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Data Processing Software for IMD's TDMA type Data Receiving Earth Station

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Abstract: ***Data Processing Software will be built for Indian Meteorological Department's (IMD) Data receiving Earth Station. This software will deal with various weather related parameters which will be used for analysis and further weather forecasting procedures. This software will automate the data storing, analysis procedure completely and provide very much user friendly interface for the ease of the end user. In built quality checks are adhered with these data values to avoid inconsistent and invalid weather parameter values. Finally the software will also provide report generation facility based on the end user's requirements. These reports can be generated based on various parameters and time intervals. Also some additional features with this software are generation of BUFR code and SYNOP messages.***

Keywords: AWS, ARG, TDMA, SYNOP, BUFR.

I. INTRODUCTION

Data processing software is developed for the Indian Meteorological Department's centralized earth station. This ground station will continuously receive the data transmitted by Automatic weather stations situated in India. There are approximately 1900 automatic weather stations which transmit data using Time Division Multiple Access methodology. The received data will be decoded in real time for obtaining the meteorological parameters with sensor identifications. It is capable of receiving downlink transmissions in the entire 300 MHz band (4500 – 4800 MHz) from any of the DRTs on board INSAT / KALPANA-series of satellites. The proposed software will be loaded in the ground station which is associated with a processing computer. The software will convert the meteorological data values of all stations for every hour into a WMO SYNOP format to disseminate the data in real time automatically through FTP (File Transfer Protocol) over a dedicated leased line connection to be made available at AWS lab, Pune, IMD.

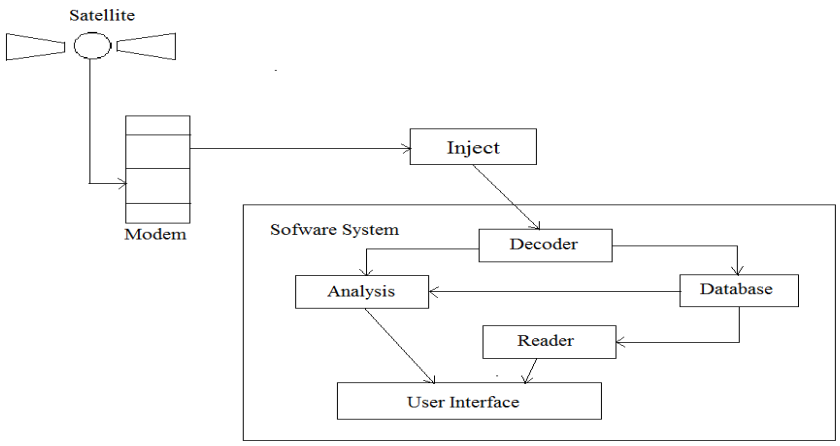

Fig. 1 System Architecture

II. LITERATURE REVIEW

A. Drawbacks of existing system:

The existing software at the Earth Station is very unstable and lacks features of quality checks and extensive report generation. This existing software lacks to generate various code messages (SYNOP and BUFR) which are required to send the data analysis report for forecasting. The current software also faces various database limitations like limited size of database and various relationship constraints. The existing database system which is implemented using MS Access can only contain the data up to 2 Gigabytes. When this limit exceeds the administrator manually has to archive the data and flush the data from the current database. This software also lacks the provision of plotting the various weather stations graphically depending on the data received from those stations. Also graphical representation is one of the major requirements.

B. Need of the proposed software:

The basic need of the software is to automate the entire data processing which will result into effective analysis. Automation of data processing will result in higher efficiency as manual errors will be reduced. Also automation will provide us with precise analysis in timely manner. As the previous software lacks the ability of performing quality control this system will overcome the drawback. Performing quality control will restrict inconsistent data to be involved in the analysis procedure. Along with all these features the system will also provide the facility to generate reports automatically as well as manually which will reduce human efforts. Graphical representations which will be provided in the system will help the users to observe the weather patterns across the country over a specific period of time.

III. IMPLEMENTATION

The proposed software consists of various different components like Data viewer, Data decoder and Quality checking mechanisms. The software will primarily focus on decrypting the data from its raw form to the meteorological values. The initial activity involved in software development process is modeling the system in structural as well as behavioral manner.

A. Decoder module:

Decoder module is the primary or core product of this software development process. As the name states, this module will perform decryption on the input raw data which is received from various weather stations as explained in the introduction part. The decryption is performed on the basis of type of the weather station from which data is received : AWS(Automatic weather station) and ARG(Automatic rain gauge).

The parameters involved in **Automatic Rain Gauge (ARG)** are as listed below:

Sr. No.	Symbol	Parameter Name	Equation
1.	C1	Battery	(x*50/1023)
2.	C2	Rain Hourly	(x)
3.	S00	Atmospheric Temp.(AT)	((x/10)-40)
4.	S01	AT_{max}	((abs(x)/10)-40)
5.	S02	AT_{min}	((abs(x)/10)-40)
6.	S07	Relative Humidity(RH)	(x/10.23)
7.	S12	Rain Daily	(x)

Table I:ARG Parameters

The parameters involved in **Automatic weather station (AWS)** are as listed below:

Sr. No.	Symbol	Parameter Name	Equation
1.	C1	Battery	(x/10)
2.	C2	Rain Hourly	(x)
3.	C3	Soil Moisture	(x)
4.	S00	Atmospheric Temp.(AT)	((x/10)-40)
5.	S01	AT_{max}	((abs(x)/10)-40)
6.	S02	AT_{min}	((abs(x)/10)-40)
7.	S04	Wind Speed	(x/10.23)*1.9439
8.	S05	Wind Direction	(x/2.046)
9.	S06	Pressure	(x/(x+0.0000001))*((x/10.23)+925)
10.	S07	Relative Humidity(RH)	(x/10.23)
11.	S12	Rain Daily	(x)
12.	S13	Soil Temperature	((x/10)-40)
13.	S17	Sun Duration	(x)

Table II:AWS Parameters

The equations mentioned in the tables are used for decryption of data which is received in the raw file. ("**x**" is the value of the symbol as received).

B. Analysis Module:

The main responsibility of analysis module is to deliver correct and quality data to the end users, as the delivery of erratic data may result into fallacy conclusions and inaccurate observations. Hence various quality checks are embedded in this module. One should keep in mind that quality check is the last line of defense in preventing degraded data from reaching the end user. The Quality Check(QC) includes Range check(gross error, climatologically limit check), step check(maximum and minimum allowable variation during measurement interval) and consistency check(temporal, internal and spatial) on the raw data in sequential manner.

1] Range Check:

Range Check primarily eliminates the outliers in the data of each station. The range is determined based on the sensor range and climatologically extremes. The range check detects values that are certainly wrong or impossible meteorologically or physically. In this check, value of a parameter is first checked with range of sensor. If the value is beyond the sensor range then it is discarded. Also the values with sudden change are flagged as either erroneous or doubtful.

2] Time Consistency Check:

Time consistency Check is based on based on the principle of maximum allowable variation(k) in a parameter within certain period of time. The values may have wide variation for different stations depending on range of parameter being checked and local climatic conditions. For example the value of parameter 'x' at time 't' is checked with the value at time 't-h'. If x(t-h)-x(t) >k, then x(t) is either erroneous or doubtful depending on the value of 'k'.

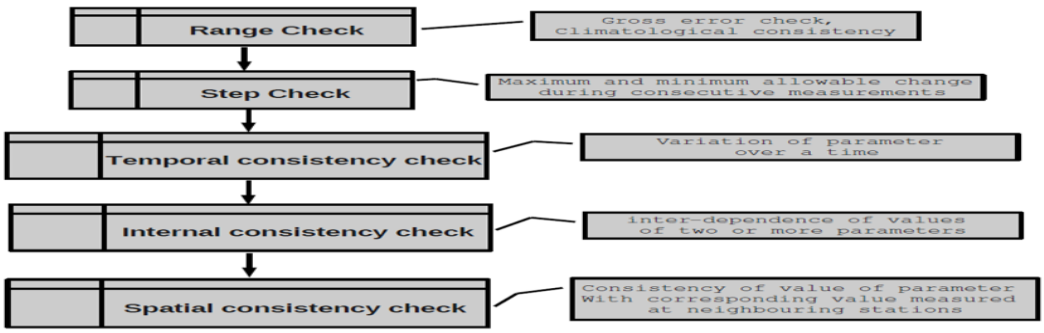

Fig. 2: Quality check techniques

3] Internal Consistency Check:

The values of weather parameter are interdependent. If significant change is observed in value of a parameter then the value of dependent parameter should change accordingly. This is the working of Internal Consistency Check. For Example, if relative humidity is low say 40% and it is raining then either relative humidity or rainfall is wrong.

4] Spatial Consistency Check:

This test checks whether the received value falls within an interval formed from surrounding stations data during a time period of length 'n'. All stations lying within 2^o latitude x 2^o longitude area from the station of interest are considered for this check.

C. Report Generation Module:

Along with analysis it is really necessary to document the observations made by the system. The report generation module deals with documenting the collective output of the observations made in specific time period.

The reports will be generated in various forms:

1] Station status:

The report generation will be helpful for the maintenance team as it will provide statistical data about working of stations.

2] WMO message generation:

Report generation also includes generation of various WMO(World Meteorological Organization) message formats like SYNOP and BUFR. SYNOP stands for Surface Synoptic Observations which is a numerical code used for reporting weather observations made by manned and automated weather stations. BUFR stands for the Binary Universal Form for the Representation of meteorological data which is a binary data format maintained by WMO.

IV. CONCLUSION

Data Processing software is an integral component of AWS network. The raw data received centrally at the Earth Station is processed by the software in near real time. The raw data are decoded to obtain engineering values of all parameters for all stations in the network. The data are archived in relational database after passing through quality control software routines. The quality control data are encoded into WMO code format for national and international exchange and are disseminated through WMO Information System (WIS), IMD, New Delhi. The data disseminated through WIS is available for operational utilization by forecasters and other end users across the globe.

Acknowledgement

Data Processing software deals with various weather related parameters which are used for analysis and further weather forecasting procedures. This software automates the data storing, analysis procedure completely and provides very much user friendly interface for the ease of the end user. Hence this software system will help the weather forecasting and analysis to be performed more efficiently and effectively.

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