Understanding the Desktop based Cross Platform Software for Digital Current Weather Indicating System (DCWIS)

Harsh Dhar[1] Shwetali Bhagwat[2] Akanksha Yadav[3] Anjali Kumari[4] Prof. Parinita Chate[5]
[1,2,3,4]Student [5]Guide - Assistant Professor
[1,2,3,4,5]Bharati Vidyapeeth's College of Engineering, Lavale, Pune, India

Abstract— Having detailed information on the current weather is important in some industries. Important decisions depend on this information and one wrong step can lead to loss of life. One such industry is India Meteorological Department. The Aviation Department of IMD requires to have continuous monitoring of the changes in the weather as the weather is the deciding factor in many actions to be taken. The fundamental aim of this paper is to design a cross-platform automated weather monitoring system that will enable us to have continuous monitoring of various weather parameters like temperature, humidity, wind, pressure etc. This paper presents a concept that functions to monitor the current weather and that is DCWIS (Digital Current Weather Indicating System). The system's design capabilities and scope has been presented in this paper.

Keywords: DCWIS, METAR, Data Digitizer, Data logger, METLOG 04A, Weather Indicating system, Weather monitoring

I. INTRODUCTION

A weather monitoring system that would gather the data relating to the meteorological parameters like Temperature, humidity, wind, pressure etc. using field sensors and record the data into the server without any human intervention is very essential for many industries. Above this, if the data stored is manipulated and results are generated which are also downloaded in the system by itself without depending on any human intervention will be a cherry on the cake. The Development of effective automated weather systems and their installations in remote locations will help to reduce the cost of weather stations as well as help to maintain them effectively. Communication link plays a very essential role in automated weather systems.

This paper presents one such concept on a cross-platform automated weather monitoring system. This system will be self-dependent as there will be no need to depend on any external factors to perform any functions except a few human interventions required for setting up the system. The system will be capable to perform every task right from collecting data from the sensors required to sense various meteorological parameters deployed on the desired area, for us the runways of various airports, to generating well-calculated results based on the data and displaying the final output after invoking and executing the relevant steps on every client machine connected which will help in accurate weather forecasting.

II. LITERATURE SURVEY

1) "An indigenous design of Integrated Automated Current Weather Instruments System (IACWIS) for aeronautical meteorological observations", Biju, P.S. & Mali, R.R. & Vasishta, R.D. (2008): In this research paper, we understood how the IACWIS system works and its implementation. The IACWIS is upgraded version of the previous conventional CWIS system, as this automated current weather indicating system is used for continuous monitoring of the wind direction, wind speed, temperature, and dew point at the touch down zone of the aerodromes. This IACWIS system is installed and currently in use at seven major airports of India.
2) "An integrated automatic aviation meteorological instrument system at C. S. I. airport, Mumbai" K. S. HOSALIKAR, K. N. MOHAN, R. D. VASHISHTA, AJIT TYAGI, (February 2011): This research paper is about the automatic generation of aviation reports; METAR / SPECI, AFTN (Aeronautical Fixed Telecommunication Network) connectivity for dissemination of aviation weather reports to user agencies and ATIS (Automatic Terminal Interface System) for automatic broadcasting of aviation weather reports to airborne pilot. Besides these features system is having facility to enter manually weather parameter for which sensors are not available such as cloud coverage, past weather, present weather for generation of aviation reports.
3) "METLOG 04A OPERATING MANUAL V1.0", Surface division, Indian Meteorological Department, Pune.: The functioning of METLOG 04A Digitizer from the METLOG 04A OPERATING MANUAL V1.0 provided by the organization. Understanding how the analogue signals received from the sensors are processed performing various computations and these computed data is transmitted through data acquisition system in .csv format and stored in the main memory of the server

III. GOALS AND OBJECTIVES

As DCWIS is current weather indicating system our focus will be to fetch live data collected by the sensors and then perform analysis on the received data to generate the aviation weather report.

With the further implementation and computation of the data along with the raw data collected, it will be displayed on the screen using data visualization techniques for graphical and tabular representation.

As data collected by sensors is specific to a runway, while displaying the data it will be displayed according to that runway number itself. To have a computed report with us for further analysis, this system will generate a timely report in which there will be every detail and will get automatically downloaded into the server. This report is called METAR (Meteorological Terminal Aviation Routine Report.)

The focus is to develop a cross-platform software with a bit more computation functionality with up-gradation of the previous software in use.

IV. UNDERSTANDING DCWIS

DCWIS stands for Digital Current Weather Indicating System, this is used by the aviation department to understand the current weather by analyzing the current weather information and take the desired decisions. In DCWIS software, current weather data is collected from various on-field sensors which are installed on the runways like Meteorological Sensors (Wind direction, speed, Temperature, Humidity and Pressure Sensors). As this software has a server-client interface the data from these sensors is transferred to the DCWIS server machine by following a specific pathway and then it is displayed on the DCWIS client machine for the officials to view and understand the current weather situations and plan out the next moves. DCWIS has a simple user interface to make it easier for anyone, even a layman to understand the weather information easily to help them make faster decisions.

V. DCWIS ARCHITECTURE

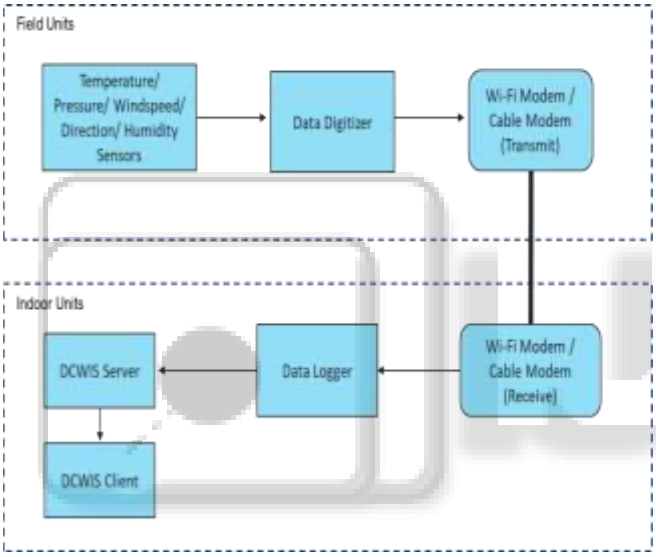

Fig. 1: DCWIS Architecture

Complete system of DCWIS consists of major sub systems - On field instruments and indoor instruments.

A. *ON FIELD INSTRUMENTS:*

On Field Instruments consists of sensors and data digitizer.
Sensors: In present DCWIS system, sensors utilized are:

1) *Potentiometric Wind vane:*

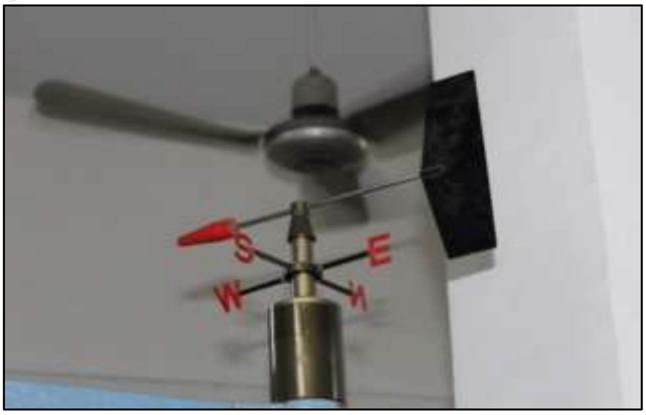

Fig. 2: Potentiometric Wind Vane

The sensor used for measurement of wind direction is an IMD-make potentiometric wind vane. The potentiometer in the wind vane is a servo-micro torque potentiometer and has a maximum resistance of 10 kilo-ohms over an end gap of about 4 degrees. Potentiometer is coupled to wind vane shaft to give resistance output increasing linearly with increasing wind direction 0 – 10 kΩ corresponds to 0° – 360°. Thus, 0 KΩ corresponding to the north, 2.5 KΩ for east, 5 KΩ for south, 7.5 KΩ for west and the variation of 0-360 degree corresponds to 0 to 10 kilo ohms.

2) *Optical Anemometer:*

Fig. 3: Optical Anemometer

Optical Anemometer is also an IMD-make sensor which gives digital as well as optical outputs of wind speed in knots.

3) *Temperature Humidity Sensor:*

Fig. 4: 4 KAS-011 Temperature Humidity Sensor

The KAS-011 is a smart sensor for the measurement of atmospheric temperature and relative humidity in automatic weather station environments. The KAS Series sensors are developed indigenously using the state-of-the-art technology and built to exacting specifications. They offer stable, accurate and reliable performance over long periods of time in the Indian conditions of environment.

4) *Barometric Pressure Sensor:*

Fig. 5: Vaisala BAROCAP® Digital Barometer PTB330

Vaisala BAROCAP® Digital Barometer PTB330 is a new generation barometer, designed for a wide range of high-end atmospheric pressure measurement. The pressure measurement of the

Vaisala PTB330 Digital Barometer is based on the Vaisala in house silicon capacitive absolute pressure sensor; the Vaisala BAROCAP® Sensor. It provides high measurement accuracy and excellent long-term stability.

Potentiometric Wind vane and Optical Anemometer sensors are made in IMD whereas rest all sensors are imported.

5) Data Digitizer:

Fig. 6: Data Digitizer

Data Digitizer is located near the runway touchdown zone. This unit reads the analogue output voltage from the signal received from sensors, digitizes the data and converts these analogue signals or values into corresponding engineering units. The output is sent serially to the Data logger in digital format. The data is transferred to Data logger over a wired modem or cable modem.

B. *INDOOR INSTRUMENTS:*

1) Data Logger:

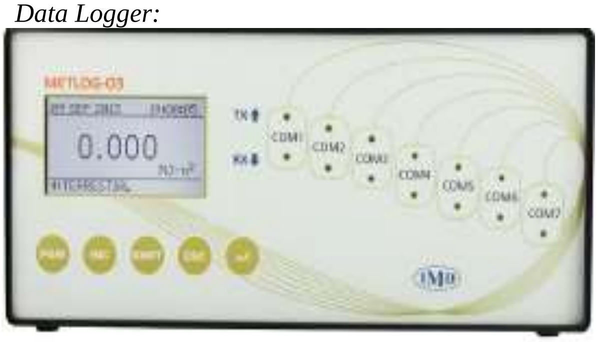

Fig. 7: Data Logger

The Data logger is located at ATC/MBR (Air Traffic Control tower). This device is also called a data acquisition system that reads the transmitted data from the digitizer. The Data logger has the functionality to interface a number of meteorological sensors; from precision temperature, voltage and current measurement to communication interfaces for intelligent sensors. Data is stored in the internal memory of the device and output to PC is sent over RS232 through which the user can monitor all the parameters in run time.

2) WIFI Modem:

Wireless modems are used in the field of aviation instrumentation for communication of data from runway site to ATC/MBR. The frequency used for Transmission is 2.4 GHZ or 5.8GHZ ± 22MHZ with at least 12 Channels. These modems need to be configured for establishing communication. It modulates the data received from the digitizer and transmits it to the ATC tower over the Wireless connection.

3) DCWIS Server:

Server software receives the data sent by the data logger and stores it into a database. These received packets are analyzed with respect to the runway. Meteorological data is computed and is stored in the database. This data is made available to various client workstations for display. After every 30 minutes software pops up a window through which the operator can generate a METAR report. SPECII (the name given to a message that is to be broadcasted to every client) and warnings can also be generated on demand. Any modifications related to the client can be performed on the server.

4) DCWIS Client:

Client software displays the data received from the server. The different options of viewing the data are provided which can be modified from the server.

VI. DCWIS WORKFLOW:

DCWIS software has the following workflow:

1) Sensors collect the current weather information
2) Information collected by these sensors is transferred to the device name Data Digitizer
3) As the data received by the data digitizer is in the analogue format it converts it to digital format and then transfers it to a device named Data logger which is installed in ATC/MBR tower over a Wi-Fi modem or cable modem.
4) The Wi-fi modem in ATC/MBR catches this data and sends it into the Data logger where it is stored in the internal memory of Data logger in .csv format and is also sent to the DCWIS PC server.
5) PC server saves this received data into the database created at server end and performs some operations on this data (operations include calculating 2 min, 10 min averages, calculating values of QNH, QFE etc.) and stores back into the database.
6) The received data which includes the values from sensors and the computed data is then sent to the DCWIS Client machine where all these values are displayed and the display is done according to the runway number.
7) The data in the server is also used to generate METAR that is Meteorological Terminal Aviation Routine Weather Report after every 30 minutes.

VII. SOFTWARE IMPLEMENTATION

1) GUI Design**:** DCWIS Software's user interface will be developed using python PyQt5. The front-end display will be classic and simple to operate. The basic frames are designed using Python libraries, from layout to the buttons and actions performed. Proper sequencing is maintained for the smooth processing of the data and its

display. The focus is concentrated on the time taken for data retrieval from the database to the display window is less than the average time taken by the previous software.

2) Data Analysis: After collecting the data into the database using file handling operations with database connectivity, it will be analyzed and worked on using NumPy and Pandas as it provides a wide range of libraries and tools for data analysis. The data is sorted and sliced in such a way that only the required data entries are used for further analysis to provide accurate results. These results are further used to plot graphs.
3) Data Visualization: Data visualization will be done using Python matplotlib as it can work on a huge amount of data and can plot 2D/3D visual representations in various formats like line/bar/pie.

VIII. Conclusion

The DCWIS is installed at various runways of airports all over India. Features like data collection from the sensors to data computation and storage into the database, self - test and calibration, has improved data quality and reliability.

Besides these features, the software is upgraded with automatic aviation reports which are broadcasted to airborne pilots. The software has Client-Server interfaces, through which the data is displayed at various stations being monitored by the server at the ATC tower. The upgraded software is cross-platform which gives it the flexibility to run on different Operating systems, with the ease of working in any environment.

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