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IOT SENSOR BASED ZONE SPECIFIC WEATHER FORECASTING AND ENVIRONMENTAL MONITORING SYSTEM

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Abstract - Weather monitoring has become a quintessential aspect in a variety of fields. Often the challenge lies in fetching accurate information from the site. Having weather information regarding just a particular city isn't sufficient as the weather changes are brisk. In a large city, weather conditions vary from region-to-region. Zone-specific information is needed during such scenarios. By acquiring resources from a group of service providers, it can aid in the easy retrieval of weather parameters and can be extended for pollutant content check as a part of environmental monitoring system. The paper proposes a sensor-based system to monitor weather and environment at zonal level.
Keywords – Internet of Things, sensor, cloud, fog Arduino, Rasberry Pi

1. INTRODUCTION

The need to get real-time updates about various weather parameters such as temperature, humidity, barometric pressure and light has inspired engineers to develop conductive systems for the same. Usage specific systems need to be developed while considering the cost and requirement for each domain. Many a time, there are drastic variations in weather parameters across a city. Some parts might experience rainfall whereas others might have an overcast or slightly sunny weather. These variations render the existing weather data redundant as there is no proper way to generalize these anomalies. Moreover, it isn't advisable to derive average readings from the same because real-time weather information is what we are targeting always. The same goes for the air-pollutant level check. To rely only on one service provider or few service providers to fetch such information is difficult. Active collaboration with a number of players in different areas is required to implement such type of framework. Here crowdsourcing can be implemented for gathering the datasets from already established infrastructure. This can include the Telecom service providers, radio stations, other government establishments. Few sensors have to be installed for data gathering and transmitting to a central location for processing that data. These sensors have to be cost effective for the large-scale implementation of this system [1,2]. The paper proposes a sensor-based approach to monitor weather influencing factors like temperature, pressure, humidity, etc. Further environmental pollutants including hazardous gases are also monitored.

The rest of the paper is organized as follows. Related work is explained in section II. Weather Monitoring and Forecasting are presented in section III. Zone Specific Monitoring is explained in section IV. System Design is explained in section V. Results are explained in section VI. Inferences are explained in section VII. Conclusions and future work has been discussed in section VIII.

2. RELATED WORK

[4] discusses an approach to design and develop a low-cost alternative weather monitoring system that connects online for logging and data visualization. The proposed system is largely based on the Arduino platform to process and send data. This system uses the traditional Ethernet wired connection for stability and reliability of data transmission at the cost of being less portable. Then the system was tested for two weeks. Based on the collected data, the sensors and microcontroller were functional and reliable in terms of its consistency in reading the desired weather variables and updating the values displayed in the online monitor. Another approach uses a device called WeBo for weather monitoring and it is equipped with weather sensors and GPS, placed on buses ceiling to measure weather variables like humidity, temperature, and air quality during the bus path. The weather variables are stored together with the latitude and longitude of the measuring place and the exact time of measurement. We Bo synchronizes its data with all other WeBos met during the path due to a Bluetooth radio. This same radio is used to upload the data when the bus arrives in the terminal to a server called TeCo. The data downloaded by TeCo is transmitted to the main server and processed by a system called SysCo. With the information captured by the buses during the day, Sys Co can generate reports of points in the city where the temperature is above the normal, and places where the air quality is inappropriate [4]. [5] make use of the telecom infrastructure for zonal level weather monitoring. Telecom towers are enacted by the service providers and once installed; they have a lifespan of around 20-25 years with less maintenance. Each tower has for itself unique geographical coordinates to identify its location, a power supply, grid-map (on the server

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side) and a database on the administrator end to keep a check of its operations. All these aspects can be used to monitor the zone-specific weather. The system consists of a sensor node which collects data in almost real time and sends it to the base station by using Zig Bee transmitter. The base station receives the data through a ZigBee receiver and sends it to the user via GSM Module. This facilitates the reception of data by the user defying geographical restrictions. An Interactive Predictive System for Weather Forecasting has a dataset that is built about Jordanian weather and precipitation related information. This information is gathered from local and web resources. A tool is built to parse all weather related information from different websites that store such information [5]. Data mining algorithms namely neural network, random forest, classification and regression tree, support vector machine and k-nearest neighbor is used in Applications of Data Mining in Weather Forecasting [7].

3. WEATHER MONITORING AND FORECASTING

Weather monitoring is used for measuring atmospheric conditions to provide information for weather forecasts and to study the weather and climate. The measurements taken include temperature, atmospheric pressure, humidity, wind, speed, wind direction and precipitation amounts. Wind measurements are taken with a few other obstructions as possible, while temperature and humidity measurements are kept free from direct solar radiation, or insulation. Manual observations are taken at least once daily, while automated measurements are taken at least once an hour.

Typical weather stations have the following instruments: thermometer for measuring air and sea surface temperature, a barometer for measuring atmospheric pressure, a hygrometer for measuring humidity, an anemometer for measuring wind speed, pyranometer for measuring solar radiation, a rain gauge for measuring liquid precipitation over a set period of time.

In addition, at certain automated airport weather stations, additional instruments may be employed, including weather/precipitation identification sensor for identifying falling precipitation, transmissometer for measuring visibility and ceilometer for measuring cloud ceiling. more sophisticated stations may also measure the ultraviolet index, leaf wetness, soil moisture, soil temperature, the water temperature in ponds, lakes, creeks, or rivers, and occasionally other data.

4. ZONE SPECIFIC MONITORING

The input gathering system relies on the weather stations which are collecting data for either a global model or regional model. So a weather station present in a computational grid can be used for taking the average reading of that sub-grid. Hence the regional models are not precise enough for determining the micro-scale climatic details for every terrain. This non-uniformity of the geography should be taken into consideration to form different zones of varying shapes depending upon the terrain. These zones would share common landscape characteristics and weather patterns on a local scale. This can be applied to cities/regions with diverse geography.

For our system, we have identified five different such zones in Srinagar city. The reason for taking this city is because of its geographical variations. The presence of water bodies (Dal Lake and Jhelum River), hills, and forest and altitude variations makes this city ideal for testing our system. The variations in the parametric values can be verified by installing the low-cost sensor setup in these zones. Because of this, the precision of the system for monitoring and forecasting the micro-scale climate details can be increased.

Figure 1. Zone Division of Srinagar City

Table 1 - Zone Classification of Srinagar City

Zone Labels	Classification
Zone 1	Near the Dal Lake and Nigeen Lake but away from hills
Zone 2	Near the Dal Lake and near the hills
Zone 3	Near the Jehlum River
Zone 4	The farthest region from any lake/river
Zone 5	Region surrounding forest

Given below are the reasons for parameters selection. These parameters are selected according to the geography of Srinagar city but it can be generalized to fit any specific area.

Table 2 - Parameter Selection Reason

Parameters	Reasons for Choosing
Humidity / Precipitation	Near / Far water bodies may change the values drastically
Water Bodies (Dal / Jhelum)	Changes the wind speed, nearby temperatures and also defines the cold/hot fronts
Hill / Forest Areas	Changes the wind speed, wind direction and also changes humidity/precipitation
Altitude	Variation in air pressure levels which determine the wind direction and speed

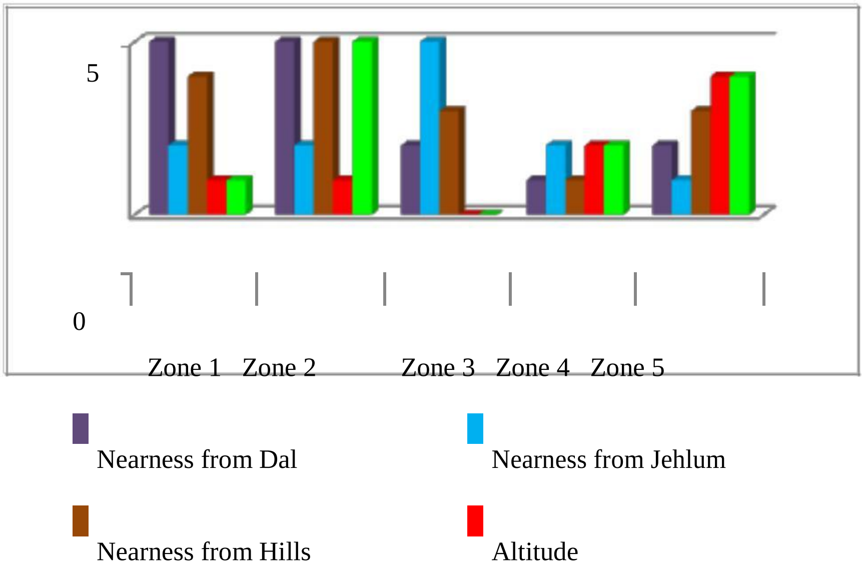


Figure 2. Relative Grading of Zones in Srinagar City

Each zone is rated on the relative scale of 0-5 on the basis of geographical criteria, 0 being the lowest and 5 the highest rating. Clearly, all the 5 zones have variations in those parameters because of the distinct geographical factors. In our system, we selected Zone 1 and Zone 3 because of high variations in almost all factors. We monitored the parameters such as temperature, humidity, and pressure, in both zones for 23 days to see the variations in the results.

5. SYSTEM DESIGN

Weather monitoring systems should be cost effective for large-scale implementation. We carefully selected the hardware components so that the system can be created in the most economical way. Also, the system is built in such a way that it can be accessed from anywhere provided the system is connected to internet. For our system, we are using Raspberry Pi based weather monitoring system. Hardware component includes: Raspberry Pi 3 Model B
Sensors:
DHT22: Measures temperature and humidity
BMP180: Measures pressure, altitude, and temperature
MQ3: Measures alcohol, ethanol and smoke
MQ7: Measures carbon monoxide content
MCP 3208: Analog to Digital Converter
Resisters
Breadboard
Connecting Wires
Weather Forecasting techniques require a huge amount of previous data, usually 30-40 years, to accurately predict the future weather conditions. This huge amount of data set is then used in Neural Networks for training (Supervised learning) and after training it can predict the future values within the margin of error.

6. RESULTS

The following are the graphs depicting the data collected from Zone 1 and Zone 3 of Srinagar City over the period of 23 days (18-05-2017 to 08-06-2017). Each day, 7 samples were collected with the time stamps as 5:30, 8:30, 11:30, 14:30, 17:30, 20:30 and 23:30. Daytime is represented by the peaks and night time by troughs. Following subsections summarize our results and inferences drawn based on critical parameters like temperature, humidity, and pressure.
In figure 3, the temperature difference is present in almost every sample of the graph but the night temperature of Zone 1 is consistently lower. This is obviously due to the presence of large water body (Dal Lake).
Temperature(In Celsius) Time

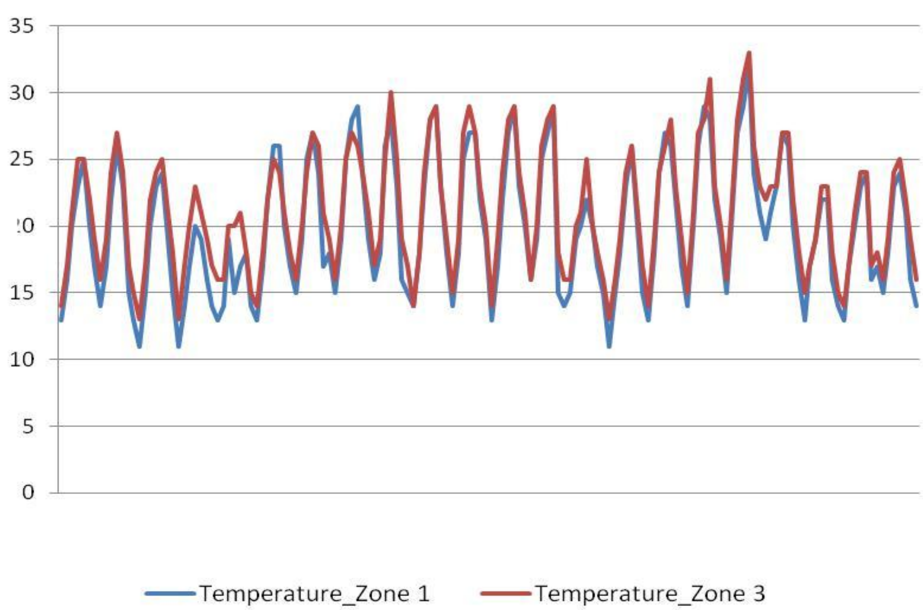
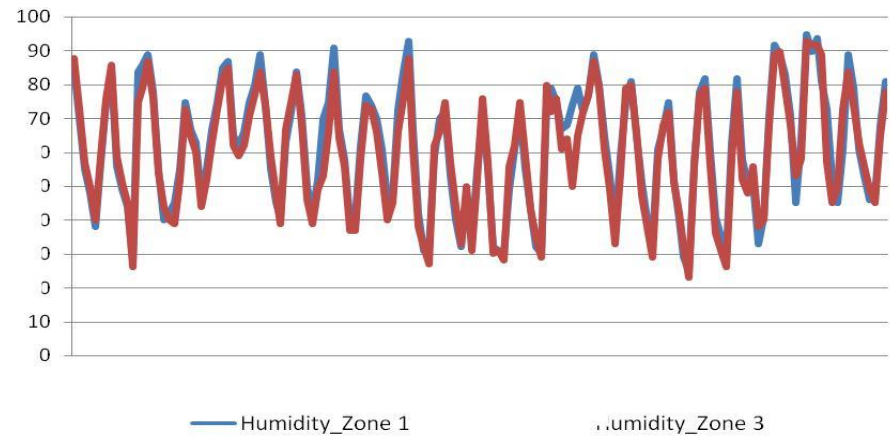


Figure 3. Temperature Graph

In figure 4, the variations in humidity levels are also quite obvious from the graph. The daytime in Zone 1 shows relatively more humidity levels than Zone 3. This is also due to the evaporation of the Dal Lake during daytime which results in more humid climate than Zone 3. Also, there are some points in the graph which don’t quite match with each other. These variations are 20% to 30% at one point.

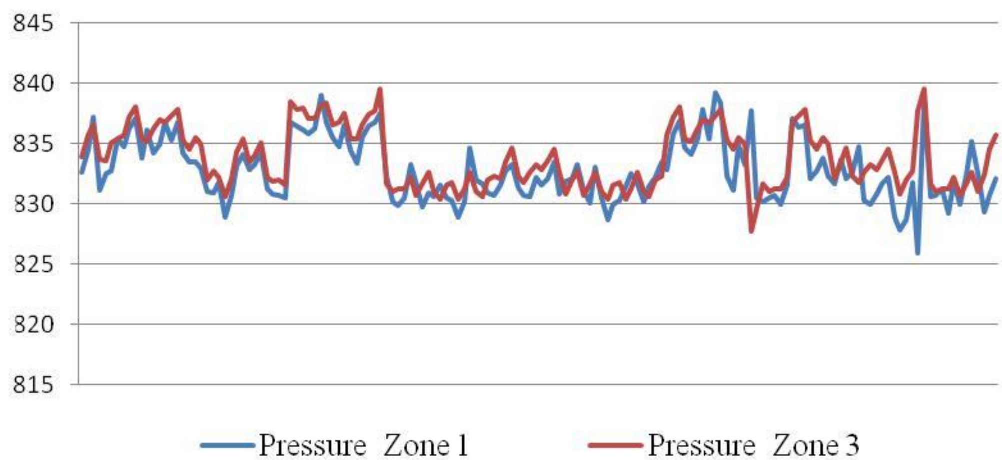


Humidity(In %age)Time

Figure 4. Humidity Graph

In figure 5, Pressure variations in both zones were quite different. General trend shows that Zone 3 relatively is a higher pressure zone than Zone 1. There are some values in the graph in which pressure levels drop more often. These are the points in which low-pressure zones are created over Zone 1. This leads to the winds moving towards this low-pressure region and probably bringing together the clouds with it (possibility of rainfall).

Pressure
(In mbar)



Time

Figure 5. Pressure Graph

7. INFERENCES

Some inferences made from these results are stated under:

Each zone has distinct weather characteristics due to variations in topography. Each zone would share common landscape characteristics and weather patterns on a local scale. Zone 1 has relatively lower night temperatures levels than Zone 3. This is due to Lake-breeze formation. Zone 3 has relatively lower daytime humidity levels than Zone 3.

This is due to the fact that during daytime evaporation of large water body (Dal Lake) is higher than that of Jhelum River. Hence the presence of a large water body near a zone leads to increased humidity levels during the daytime. There are some points in Humidity Graph where Zone 1 has 20% to 30% more humidity than Zone 3. This is due to rainfall in Zone 1 but not in Zone 3, which verifies the fact that there are local variations present. Although Jhelum is also a water body, the scale of the Dal Lake and Lake-breeze phenomena on such large-scale results in these variations. Pressure variations in Zone 1 are also much more frequent due to the presence of large mountains nearby and the Dal Lake. These factors cause the creation of different pressure zones above the lake which are very unstable.

8. CONCLUSIONS AND FUTURE WORK

The aim of this system is to create a low-cost zone specific weather monitoring system and also be used as an environmental monitoring system. This system will also be able to predict the zone level weather using the current data set within the margin of error. The secondary task is to create an environmental monitoring system. This system can also be extended for air quality monitoring in polluted regions, forest fire detections, flood detection and many more

The system can be further extended with the help of already established government infrastructures and third parties such as Telecom Service providers. Large-scale implementation of this system with more sensors can be used to gather large datasets of weather parameters and can be used in far-flung areas.

With some of the prediction models like Linear Regression, Multi-Variable Regression, SVM (Support Vector Machines), Numerical Prediction Model and some Neural Networks more precise and accurate predictions can be made.

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