Networking of Pressures and Temperatures using IoT for Industrial Applications

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Abstract— Pressure and Temperature play important role in heat engines and machines. In a constant volume or known volume changes of these two parameters and their knowledge can lead to many important decisions. High rise in temperature or pressure either directly noted or indirectly obtained through extrapolations and calculations can help in maintenance activity to even intercept and avert accidents. Temperature and Pressure in real time can be simultaneously monitored by resorting to IoT. Using sensors and Arduino mother board we monitor these parameters in this work. Decisions related to maintenance or calculations therefore (around Temperature, Pressure and Volumes known) can be improved to higher precision and accuracy by this technique. Thermodynamic cycle related experiments for example can use this network method if the sensors can be installed in the work volume. Only ranges of the sensors have to be carefully kept in mind at design stage. Also their time to time calibration has to be duly taken care.

Key words: Sensors, Internet of Things, Aurdino, Things Speak, LM-35

I. INTRODUCTION

Pressure and Temperature measurements are important in engineering use. They are monitored in machines,engines and industrial equipment in their maintainence. In this work, we will analyze that how both pressure and temperature can be monitored simultaneously. The recorded data will be available in the tabular as well as graphical form. The data will be available in the form of Pressure vs Time as well as Temperature vs Time. That data can be further stored into the clouds using wifi and internet so that if any undesirable change occurs in the pressure or temperature the alarm will automatically give warning so that the system can be prevented from any sort of damage.

In this work we have used one pressure transducer and one temperature sensor which will measure Pressure and temperature simultaneously. The output from the sensors will be given to wifi through aurdino which can be further put into the clouds and can be monitored in both tabular as well as graphical form with respect to time. The further ranges of sensors will be useful in sensing high ranges of pressure and temperatures for many other applications.

II. PROBLEM STATEMENT

Temperature and pressure measurements and applications using IoT are taken up. Both pressure and temperature are measured simultaneously using two different sensors on a small frame which are connected to the microcontroller. Through microcontroller and wifi the details are stored in cloud. It can be in the form of a table or graph. Both are illustrated. Thresholds, limits on pressure and temperature or any variations thereof can be taken care for triggering alarm or bring it to the notice of the maintainance squad of the equipment. Thus sensor based data stored in cloud can be made accessible by using IoT and cloud. Decision making using multiple further processing steps of data thus stored will be very useful in maintainence activity. Even archives and past maintainance records accessible this way through cloud are of very high value.

To illustrate a rice cooker example is taken up without the maintainance problem associated with it. Measurement of pressure and temperature and records of this rice cooker are shown.

III. LITERATURE SURVEY

The Internet of Things (loT) is a recent communication, in which a network connects all things to the internet for communicating through the sensing devices with suitable protocols, and exchange data with each other by using wireless sensor networks [1].

Using IoT the device is connected to the internet and all the data can be shared with other objects without human interaction in the middle. The loT is used to measure real time events and control particular task. IoT provides the detailed information in all fields like agriculture, health monitoring, home automation, etc. With the increase in the number and functions of different sensors the IoT which connects a particular set of things, is easily programmable, and more capable of interacting with human through technologies [2].

Several papers have appeared in the literature which discusses the measurement of pressure. Monitoring of pressure was carried out with the help of different sensors and microcontrollers. The work carried out by some researchers related to pressure measurement system is as follows:

Sankar. [6] has developed microcontroller based calculating and monitoring the pressure, temperature and humidity with respect to time and date using hydrogen balloon. The microcontroller, pressure, temperature and humidity sensors are embedded into the hydrogen balloon. The measured values are sent to ground stations using radio frequency signals.

Maryam Kahali Moghaddam [7] constructed real-time monitoring pressure changes inside the fiber composite laminate using a BMP085 barometric pressure sensor.

Ambarish G [8] has designed and developed direct type pressure on the tires using piezoresistive pressure sensor and PICI6F877. A microcontroller which is used to convert analog output voltage into digital form. The digital data then transmitted to the receiver to display the pressure. From the literature, it is very much clear that it is the working and the principle of measurement of pressure. But

the automatic measurement of pressure and the temperature was not found.

IV. PROPOSED SYSTEM

The proposed system deals with the temperature and pressure measurement as they play a very crucial role in engineering use. Two sensors are used to measure pressure and temperature on a small frame which are connected to the microcontroller. Through microcontroller and wifi the data is stored into the cloud. Networking of temperature and pressure can be also very useful for the further mechanical systems with high ranges. The details of the components are mentioned below with their characteristics:

A. LM-35 (Temperature Sensor)

- Calibrated Directly in Celsius (Centigrade)
- Linear + 10-mV/°C Scale Factor
- 0.5°C Ensured Accuracy (at 25°C)
- Rated for Full −55°C to 150°C Range
- Suitable for Remote Applications
- Low-Cost Due to Wafer-Level Trimming
- Operates from 4 V to 30 V
- Less Than 60-µA Current Drain
- Low Self-Heating, 0.08°C in Still Air
- Non-Linearity Only ±¼°C Typical

B. BMP 180 (Pressure Sensor)

- Vin: 3 to 5VDC
- Logic: 3 to 5V compliant
- Pressure sensing range: 300-1100 hPa (9000m to -500m above sea level)
- Up to 0.03hPa / 0.25m resolution
- -40 to +85°C operational range, +-2°C temperature accuracy
- This board/chip uses I2C 7-bit address 0x77.

C. NodeMcU (Microcontroller)

- Advanced API for hardware IO, which can dramatically reduce the redundant work for configuring and manipulating hardware. Code like arduino, but interactively in Lua script.
- Event-driven API for network applications, which facilitates developers writing code running on a 5mm*5mm sized MCU in Nodes style. Greatly speed up your IOT application developing process.
- Less than $2 WI-FI MCU ESP8266 integrated and easy to prototyping development kit. We provide the best platform for IOT application development at the lowest cost.

D. Block Diagram:

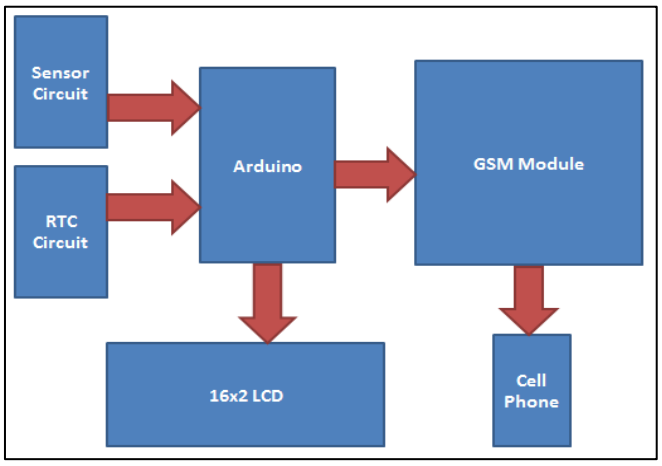


Fig. 1: Block Diagram

V. WORKING PRINCIPLE

The working principle is based upon the combination as well as networking of two sensors which are Temperature sensor and Pressure sensor. It will allow us to monitor the exact Pressure and Temperature of any mechanical system in industries. The sensors outputs are given to the Arudino and from there it is transmitted to the wifi module and through there the data is directly given and stored in the clouds. An application called Things Speak will help us to monitor the data through internet at each and every point of time through our mobile phones or laptops. If we find any undesirable changes in the sensors output then immediately we need to switch off the system and try to rectify the problem to avoid the damages.

The errand of the microcontroller is to screen the information got by the sensors (yield of sensors) without interference. The microcontroller which we are using here is a wifi inbuilt microcontroller which means we will not require any external wifi module to transmit our data to the internet.

A. Pressure Sensor:

A pressure sensor is a for pressure determination of gases or liquids. Pressure is an outflow of the power required to eradicate a liquid from extending, and is typically given as far power per unit area. A pressure sensor is a

Fig. 2: Pressure Sensor

1) Transducer;

It creates a mark as an element of the weight forced. For the reasons for this article, such a mark is electrical.

2) Rise Time & Time Constant:

The reaction time conduct of weight sensor. How is the reaction time characterized and what is the meaning of the ascent time. The reaction time of pressure sensors is reflected in a substantial number of differing parameters, for example, the reaction time, settling time or rise time in details or information sheets. By and large, it can be accepted that the reaction time is characterized as the interim required by the yield flag of a weight sensor to show an adjustment in the connected weight. Of most noteworthy reasonable pertinence is the alleged ascent time. The realistic demonstrates a rearranged graph of a stage like change in weight (appeared in blue) with a period deferred change in flag of the weight sensor (appeared in red). For straightforwardness, the photo just demonstrates a perfect circumstance.

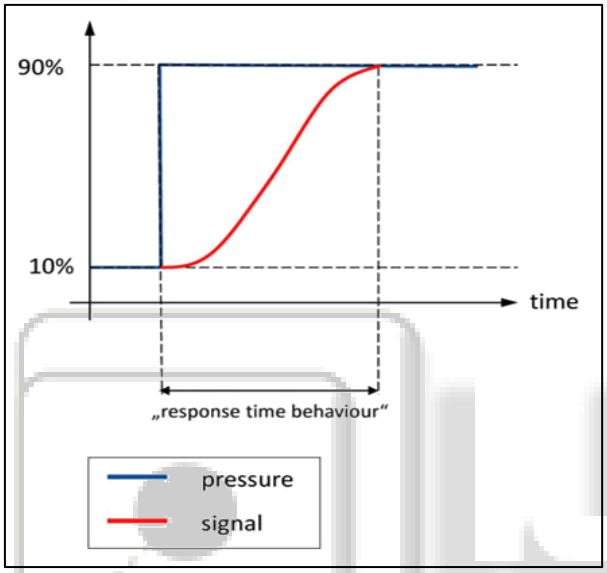


Fig. 3:

B. Temperature Sensor

Temperature sensing is one of the most sensitive properties or parameters for industries like petrochemical, automotive, aerospace and defense, consumer electronics, and so on. These sensors are installed into devices with the purpose of measuring the temperature of a medium accurately and efficiently in a given set of requirements.

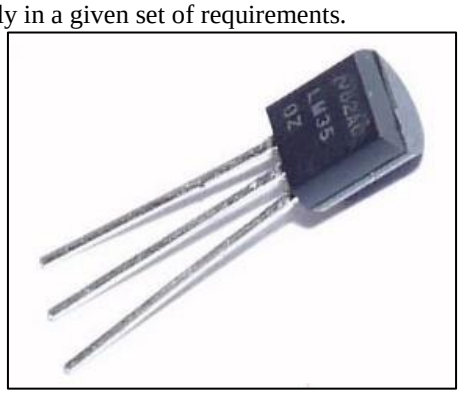


Fig. 4: Temperature sensor

1) Rise Time & Time Constant:

The warm reaction of a temperature sensor is the speed at which it reacts to a sudden change in temperature. Warm reaction time is the time taken for the sensor to respond to this adjustment in temperature.

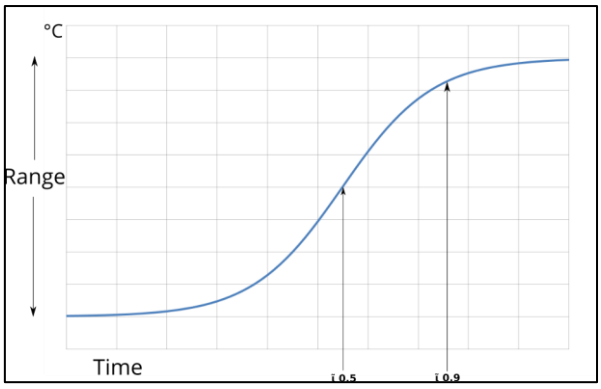


Fig. 5:

2) How to Get Good Thermal Response Times:

To develop the thermal response time of a sensor, there is a number of design considerations that must be taken into consideration during sensor manufacture. Response times can be developed by following simple techniques during the manufacturing stage as detailed below:

1) Select a sensor – It should not be as powerful as larger sensors but smaller sensors will produce faster signal responses. In this case you have to make a technical compromise whether you need a fast and small sensor or a larger and most powerful probe.
2) Guarantee the producer fills all air voids – An air void is an insulator, which will increment the response time of a probe.
3) Just utilize a security sheath if completely fundamental – The material of the assurance sheath will diminish the reaction given.
4) Carefully select the sensor according to your requirement – With regards to warm reaction, careful idea must be implemented as to which sensor might be utilized. Thermocouples show faster outcomes than the normal thermometers. As we all know that thermocouples contain just 2 wires, though RT's are a discrete component with a warm mass. An essential component with no sheath is the most effective plan, in more forceful conditions a mineral protected thermocouple is generally prevalent.

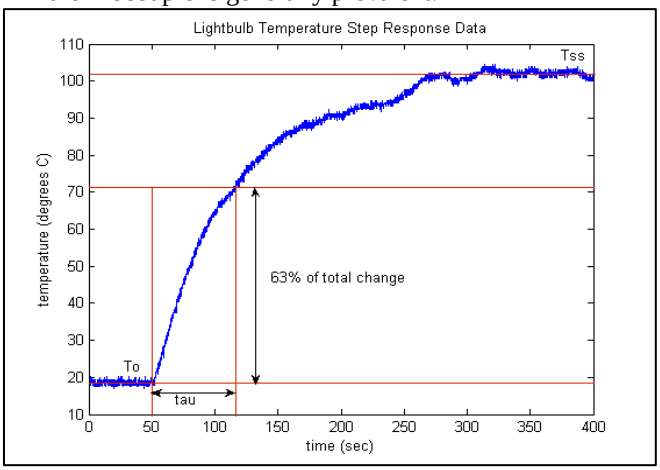


Fig. 6: Time Constant

C. NodeMCU:

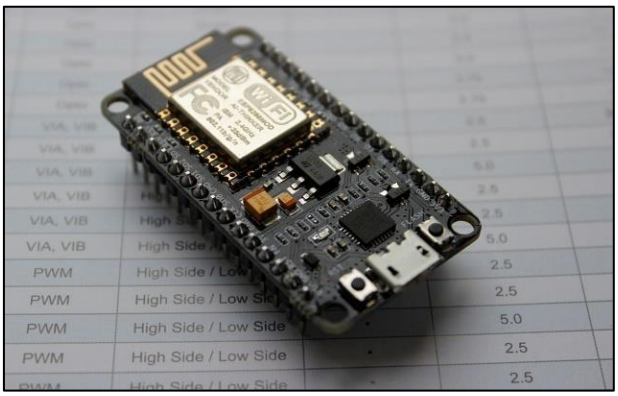


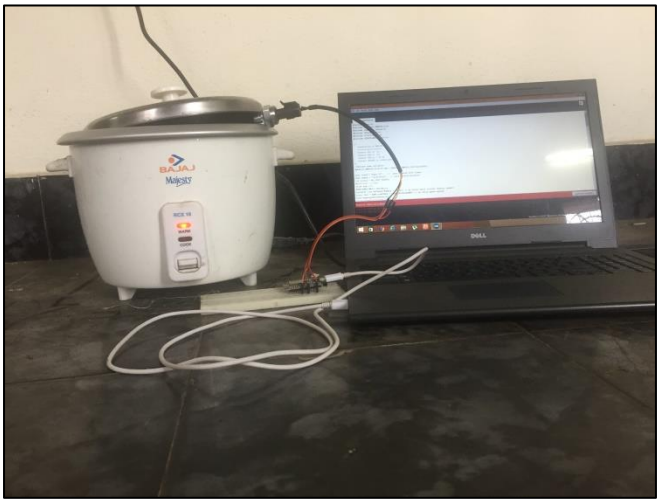
Fig. 7: NodeMCU

The NodeMCU (Node Microcontroller Unit) is an open source software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains all crucial elements of the modern computer: CPU, RAM, networking (wifi), and even a modern operating system and SDK. When purchased at bulk, the ESP8266 chip costs only $2 USD a piece. That makes it an excellent choice for IoT projects of all kinds.

VI. ADVANTAGES

1) There are no complications because considerable distance can be covered including the internet of things for the receiving point of signals.
2) Analog and Digital forms being available in tabular and graphical forms so they can be saved in the cloud.
3) Archives and past maintenance records accessible this way through cloud are of very high value.
4) The maintenance cost of this work is affordable and reliable.
5) This work can be also useful in industrial applications with some high ranges of sensors.

VII. PRACTICAL IMPLEMENTATION:



The Practical implementation of this system is tested through a rice cooker where we have connected the pressure and temperature sensors into the rice cooker along with the whole circuit setup. Here we have observed that with respect to time the temperature and pressure increases and both can be obtained in graphical form as well as tabular form. We can also use these sensors for the pressure measurement for water flow as well as oil pressure measurement and for other industrial purposes also is well.

VIII. OUTPUTS

A. Temperature graph:

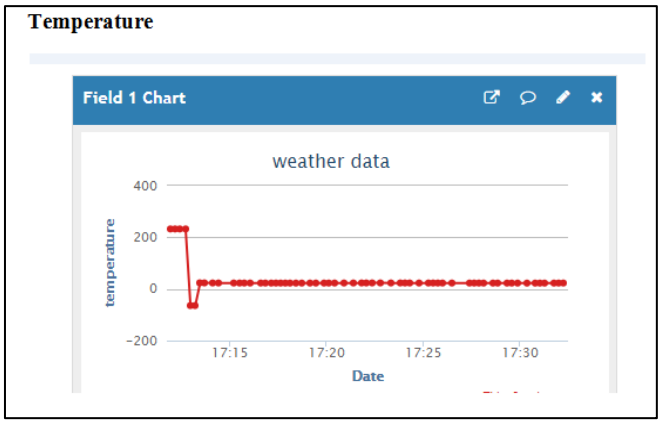


Fig. 8.1:

The above graph is a graph of Temperature which is measured through the Sensor LM 35. This graph shows that how the Temperature Varies at every time within a gap of 5 seconds. The graph is showing that how the temperature varies when it was taken to area with more temperature and then again we took it to area where the temperature is low. So, here we can see a sudden decrease in the graph and after that the graph remains constant which means the temperature is also constant in that particular area.

B. Pressure Graph:

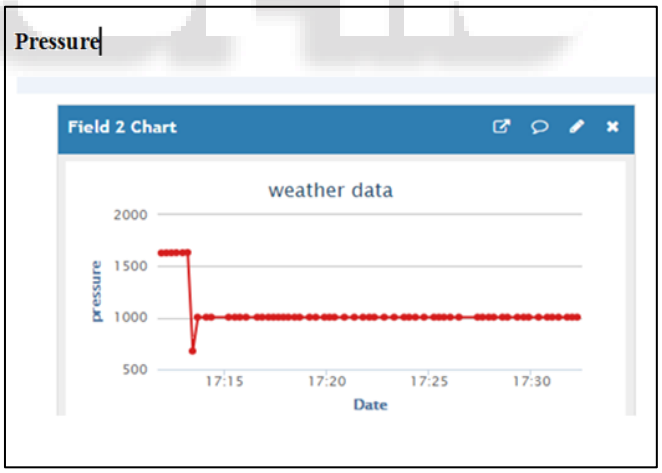


Fig. 8.2:

The above graph is a graph of Pressure which is measured through the Pressure Sensor. This graph shows that how the Pressure varies at every time within a gap of 5 seconds. The graph is showing that how the Pressure varies when it was taken to area with more Pressure and then again we took it to area where the Pressure is low. So, here we can see a sudden decrease in the graph and after that the graph remains constant which means the Pressure is also constant in that particular area.

C. Tabular Data Information:

```
-------------------------------------
Pressure:    1642.76 mBar
Temperature: 232.40 C
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Pressure:    1643.85 mBar
Temperature: 232.40 C
-------------------------------------
Pressure:    1645.20 mBar
Temperature: 232.40 C
-------------------------------------
Pressure:    1646.35 mBar
Temperature: 232.40 C
-------------------------------------
Pressure:    1647.84 mBar
Temperature: 232.40 C
-------------------------------------
Pressure:    1649.67 mBar
Temperature: 232.40 C
-------------------------------------
Pressure:    1650.70 mBar
Temperature: 232.40 C
-------------------------------------
Pressure:    1650.58 mBar
Temperature: 232.40 C
-------------------------------------
Pressure:    1650.90 mBar
Temperature: 232.40 C
-------------------------------------
Pressure:    1651.81 mBar
Temperature: 232.40 C
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IX. CLOUD COMPUTING:

Internet of Things and Cloud Computing technology will provide new opportunities in loT-based applications and services. In loT applications, the sensor data will be available in a Cloud environment [4]. This Cloud Computing provides the users three different kinds of service models, such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) which are run either by private, public or virtual private Cloud or a combination of Cloud types. Cloud Computing provides the security, monitoring and maintaining the data. The main use of this Cloud technology is an efficient use of resources and reduces the cost. It has high flexibility, accessibility and device independence.

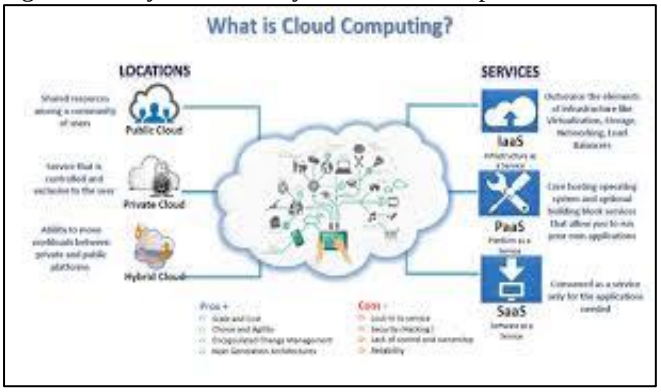

Fig. 9.1:

A. Advantages of Cloud Computing:

Distributed computing is one of the important moves from the IT assets. What is about distributed computing? Why was the distributed computing so mainstream? These were the six basic advantages of Cloud Computing and its streaming:

1) Cost

The cost of the machinery and as well as the goods were in the reach of the normal people. Computing decreases the capital cost of purchasing the things we need, things needed for programming and running nearby datacenters.

2) Speed

Most appropriated computing authorities have given self administration on request, so equal boundless measures of computation assets can be prepared in minutes, commonly just with some couple of mouse clicks, presenting institutions a huge measure of adaptability.

3) Global Scale

The benefits of distributed computing administrations include the capacity to increase the flexibly. In cloud computing, it implies bringing its applicable measure assets.

4) Productivity

In some of the location datacenters, they generally require a large measure of "racking and stacking. Distributed computing abandon the necessity for the meaningful number of these tasks, so that IT companies can lend energy in achieving more necessary business goals.

5) Performance

The great computing authorities keep running on the general system of protected datacenters, those are frequently carried up to the most current age of quick and proficient registering apparatus. This offers a few advantages over a unsociable corporate datacenter, which includes decreasing of system idleness for functions and more outstanding economies of scale.

6) Reliability

Distributed computing makes the news or facts support, fiasco recovery and furthermore the business progress much problem free, in fact that matter can be reflected at numerous repetitive locales on the cloud supplier's system.

X. THINGS SPEAK

This is an open channel Internet of Things (IoT) programming or function and Function Program Interface (API) to stock and get data from things by using the HTTP convention in the Cyberspace. Thing Speak permits the production of sensor logging functions, area following functions, and an informal community of things with immediate announcements".

Thing Speak was really propelled by ioBridge in 2010 as an administration in help of quickly expanding IOT functions.

Thing Speak has collaborated and have a help from the numerical processing programming MATLAB from MathWorks. It enables Thing Speak clients to break down and picture transferred information utilizing Matlab without the buy of a Matlab permit.

A. How to Use Things Speak:

1) The user has to create their personal ID in Thingspeak.
2) After creating the ID user will get one channel number which is unique.
3) The user has to link that channel number with the code so that the outputs will come according to the code.
   - The user has to define the fields that what are the parameters he is going to measure like in our case we have choosen two fields which are Temperature and Pressure
   - The output will be in the form of Numerical as well as Graphical and we can see that from anywhere around the universe through internet.

XI. CONCLUSION & FUTURE SCOPE

- Limits of pressure and temperature sensors their range, sensitivity, response time can be suitably changed depending on the need, availability and affordability.
- Pressure and Temperature can be sensed and their records can be obtained in the form of table or graph with respect to time.
- They can be further used for processing to pressure arivate pressure volume calculations related to DSP results are also obtainable if needed using the same tables from the cloud.
- Cloud Data thus obtained can be used for decision making through cloud computing.
- Accuracy has to be kept in mind.

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