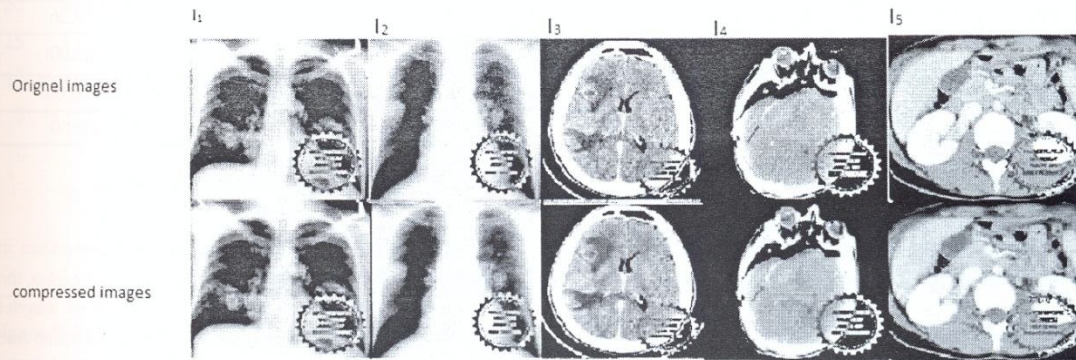


Figure 5: Original and compressed CT scan image sequence using wavelet transform compression technique

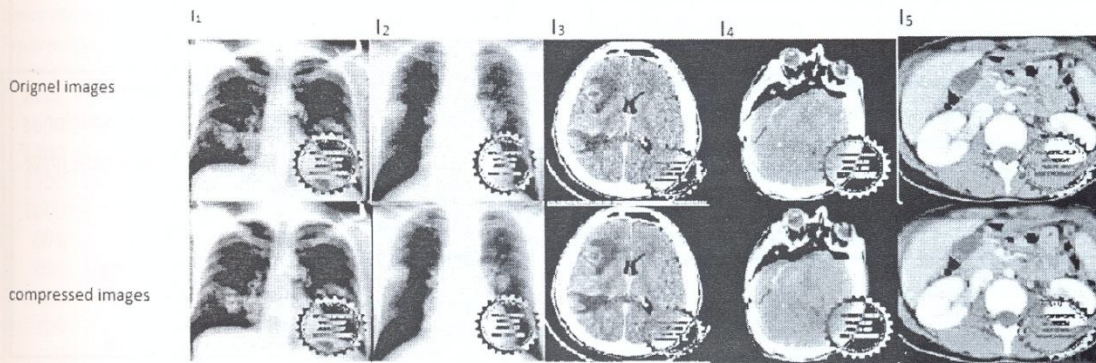


Figure 6: Original and compressed CT scan image sequence using JPEG compression technique

Table 1: The CS, CR, PSNR and MSE results of chest, brain and kidney scan image sequence using wavelet transform

S. No.	Images	Original size (KB)	Compressed size ( KB)	CS (%)	CR	PSNR (db)	MSE(db)
I	$I_1$	83.20	3.00	3.60	27.70	30.00	61.72
Ii	$I_2$	75.10	2.28	3.00	33.00	31.00	47.65
Iii	$I_3$	87.70	2.86	3.26	10.70	23.80	270.80
Iv	$I_4$	75.70	2.20	2.90	34.40	25.37	189.00
v	$I_5$	154.00	4.16	2.70	37.00	28.58	90.10



**Table 2:** The CS, CR, PSNR and MSE results of chest CT scan image sequence using JPEG

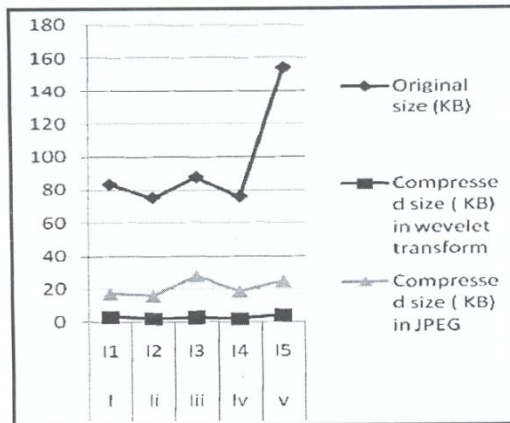
S. No.	Images	Original size (KB)	Compressed size (KB)	CS (%)	CR	PSNR (db)	MSE (db)
I	I <sub>1</sub>	83.20	17.10	20.50	4.80	20.56	570.51
Ii	I <sub>2</sub>	75.10	15.70	21.00	4.70	19.27	769.26
Iii	I <sub>3</sub>	87.70	27.70	31.50	3.16	18.20	982.00
Iv	I <sub>4</sub>	75.70	18.50	24.40	4.00	15.80	1700.00
v	I <sub>5</sub>	154.00	24.60	15.90	6.20	20.00	640.60

**4. RESULTS AND DISCUSSIONS**

This section discusses the results of both compression techniques applied on Medical Tomographic Images.

**4.1 COMPARISON BY SIZE**

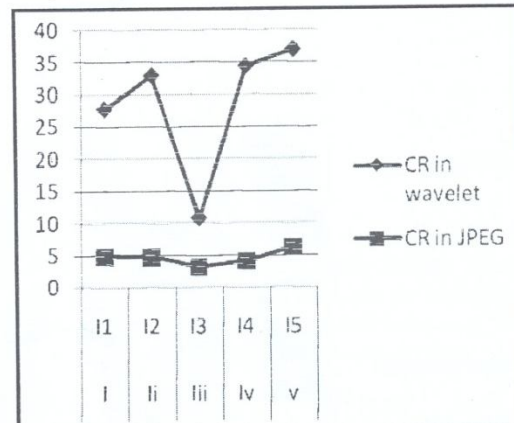
The size of the original images and compressed images are represented in Kilo Bytes (KB). In the Figure 7 vertical axis of the graph shows the size in KB and horizontal axis of the graph shows the sequence of tomographic images. The result shows three patterns of line. Diamond shows the original size of the image that is in TIFF format. Square line shows the size of images after Wavelet compression technique while Triangle line shows the size in JPEG transform compression technique. It is clear that wavelet gives us minimum memory size as compared to the JPEG that is almost all image sizes are below 10 kb.



**Figure 7:** Comparison in terms of Memory Size required for original, JPEG compressed and Wavelet compressed images

**4.2 COMPARISON BY COMPRESSION RATIO**

A simple graph is constructed (according to the values in tables 1 and 2) to show two different patterns of lines, the line with diamond shape represents the result of wavelet transform of compression ratio and square patterned line represents compression ratio in JPEG. Higher the value in compression ratio means higher compression is achieved.



**Figure 8:** Comparison of Compression Ratio against the tomographic image sequence for both compression techniques of JPEG and Wavelet Transform.

**4.3 COMPARISON BY PSNR**

In the figure 9 the analysis gives that wavelet has higher values of peak signal to noise ratio in all images. It means wavelet has better quality of reconstructed images as compared to the JPEG.

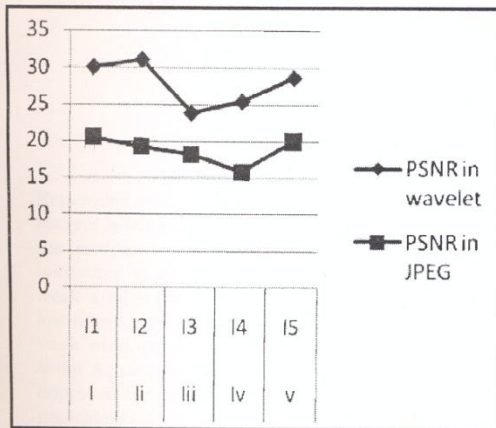


Figure 9: Peak-signal to noise ratio against chest CT scan images sequence for wavelet and JPEG compression

4.4 COMPARISON BY MEAN SQUARE ERROR

The analysis says that lower the value of MSE means better the result, so it can be observe that all images give lower value in wavelet transform.

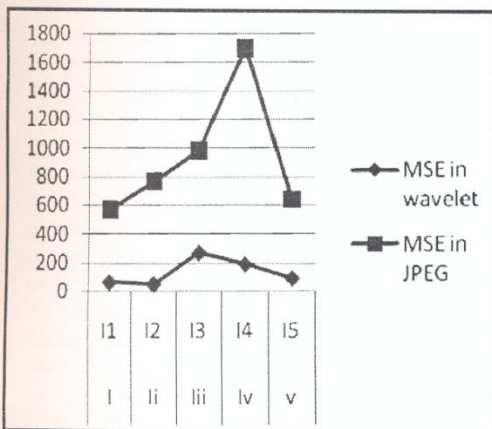


Figure 10: Mean square error against the image sequence of JPEG and Wavelet compression

5. CONCLUSIONS

In this paper different tomographic medical images which are chest, brain and kidney are compressed using wavelet transform and JPEG compression techniques. The result of this research concludes using objective analysis. The

results are compared by Compression ratio (CR), compressed size (CS), Peak signal to noise ratio (PSNR) and Mean square error (MSE) between two techniques of compression i.e wavelet transform and JPEG. The analysis says that the wavelet compression can be used at higher compression ratio than JPEG for tomographic images. For CS it is concluded that as compared to JPEG the Wavelet Transform technique saves much more memory size for the images. Lower the value of MSE gives better result, so observation says that wavelet gives lower values than JPEG. Whereas PSNR proves that the quality of CT scan Images are better in wavelet transform technique than JPEG compression technique by giving higher values in all calculation for the images. It is very useful for medical images to be at as high resolution as possible.

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## PERFORMANCE ANALYSIS OF NON-CONVENTIONAL WIND DUCT INTEGRATED WITH WIND-BY-WIND ACCELERATOR

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### ABSTRACT

Renewable energy sources utilization is crucial demand of the day. Present contribution of renewable energy sources is not at the satisfactory level. The critical reason is the transient and irregular nature of the sources and the insufficient efficiency of the renewable energy systems to rely upon them for power generation. Present work is devoted to environmental friendly renewable energy source, the wind. Improvement of the power of low or weak wind is the main focus of the study. The purpose is to enhance the boundary of wind energy source to the low windy areas. Non-conventional wind duct is introduced in this study to collect, concentrate and accelerate the weak wind, consequently make it useable for power generation. Finally the duct is integrated with a Wind-by-Wind Accelerator (WWA) to enhance the duct efficiency. The developed system showed positive response and improved the power of wind by 69%. This system is expected to facilitate both horizontal and vertical axis wind generators and provide them, for their efficient working, wind energy in improved form.

**Key Words:** Renewable Energy, Wind, Converging Duct, Wind-by-Wind Accelerator.

### 1. INTRODUCTION

Energy crises and the environmental degradation are the global issues and are at the top priority of the researchers. They have been striving and searching dependable and environmental friendly energy options to provide sustainable solution of the top issues. Renewable energy sources now days seem the only solution to energy and pollution crises in the world. Solar and wind are at the peak in the priority of researchers, since both possess numerous qualities of dependability. Wind energy is the focus of this study targeting at the low windy zones where it is insufficient to be utilized in place of non-renewable sources. The power output enhancement to the conventional wind turbines have long been studied through rotor design modifications but for improving power of weak wind the most assuring option is ducting the turbines. It has been reviewed that there is low number of such sites in most of the countries of the world which bear high wind. Various sites, often urban areas, has wind speed less than 4m/s and turbulent in nature [1, 2]. More effective systems are required to facilitate the thickly populated low windy regions. It is also suggested to site wind turbines near rich populated places even in case of rural areas [3].

Most suitable system for these sites will be one having wind force improving technique integration. Studies on

the effect of ducting the turbine rotors on power output are available. The basic principle behind the use of a duct is to obtain a higher energy density at a rotor than would be seen in a free moving wind [4].

Ducted wind turbines have been studied since long but are still at an experimental stage and show good signal for low wind regions. Grant, A.D, et al [5] worked on the ducting effect to the free wind turbine. Tests were conducted both in the wind tunnel and out in the field. From the wind tunnel testing, various aspects of the wind turbine performance were studied, particularly by modifying the model geometry, the improvement in Power Coefficient  $C_p$  was observed. A roof spoiler was introduced to the ducting structure that brought most significant change in terms of  $C_p$ . Another observation in this trial was that the turbine was sensitive to wind direction but it would tolerate a misalignment of  $\pm 15^\circ$ .

Effect of duct length, diameter, diffusion, and addition of flange at duct outlet was studied by Matsushima T, *etal* [6]. In this work a bucket-shape ducted wind turbine was developed and tested in field, the ducted turbine does improve the flow around the generator and thus increase its power extraction efficiency by about 80%.

A comparative study of turbine with and without guide vanes has been conducted [7]. It is shown that the

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efficiency and starting characteristics of the Wells turbines with guide vanes have improved when compared with the respective turbines without guide vanes. It is also reported [8] that by employing means of a wing structure placed at some distance around the turbine, it can successfully increase the power of a wind turbine by a factor of 2.0. Wang, et al [9] have indicated that by using a scoop, energy capture of wind turbine can be improved at lower wind speeds. In Japan, a study was conducted by Takao *et al.* [17], the study has shown that by adopting of the guide vane row, the power coefficient of straight-bladed vertical axis wind turbine (VAWT) was 1.5 times higher than wind turbine which has no guide vane. A bucket-shape ducted wind turbine is proposed by [11]. This study shows that a sucking effect can be produced according to the Bernoulli's principle, and this significantly increases the wind speed inside the duct and substantially enhances the efficiency of the wind turbine. Urban zones are also included in low wind velocity zones due high rise structures and research trend is tilted towards the architectural integrated wind power systems. construction of small turbines on the roofs of existing buildings and the construction of new building having a wind optimized shape and distribution are two highlighted modes of research [12,13]. To enhance the wind speed artificial structures are used in order to obtain the duct and hill effects [14]. Rigid or flexible duct like structures can be used to increase the wind power in low wind speed areas [15, 16]. VAWT was integrated with Omni-directional Guide Vane (ODGV) [18, 19]. The ODGV improves the power output of a VAWT and this integrated design promotes the installation of wind energy systems in urban areas. In the present work non-conventional duct is introduced, its performance at various geometrically important locations is studied finally integrating effect of WWAT technique is analyzed.

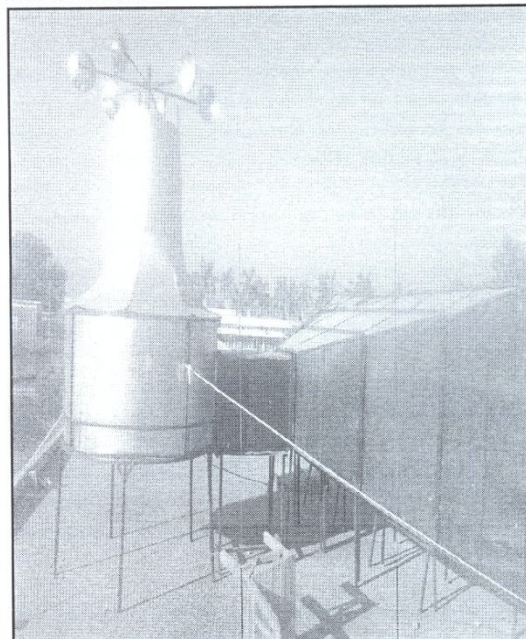
## 2. SYSTEM DEVELOPMENT AND DESCRIPTION

The turbulent and non uniform behavior of wind requires proper systems for its use in general however for its low intensity the most efficient solution is how to increase its speed. Therefore, energy enhancement of weak wind is the prime objective of this work. In this regard vertical enlargement is given to the conventional wind duct that to be used for ducting the turbine at its diffuser section with integration of Wind-by-Wind Accelerating Technique (WWAT). In this technique, two sets of blades, connected through a co-axial vertical shaft with the vertical cylinder, are used. One set is located axially outside the vertical

duct exit with outer end of shaft, using direct natural wind (except duct incoming wind) as its input power to rotate and other set of blades located inside the exit of vertical duct to suck the wind available in its vertical portion and forward it in the exit direction. This system causes vacuum creation above the test (turbine) section resulting improvement in the wind velocity during its passage through the duct.

### 2.1 WIND-BY-WIND ACCELERATING TECHNIQUE (WWAT)

A set of twisted Savonius blades is introduced in the elbow duct before the exit of its vertical end mounted on a coaxial shaft at its lower end. The other end of the shaft is enlarged out to upper end of duct where anemometric styled blades are fixed. Natural wind, blowing to any direction, hits the blades and rotates them. The blade set mounted on the same shaft at its inner end inside the vertical portion of the duct rotates and sucks air from the bottom and exits from outer end causing pressure difference in the elbow duct. This technique (shown in fig. 1) improves the performance of the system in terms of wind acceleration.



**Figure 1:** Non-conventional wind duct integrated with Wind-by-Wind Accelerating Technique (WWAT)

### 3. RESULTS & DISCUSSIONS

As the enhancement in power of the low-wind is the prime objective of this study, so, the system requires techniques that can do accordingly. In this regard a multi-sectional duct integrated with a WWAT technique is introduced, developed and investigated.

The natural low power wind enters with velocity  $V_1$  in the converging section-1 at its inlet. The first section compresses the incoming air and then transfers it to the section-2 (test section) with velocity  $V_2$ . The compressed air expands in section-3 with a new velocity  $V_3$ , finally leaves the upper converged section-4 with velocity  $V_4$ .

Tests were conducted to study wind behavior in terms of its velocity during its flow through the multi-sectional duct without addition of any other wind accelerating system. Wind velocity was observed in the path of wind flow at four important locations. (1) Converging duct inlet, where the natural wind is captured. (2) Converging duct exit (test section), which is most important location to use the wind power, (3) Diffuser section, to create pressure difference, and (4) Vertical duct exit, to observe its vertical flow behavior.

#### 3.1 LOCAL WIND BEHAVIOR.

At initial levels wind behavior in terms of its velocity was studied near the system. The system was located on the corridor of QUEST building about 12 ft above the ground. Two locations were selected 10ft away from both sides of test system (10ft away from left and 10 ft away from the right) to study the wind behavior. Tests results were tabulated and graphically represented as shown above in fig .2.

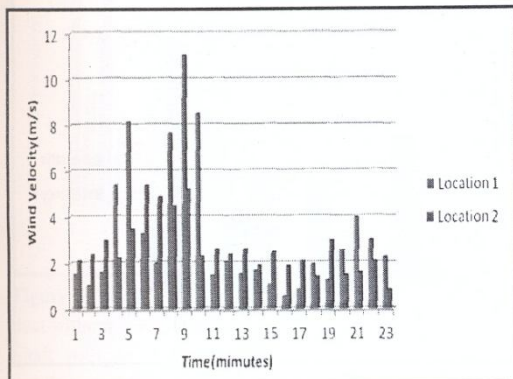


Figure 2: free wind velocity at two locations near duct

It was observed that the nature of the wind is irregular and turbulent at all locations.

In the wind path, duct existing effect was checked by comparing wind impact at the duct inlet and 10 feet away from the duct. The data collected is shown in the fig.3.

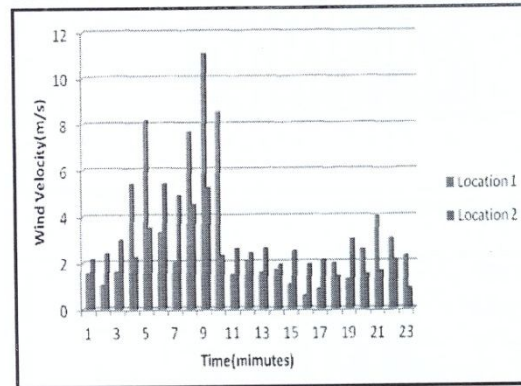


Figure 3: free wind velocities at inlet of duct and near the duct

It was observed that the nature of the wind is turbulent at all locations but show slightly lesser intensity at the duct inlet as compared to another location near the duct showing the blockage effect on wind flow.

In the developed system efficiency of converging duct was separately studied. Inlet and outlet velocities of the captured wind were recorded and are mentioned in next section.

#### 3.2 EFFECT OF CONVERGING DUCT INLET AREA ON WIND VELOCITY.

Wind collecting/catching and concentrating was the focus of study. In this regard 1<sup>st</sup> portion of the system, horizontal duct was developed and tested. Inlet area of the duct was selected as one parameter to effect on its performance in terms of increase in velocity at reduced section. Four different inlet cross-sections were tested keeping exit constant with 6, 12, 24, and 48 area ratios. Test results in terms of increase in velocity are shown in fig.4 (a-d).

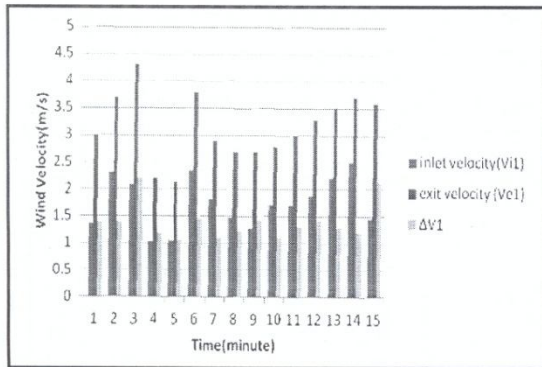


Figure 4: (a) Duct Performance with area ratio 6

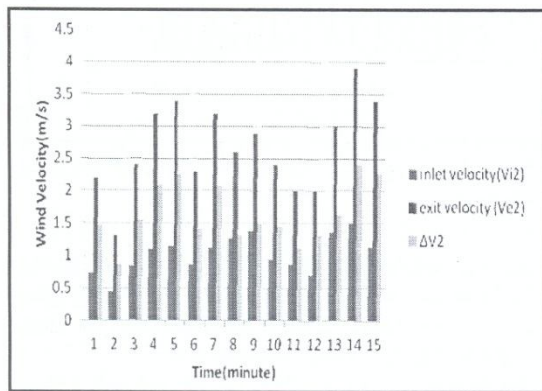


Figure 4: (b) Duct Performance with area ratio 12

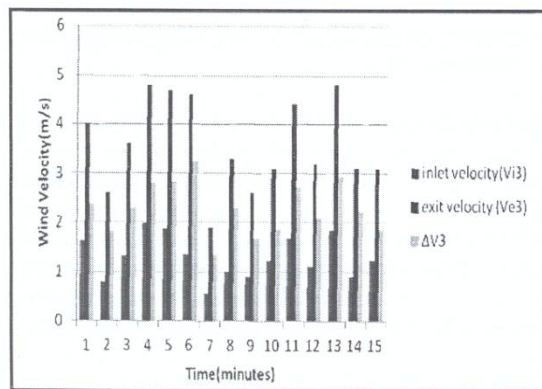


Figure 4: (c) Duct Performance with area ratio 24

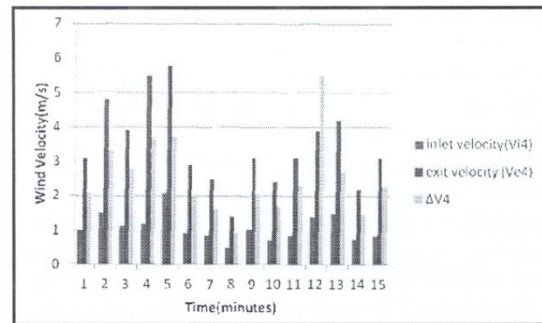


Figure 4: (d) Duct Performance with area ratio 48

The average value of increase in velocity taken from the test results is shown in table.1 and finally the result is compiled in fig.5 (a & b). Against each area ratio, increase in velocity per square fit increase in inlet cross-section of duct is shown in column three of table.1 which indicates declined performance after each step. The column-four shows efficiency of the duct per square fit of inlet area. It can be concluded that the total efficiency of the duct in general increases with increase in its area ratio but its performance per square fit decreases.

Table 1: showing average increase in velocity, increase in velocity/ft<sup>2</sup>, efficiency/ft<sup>2</sup> of the duct

Area ratio	$\Delta V_{av}$	$\Delta V/ft^2$	$\eta \%/ft^2$
6	1.38	-----	31
12	1.64	0.8	22
24	2.28	0.33	16
48	2.09	0.19	13

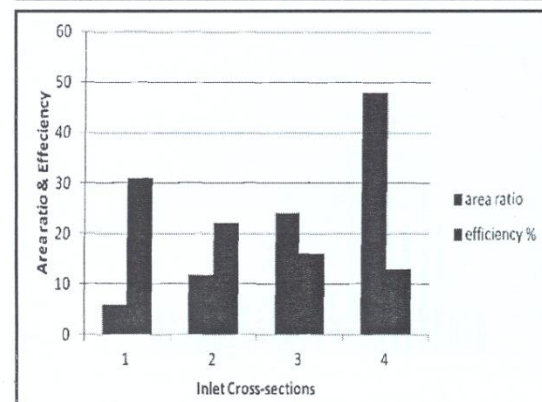


Figure 5: (a) Efficiencies of ducts with area ratios 6,12,24, and 48.

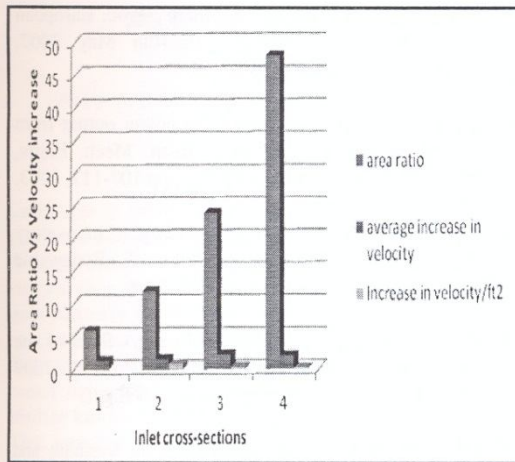


Figure 5: (b) Average increase in velocity & increase in velocity/ft<sup>2</sup>, of ducts with area ratios 6,12,24, and 48.

3.3 SYSTEM ASSEMBLY

In the next step 2<sup>nd</sup> part (vertical portion) of the duct was connected with the horizontal (1<sup>st</sup>) part. Allowing wind through this new path its behavior in terms of velocity was measured at four points in the duct and recorded as shown in fig.6. It is obvious from the figure that the efficiency the system particularly at the test section in average is 54%.

In the third step at the upper portion of vertical duct a wind-by-wind accelerating system was introduced comprising two sets of blades connected through a co-axial vertical.

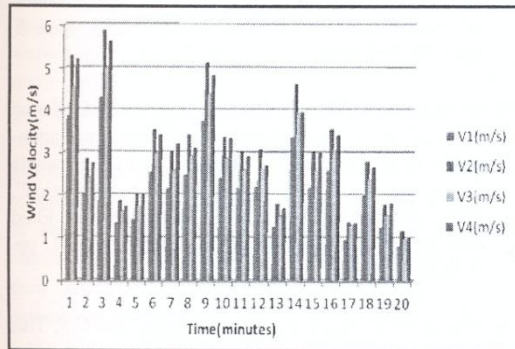


Figure 6: Wind velocities at four different sections of the duct without wind accelerator

Shaft with the vertical cylinder. One set was located axially outside the vertical duct exit using direct natural wind as its input power to rotate internal blades, and other

set was located inside the duct below its exit to suck the wind available in its vertical portion and forwards it in the exit direction. This system causes vacuum creation above the test section-2 resulting improvement in the wind velocity during its passage through the duct. Performance was studied and data was recorded as shown in fig.7.

It was observed that at the test (turbine) section system shows improvement in the wind velocity from 54% to 69% due to the performance of wind accelerator.

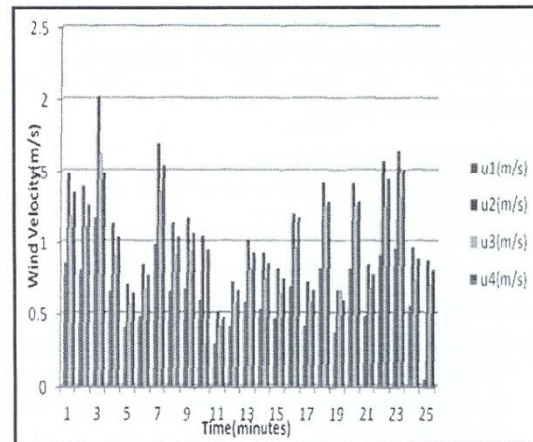


Figure 7: wind velocities at four different sections of the duct with wind accelerator.

CONCLUSIONS

The developed system was tested & analyzed with following conclusions;

It was observed that the nature of the wind is turbulent at all locations but show slightly lesser intensity at the duct inlet as compared to another location near the duct showing the blockage effect on wind flow.

Against each area ratio, increase in velocity per square fit increase in inlet cross-section of duct indicates declined performance after each step. It can be concluded that the total efficiency of the duct in general increases with increase in its area ratio but its performance per square fit decreases.

The developed system without WWAT technique gave 54% improvement in the natural wind force but with the introduction of WWAT technique, particularly at the test (turbine) section improved performance from 54% to 69%. The working model of the system may successfully be implemented for power generation through wind turbines in low windy regions.



## SUGGESTIONS

Effectiveness of the WWAT can be improved by changing the blade designs externally and internally. Redesigning of duct keeping in view of frictional and geometrical resistance can improve the effectiveness of the system.

## ACKNOWLEDGEMENT

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## AN INTELLIGENT ASSESSMENT TOOL FOR IT PROFESSIONALS

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### ABSTRACT

Computer is involved in every walk of life. It is being used in education as an essential tool to enhance the academic activities from lecture delivery to assessment. Academic personals are keen to perform their activities through computer but lack of the particular software which limits the real advantage. Students become lazy in study if they know their assessment results late, By considering the great benefits of computer, we have developed quiz software named who wants to be IT professional (WWIP). It has a sufficient variety of questions, where IT users can test their knowledge by attempting the right answer in a sequence but question stochastically taken from Question Bank with options and supporting life lines (50:50, Phone a friend, Audience). The software is fully based on artificial intelligence and incorporates the Microsoft Text-to-Speech engine. One can not only test his/her knowledge of IT but, he will be entertained and become artisan in the field of IT gradually. This paper elaborates the overall design, architecture and flow of WWIP software and presents the numerical analysis and the assessment scheme.

**Keywords:** Education Learning and Assement, Learning And Assessment through Computer, DBN(Dynamic Bayesian Network), Life lines and Quiz Type Software.

### 1. INTRODUCTION

Learning process is being improving since many years when the technology was not so rich, but learners are not only learning for self but they are basically providing their observations and conclusions in the form of products, inventions and projects. So the best learner can provide the best platform of how to learn. Teachers are playing the vital role in the schools, colleges and universities taking benefits from computer as an interactive tool to boost the teaching methodologies, they are providing the innovative environment to the students/learners not only in the academic point of view but in the professional trainings as well. Researchers have worked to make computer efficient and intelligent to make quizzes or assessments for the students which not only provide the electronic environment but they are also reducing the headache of evaluating results by automatic generated results/grading. By involving the computer technologies such as quiz type software, candidate has not to wait for results; user can view his/her grading, status/ranking in the class and discuss very effectively their results with their colleagues as soon as the assessment ends in a particular time slot electronically.

Computer due to the fifth generation lacking the efficiency to understanding and talking with candidates, which is already a big challenge of nowadays in the form of speech synthesis and recognition. Machine learning is

also going to be implemented to make computers smarter, efficient and reliable. By considering all the pros and cons the software who wants to be IT professional is developed.

The idea is basically taken from the already international game WHO WANTS TO BE MILLINIORE a program which was telecasted since decays where user is in front of host along with computer and candidate is asked a question with four options user must attempt one from four to precede. If user attempts wrong option then he will be no more for game to continue. The same type of program (s) have been telecasting since years on Indian channels such as star plus, Sony TV, in the form of 'Kaun Banay Ga Krore Pati' where Amitabh Bachan hosted in many shows.

By considering these types of environments we planned to work on it and developed the same environment virtually where host talks can be generated by Microsoft Text-To-Speech engine as speech synthesizer, and user has to sit in front of the executed software WHO WANTS TO BE IT PROFESSIONAL. This software comprises of a good bank of questions stochastically taken from the field of computing, such as networking, Databases, Number Systems and Multimedia Technologies, etc.

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## 2. RELATED WORK

Satisfactory student evaluation acting a chief role in the usefulness of distance and self-paced education tracks. Even for tiny classes (less than or equal to 30 students), teachers often feel weighed down by the attempt required to mark tests on demand within a practical moment structure. The majority of recent systems for regular pupil assessment are extensions of the so called computer based training (CBT) systems. Although the majority of these systems are inclined to be very leading, providing Graphical User Interface (GUI) based scripting languages, learner database support and examination flexibility, they suffer from the need of two necessary characteristics to be productively applicable in distance and self-paced learning in universities: reusability and portability. Students should not be concerned with the internals of dissimilar software correspondence, nor with the all-purpose problems of getting a feel for to a new environment each time a new description of the network software is modified, for example. With the rise of the World Wide Web (WWW) as an effectively standard for delivering on-line path fabric in universities, a number of Web-based training (WBT) systems including test assessment units have started to come into sight [1]. "BEST" (Basic Engineering Software for Teaching) Dynamics software, holding about forty-five dynamics problem reproductions, has been developed and classroom tested at the University of Missouri-Rolla. "BEST" was originally imagined as a tool to encourage visualization. Students have responded positively to use of the software and details that visualization of method is enhanced. Improved visualization only, however, does not promise improved presentation on characteristic engineering problem-solving-oriented exams. Students asked to reproduce answers given by the software experienced some irritation, as they often do with textbook problems in a difficult-to-master course such as dynamics. Students who had used the "BEST" Solutions to study a four bar method problem achieved roughly a letter score higher on a four bar method quiz when compared with students who had not played the software [2].

With the help of computer as electronic machine objective type questions present one structure of evaluation for teachers that permit for instant advice for students and teachers. In adding together, the electronic environment of the tool permits for permanent age group and changing of evaluation questions. When the hope is to measure lower-level cognitive education electronically, several

ways are present, along with them textbook ancillaries, Web course creations, and presented freeware. This scheme tenders a freeware alternate to quiz creation. The software currently implemented and comes out to assemble the main goals of effortlessness of use, elasticity, and convenience. The product and procedure has been checked and distilled using tiny quizzes in classes of summer. This will create the product suitable for more inclusive exams. The software with complete installation and prepared instructions will be completed priceless accessible to the educational society [3].

Educational scheme using internet has been existing one of the best rising fields in educational skill study and improvement. Contrasting to a actual classroom, most Web-based educational skills still have quite a few limitations, such as need of appropriate and adjusting support, be deficient in of stretchy hold of the arrangement and feedback, need of the joint support between systems and students, be short of supervision and motivation tasks. The main motives of our study are to personalize systems of online education. Based on the academic hypothesis, personalization raises education inspiration, boosts the education efficiency. A Fuzzy epistemic reason has been used to at hand student's awareness condition, and the course substance is formed by the idea of framework. Using such Fuzzy epistemic sense, the content reproduction, the student form, and the education chart have been cleared properly. A multi-agent based student sketching system has been offered.

Our subsystem of profiling stores the learning behavior and communication history of each person undergraduate into the database of student profile. On the basis of student form and the contented form, active learning plans for each student will be completed. Pupils will get their education resources, examination, and suggestion. In account to appreciate the students' awareness and to assess the students learning efficiency of study has been carried out. The results show that our sample system builds huge improvement on educational personalization and achieves the exercises of education [4]. With adequate hardware stores, open source software being winning in offering a realistic practical stage for managing position investigations to large statistics of pupils in a little time. Time managing, though, was remarkable in the marking and study of test scores. Economic costs being low for hardware, software, and reasonably elevated for people in the first year of growth. It is expected that time for arrangement will be very low

in succeeding 979 Proceedings of CLaSIC 2004 years that the position test is employed. In the other research question, the consistency of the test items, twenty four of the fifty test items were marked for revision or removal after item facility and item discrimination analysis [5]. Applying an open-source LMS to about 2000 on-screen English assessments for required courses that are part of the Università di Milano's degree program, the authors report on smart possessions of using such a system. Huge class size led to the acceptance of an LMS designed for remote learning as a stage for computerized test scoring. A better intelligence of going surrounded by students result is evaluated. At the end of a test, students look a place of vis-à-vis the group at large, and students did not focused the class can be brought into the scheme/area [6]. The report presents one feature of the science research project titled "The Distance education in Bulgaria: Opportunities and advantages for their application in Technical College – Yambol". The reason of the paper is to show E-learning process of education by Moodle software proposal and their realization in Technical College – Yambol. E-learner is a method to use a range of computer and networking technologies to contact (often geographically remote) teaching materials, cooperate with learners, etc, with the management system for learning. To achieve that practical and objects base, methods for computer and electronic education practice, standards for the construction of electronic track and multimedia textbooks and trained staff are needed for its comprehension. The results of the execution of Moodle enclose courses in Informatics, Programming languages and Information technology. The execution of the information and communication technology in education with e-learning management system allows civilizing effectiveness of the education. The Management System of Education allows better collaboration among the learners, the tutors and the students. The convenience, usability and student joint learning are improved. Higher inspiration among the students and the teachers is accomplished [7].

The chief objective of this document was to start an expansion for mathematics culture using quiz by Bayesian inference scheme. The Joomla! As open source is used for this experimental approach, namely expanding Content Management System toward Learning Management System. Mathematica go round to be reasonably helpful software for dynamically generating quizzes. It is observed that Bayesian network based quiz is expanded inside Joomla!. The tool presents the test score and

concludes the level of each knowledge point. Therefore the student can decide to proceed and follow a learning policy to strengthen comprehension objects. In this approach, logical part is united with quiz producer for managing personalized education for middle school math [8].

TPACK(Teachers' technological pedagogical content knowledge) is not narrow to a exacting approach to education, education, or even skill combination, it is significant that TPACK-based professional growth for teachers be elastic and comprehensive sufficient to contain the complete variety of teaching attitudes, approaches and methods. One method to make certain that elasticity is to split the complete variety of curriculum-based group types within each regulation district, heartening teachers to select among them based on apparent suitability and benefit with indication to students' education wants and favorites, connecting in this collection/grouping procedure each occasion they plan a new session, development, or component. In the first classification of content-specific TPACK-based movement types has been tested reasonably freshly, and that it refers to just one set of courses content region, it is clear that much more work in this line of investigation needs to be done. The frequent development of pedagogy, technology, and content frequently fetches new education movement types to brightness [9].

In association with a range of efforts to recover the excellence of CS education at Virginia Tech, the QUIZIT system has been developed to present fast feedback to students as they get online quizzes, as part of conventional or Personalized System of training courses. Developing quizzes with it takes about the similar time as conventional quizzes, but remarkable time investments when ranking and assessing learner evolution, for the compound record maintenance required in proceed-at-your own-pace courses [10].

### 3. NUMERICAL ANALYSIS

WWIP is the platform where certain IT professionals, students, teachers or IT related people can test the field knowledge by using the desktop based software. In education various type of methods and techniques are needed and used to enhance the standard of education from learning to assessment and also in the form of exam results. ves and experiences make decisions, sometimes broker's advice, WWIP need some sort of mathematical analysis in the form of data bank of questions where from

a random question be fetched in front of candidate of the quiz, which is basically random method of the language in which the software is developed such as Visual Basic 6.0 so the random and difference questions can asked from candidate which is symbol of standard assessment.

In the proposed technique we have used the DBN(Dynamic Bayesian Network) shown in Figure 1 Here Probability (P) marked with single quotation showing the decreasing probability, P only with symbol “\*” pointing to the equal probability and P marked as blank “” shows the growing probability.

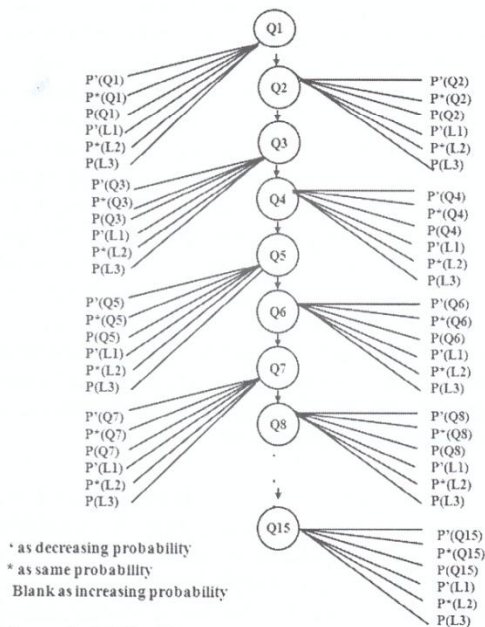


Figure 1: DBN of System

The DBN shows the joint probability distribution of the arbitrarily fetching 15 questions, any quiz every first question, 2<sup>nd</sup> question is bound the correctness of first to proceed and successfully cross the all questions. While one question is completely free and randomly be changing without manipulate to each other.

DBN network chosen because of real time environment and non-linear culture is given; where in WWIP MCQs are asked by combination it will give us huge number to evaluate result. Dynamic Bayesian graphically hold the difficulty criteria shown in Fig. 1 and attain the desired target by estimating best inference finalized below.

$$P(D2) = \text{Rand}(Q) | \text{choice A} | \text{choice B} | \text{choice C} | \text{choice D} | L1 | L2 | L3 \quad (1)$$

The Equation 1, shows that using DBN after getting updated chronological data features can be investigated to attain successfulness. The conditions given in Equation 1, as explained in the Table 1, Probability of Q2 is estimated on this inference of question. Following are the mathematical conditions of one successful inference on the foundation of these inference factors results are being estimated for reaching to next question.

Table 1: Terms used in Equation 1, and their descriptions

Term	Description
<b>Rand(Q)</b>	A random question is fetch from data bank here it is working as function of method to evaluation a very difference question every time the candidate interact with WWIP.
<b>Choice A</b>	This is the choice A of any random question which becomes visible at the time of quiz is executing.
<b>Choice B</b>	This is the choice B of any random question which becomes visible at the time of quiz is executing.
<b>Choice C</b>	This is the choice C of any random question which becomes visible at the time of quiz is executing.
<b>Choice D</b>	This is the choice D of any random question which becomes visible at the time of quiz is executing.
<b>L1</b>	This is life line such as 50:50 for candidates help to remove two wrong or incorrect options to provide the flexibility to answer the question.
<b>L2</b>	This is a life line phone a friend to make a virtual call to candidate's friend who will tell the correct answer if he knows.
<b>L3</b>	This is a life line known to be Audience when attempted by candidate and will take help from the bar graph with high percentage shown virtually answer the audience the correct option.

Equation 1, above the terms Rand (Q), Option A, Option B, Option C, Option D, L1, L2, and L3 are all of discontinuous nature concerned in the network as

mainstay of getting desired results. These factors helped to evaluate the candidate successfulness in the quiz.

The question increasing one by one when candidate attempts correct option is depend on the following creative representation; at time  $t, t \in \{1, \dots, T\}$ , a question likelihood leaves in a set of states shown by a tentative vector, taking on the boolean values of "true" and "false" for every of the  $m$  basics (in the case  $m = 3$ ) according to dynamic behavior. The issue then probabilistically selects a set of visible questions to show, represented by the stochastic vector using boolean values "true" and "false" for every of the  $n$  basics (in the case  $n = 15$ ) according to, the DBN unrolled over instance to make open of time and causal needs, and is written the joint probability allocation over states and questions as

$$P(S_0, \dots, S_T, Q_1, \dots, Q_T) = P(S_0) \prod_{t=1}^T P(S_t | S_{t-1} : P) \quad (2)$$

Where

is some original distribution over shares states,

$$P(Q_t | S_t) = \prod_{i=1}^m P_i \quad (3)$$

And

$$P(S_t | S_{t-1}) = \prod_{i=1}^n P_i(s_t | s_{t-1}, \dots, s_1) \quad (4)$$

Training propose system representation signifies approximating distribution, the transition model.

### 3. SYSTEM DIAGRAM:

The block illustration shown in Fig. 2 shows the system plan of our planned scheme. It is comprised of Graphical User Interface, Fetching Random MCQ from data bank, MS text-to-speech synthesizer, Machine learning technique, Knowledge base and Correct/Incorrect question results.

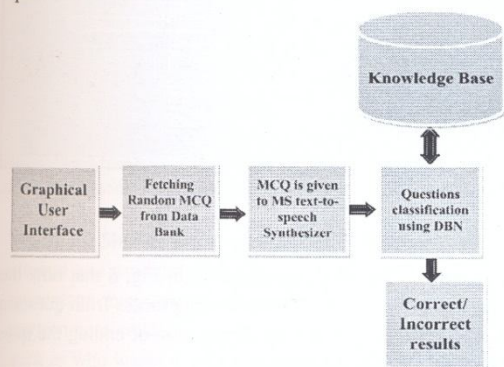


Figure 2: System diagram of proposed system

### 3.2 GRAPHICAL USER INTERFACE:

This is basically a chief component of WWIP system which asks MCQ along with MS text to speech synthesizer talks or reads the visible MCQ which is fetched randomly from the data bank and efforts as a crossing point needed to perform those mentioned steps having certain available clicks to attempt options and proceed for results.

### 3.3 FETCHING RANDOM MCQ FROM DATA BANK

The Who Wants to Be IT Professional is a desktop based application as quiz based software has textual records of the questions next to with options as shown in Figure 3. Using DBNs and data mining technique question statistics can be pulled out, processed and results can be achieved of various fields which can be evaluating an IT professional.

### 3.4 MCQ IS GIVEN TO MS TEXT-TO-SPEECH SYNTHESIZER:

The job of this component is to take question from data bank of WWIP backend store to speech synthesize the fetched question data for candidate.

### 3.5 KNOWLEDGE BASE

This constituent includes MS Access database to accumulate the data bank of question which be stored and taken out by fetcher or proposed technique. The knowledge base shown in Figure 4 keeps updated data.

### 3.6 MACHINE LEARNING TECHNIQUE

The Dynamic Bayesian network as machine learning technique used for prediction of shares with reasons shown below

- DBNs (Dynamic Bayesian Networks) are moment state development of largely used Bayesian Networks articulate doubt and unpredictability which suits WWIP.
- DBNs can grasp incomplete data.
- Competent of construction with major difficulties.
- Accomplish forecasting inference.
- Building for uniting aforementioned knowledge.

3.7 INFERENCE ENGINE:

The research work is dealing with real time, non-deterministic and uncertain type of data, so in the DBN the inference should be evaluated to work on further data. Approximately around one inference is used to provide the non-deterministic and random environment in the software.

4. QUIZ QUESTIONING AND ANSWERING

This segment is very distinctive regarding prediction in which, the candidates are crossing questions of the exacting any area of IT. This segment has many complications to resolve. Generally, real world professionals as teachers assess the students in a particular subject and exam results are declared by other resources. Inference Engine is the implementation of policies for a candidate to provide MCQ using GUI in the look of full screen view which obtains effort to implement the requirement rules, and works as Inference Engine, from machine learning method piece, as catalog of questions gifted from the knowledge base.

There is gateway to start the quiz shown in Figure 3. Below and need the name of candidate and just press enter key

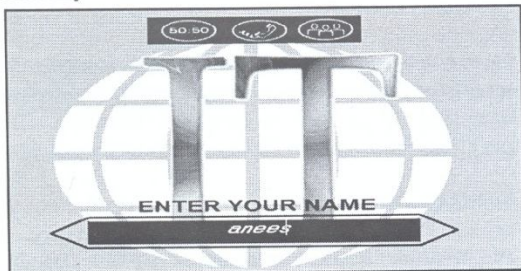


Figure 3: Gateway to start Quiz

The component Inference Engine interacts to existing knowledge base and analyzes the following factors for assessment Q2 FROM GIVEN D1 correctness using choice A, choice B, choice C, choice D, L1, L2 and L3 using data bank. The is an intelligent system shown in Fig. 4 needs three mechanisms as GUI, Knowledge Base and Inference Engine The GUI is full screen desktop, Knowledge base is shaped in MS Access and finally Inference Engine used/developed in Visual Basic 6.0 in the proposed system.

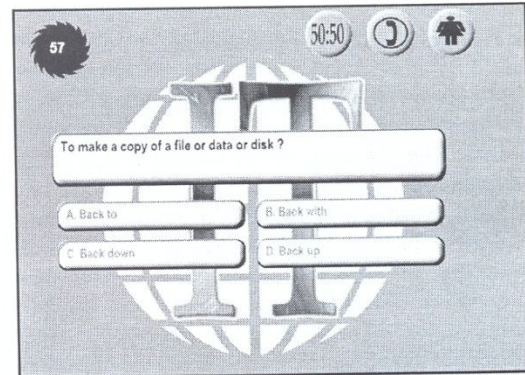


Figure 4: MCQ with Speech synthesizer and life lines

There is also a timer functioning as stop watch which is infernally counting from 60 to 0 to terminate the quiz/game if user/candidate fails to attempt correct option and game shows the message of termination, it means candidate has to attempt right or wrong option using mouse click with one minute of time constraint.

If the candidate attempts the correct option of the question then user will be temporarily entered in the status board environment shown in Figure 5. to show the position of the candidate for crossing the 15 question to become IT professional.

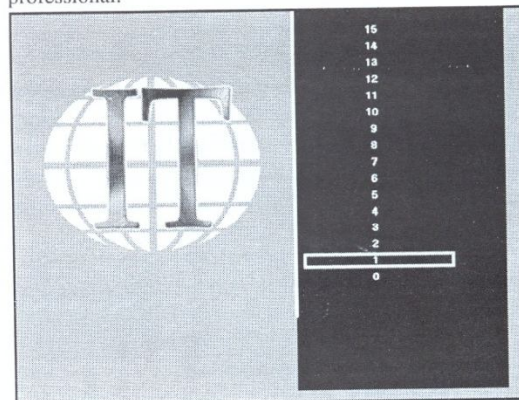


Figure 5: Counter and status board with cheerful remarks to show status

The flow chart of MCQ is shown in Fig. 6 that how the system is making the flow of every process from question fetching to result crossing 15 question or ending the quiz if candidate fails to proceed.

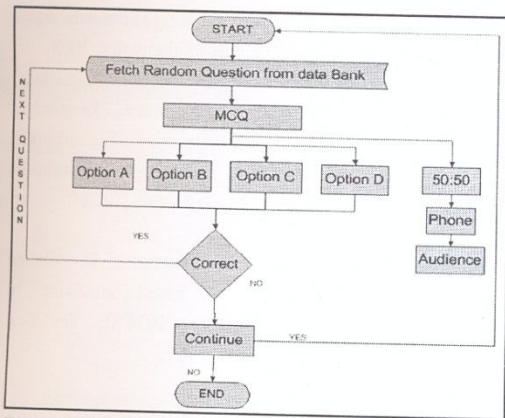


Figure 6: The Flow chart of successful MCQ execution

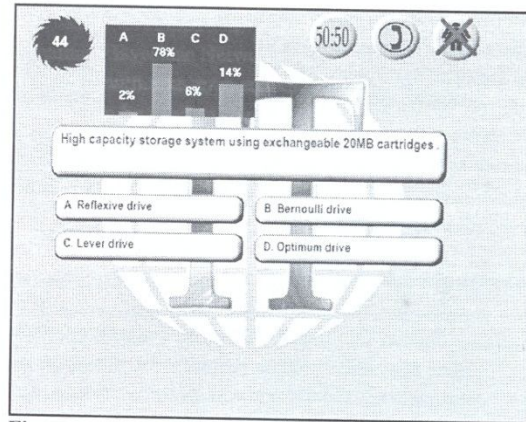


Figure 8: Execution of Audience life line of WWIP

### 5. QUIZ VIRTUAL LIFE LINES

Virtual Life Lines help candidate to know about the correct option of any three questions in other words candidate can take help to know the right option of any three MCQs if answer is unknown or difficult. Generally students/teachers and computing peoples can also obtain benefit from this part; they can resolve their hard troubles and can contrast associated outcomes.

The Figure 7. Shows the executed form of life line 50:50 where two wrong or incorrect options are removed by the system to provide the easiness to candidate.

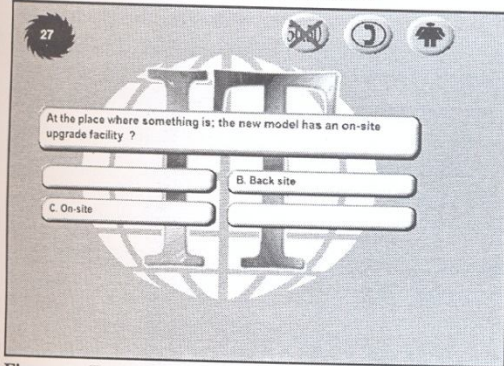


Figure 7: Execution of 50:50 life line of WWIP

Figure 8. Shows the execution of Audience virtual attempt and candidate is helped by viewing the audience percentage bar option. Although it is totally virtual environment created while in the other type of softwares such as who wants to be millionaire or in Indian live quiz program kaun banay ga krur pati the audience is real time.

### 6. RESULTS AND DISCUSSIONS

For the strength of the proposed system, we composed the questions from various resources mostly manual books of IT. On a single question amount of execution is made stood on available data bank. The candidate has to cross 15 questions right answers otherwise he cannot precede the game, the non-deterministic and random nature of questions are creating the interactive environment and candidate can take more interest to boost the knowledge by hardworking and making the discussion with colleagues. If the candidate is successful to cross 15 questions it means he has good knowledge of field and one can justify as IT PROFESSIONAL as the quiz is providing this type of platform. This software is resulted good feed back in the national level software competitions such as 2<sup>nd</sup> Position in First All Pakistan Inter University/College Software Competition 2002, SUIS College Abbotabad and 1<sup>st</sup> Position in SITSO (Sindh IT Students Organization) EXHIBITION, 2002 IMSA Hyderabad. But it is now going to be published in the research journal.

### 7. CONCLUSIONS & FUTURE WORK

We have developed an Intelligent System based on Dynamic Bayesian Network to provide the stochastic questions with text-to-speech environment. The proposed system can be used to check the knowledge of candidates of IT/Computer peoples. Candidates can be joyful to know right time for testing their IT/Computing knowledge without using manual techniques of assessment. This will augment the trust and interest in IT



people to work hard using computer to improve education. The proposed system is recently been explored as factor of information technology and computing. The research has augmented more interest to develop this type of software for various fields. Proposed system is going to update research in client-server environment in which many users may involve to be a part of quiz using network programming.

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