Smart Irrigation System

Rishabh Modi, Madhavan P, Karan Veer Mahajan

[1] ***ABSTRACT-In the fast-paced society of 21-century urbanization has led to the reduction of greener spots around humans. To tackle this problem many citizens tried the alternative in the form of In-house gardening techniques. But due to lack of time in this killing pace world, these plants suffer inattention and undernourishment and degrade eventually. Henceforth the nutshell remains the same. With time the soil quality ought to degrade. We cannot stop that. But we can be prepared for it. And so comes our device to rescue! Our device will regularly check for moisture content in the soil and analyze it to complete precision. We also provide regular and upgraded precise data in the form of bar graphs and pie charts to make the stats conveniently readable for users. We also show per hour water retention of soil which in advance prepares user to plan his/her next big step. And hereby providing a platform to monitor plants and analyze soil quality conveniently.***

Index terms— IOT, Arduino , Esp8266, soil moisture sensor, actuators,android application.

I.INTRODUCTION

The special class arduino, Arduino UNO is an open-source development board that is based on the infamous ATmega328P micro-chip. The board was developed by none other than Arduino.cc. It is equipped with an appropriate number of digital and analog input and output pins that can be programmed with various development boards (shields) and circuits. The ESP8266 Wi-Fi Module is a System on a Chip (soc) with integrated networking protocol stack that can give any micro-controller, that is compatible, access to a standard Wi-Fi network. The ESP8266 is capable of both hosting an application and offloading all Wi-Fi networking functions from another application processor. The prestigious sensor of Soil moisture FC-28 helps in calculating the volume of water in the soil which acts as our output. The determined output can be displayed in both analogue and digital mode. (Approximate cost: ₹120-₹150).

The project also includes an android application that will provide an interface for the end user to communicate with the sensor module and monitor the soil moisture data remotely over the web.

A. Important Characteristics of Arduino Uno

- open source
- Cross platform
- Easily programmable

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B. Important Characteristics of Soil Moisture Sensor

The sensor used in this project is an FC-28 Soil moisture sensor. It quite cheap and easily available in the market. The soil moisture sensor contains about 2 probes. The 2 probes work in sync to measure the volume of water. The electricity is allowed to pass through the soil. Inversely proportional to the electricity Resistance is calculated. And this in turn helps us determine the soil moisture content.

With increasing water content the soil moisture sensor's probes conduct more current thereby providing less resistance. Dry soil conducts has a low dielectric constant. So when there is less water, then the soil conducts less current and hence a higher resistivity. Therefore, the moisture level is lower.

C. Important characteristics of ESP8266

The brand new ESP-8266 is a wireless fidelity module backed up by an average of 3V which is commonly used for IOT applications. Its upper voltage can gauge up to 3.6V. The following is cost friendly microchip with full TCP/IP stack and built in micro-controller capabilities.

The ESP8266 was first introduced august 2014 along the ESP-01 module. It was manufactured by a third-party Inc. called the "Ai-Thinker". This component allows all micro-controllers to connect to standard Wi-Fi networks thereby making TCP/IP connections and IOT applications simpler.

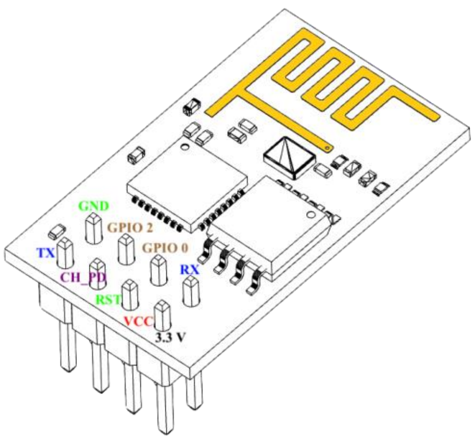

Fig 1 : general pin diagram of esp – 8266 wifi board

D.Objective

The main objective of this project is to create a product that can measure the soil moisture content of the soil actively. This data obtained from the soil will be pushed to a cloud platform for analysis and this data will be used to show soil moisture and quality on the android application. This product can be used in urban spaces and smart farms to remotely trigger the irrigation actuators to automatically irrigate plants in the soil.

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E. Future Aspects

- Including a module for analysis of the soil moisture retention
- Including a module for prediction of plantation suitable for a particular kind of soil
- Multiple language support for the application
- Improved UI of the android application
- Add a prediction model to predict the type of plant suitable for soil depending upon the soil type.

II.II. STATE OF THE ART

The idea of smart irrigation system has been implemented throughout the world in different formats. The most basic implementation includes a FC-28 soil moisture sensor to monitor moisture level of the soil and map the raw data to human readable form using a micro-controller. And relay is used to trigger the actuators to start or stop irrigation as and when required by the system.

The current implementations are good but they intend to be expensive and not easily accessible to the general public. Our model uses cheaper micro-controllers to bring down the cost and we tend to use as low amount of sensors as possible without cutting the performance aspect of the product.

This project also includes integration with a cloud based real time database (Firebase). This allows us to remotely monitor the soil moisture values and also it allows us to display the information on a remote device such as an android application for easier accessibility of the data.

This project includes the use of a ESP 8266 board which is basically a wifi module which allows us to connect to the web and also cuts down the cost as it can be used in place of a microcontroller.

This project also aims to analyse soil moisture retention value based on the irrigation patterns and predict the quality of soil and suitable plantations for a particular kind of soil.

III.III. METHODOLOGY

The project contains of two major components namely IOT and Android application. The sensor used will be an FC-28 soil moisture sensor. The micro-controllers used in this project are Arduino and esp8266 WiFi module.

The basic methodology of the project will be to push the data onto the cloud and use that data to show a the soil moisture content remotely on an android application. This data will also be used to suggest the type of plants and predict a retention value of the soil.

Interfacing ESP8266 with the sensor

The wifi module needs to interfaced with the cloud (firebase) to be able to interact with the sensors . The basic idealogy is to connect the wifi module to an inernet connection using a wifi acess point. For this the module has to programmed with the SSID and the password of the access point. After the mdule is connected to an internet connection, the next step is to authenticate and connect to the firebase project. Each project has a specified authentication key and the program for the module needs to contain that authentication key to get connected to Firebase.

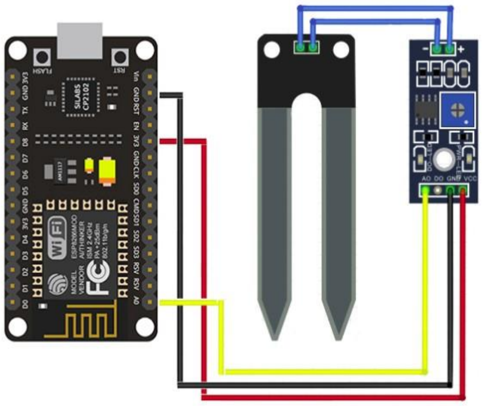

Fig 2: Connection of soil moisture sensor with ESP8266

A general algorithm to used to connect the ESP module to cloud and authenticate to firebase is given below.

Step 1 : start
Step 2 : define host , auth key, ssid and password for the network
Step 3: initialize sensor pins
Step 4: begin a serial connection with the board
Step 5: begin wifi connection
Step 6: authenticate firebase
Step 7: read data from sensor
Step 7: map data to according values
Step 8: push the mapped data to firebase
Step 9: create a child value for every new input from sensor
Step 10: push the data to the applications
Step 11: end

IV.IV. LITERATURE SURVEY

There are a lot of approaches to solve this problem of traditional irrigation. Extensive amount of research has gone into devising an optimal cost effective design to minimize wastage of water and optimise plant growth. Automated Irrigation System Using Solar Power by Jia Uddin et al. proposed a flexible rate automatic micro-controller based irrigation system. The farmers can get the information bout the water levl in the feilda without even physically going to their fields. A Photovoltaic (PV) cell happens to be the only source of energy to drive this proposed idea. The energy gets stored in a DC Battery via power supply. The sensors, micro controller and cell phone interface are driven by DC power. However, the pump is powered by AC power. An Inverter is used to convert DC to AC. The resulting AC power ensures that proper AC power is supplied to the pump. Solar Power will not always be available. In countries with overcast, power manipulation will not be possible. Source of energy can be replaced with electricity since it is readily available and easy to manifest. An Automatic Irrigation System Using Soil Moisture Sensors and And App by Shalu Sharma , Shivani Seth and Tanya Gandhi. Using low cost soil moisture sensor and android app, We develop an app based automatic irrigation system using self-made capacitive sensors.

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Then sensors are interfaced with Raspberry Pi micro-controller. This algorithm is carefully developed to measure the threshold levels. The system sets the irrigation time based on the moisture reading from the sensors and irrigates the field automatically, when unattended, then uses a capacitive sensor to measure soil moisture, which is inserted at various positions near to the plants. The Raspberry micro-controller receives the sensor output. We take the level of water sensed by sensors as input to decide the manual/automatic on or off of motor controlling the supply of water to plants. DB used doesn't provided real time updation. The lag between request and response can lead to a higher error rate. DC motor can easily get damaged if a higher voltage flows. We can use Servo motors instead or attach a different capacitor to control the excess voltage difference.

Intelligent Automatic Irrigation System byDr. Sarika Tale and Sowmya P emphasizes the fundamental point is to minimize the manual mediation by the rancher which helps in sparring cash, water and human efforts. The system consists of a circularly connected wireless network of temperature sensors along with a soil moisture which is bestowed in the roots of the plants. There is a fire detection and an infrared sensor placed in the corners of land. Whenever conditions like temperature and humidity changes, these sensors give signals to the micro-controller enactivating the sprinkler. The outdated 8051 micro-controller doesn't provide real time data analytics. Without any interface, user will be kept in dark and cannot monitor water supply. A Mobile app and a modern micro-controller like Atmel can make the project fast and efficient. A cost-effective and customizable automated irrigation system for precise high-throughput phenotyping in drought stress by Diego Ortiz et al. proposed that Different plants have different photosynthetic rates especially during the dry conditions. Hence Cost friendly automation systems can help controlling the substrate content of water for individual crops to accurately compare their phenotypic responses and scale them up for high phenotyping conditions. Substrate volumetric water content (VWC) is calculated with capacitance sensors like EC-5, high capacitance Decagon Devices, Pullman, WA are calibrated specifically for these type of dry soils. Calibration can be further expressed by adding a calculated amount of water to a fixed volume of water in a dried substrate of 500 milliliter container to reach targetted water content value. After the soil has been homogeneously mixed with the substrate, the sensor is placed and the voltage recorded. The project uses soil moisture capacitor that is only built to measure small moisture content. Genotyping is not cost efficient. Gravimetric sensors perform water monitoring based on weight cause of which can also be bright sunlight and not drought. Instead of depending on the weight, soil moisture content is a much better and lean way to establish constraints. Automatic Irrigation System on Sensing Soil Moisture Content by R.Vagulabranan et al. aims to create an automated irrigation mechanism which turns the pumping motor ON and OFF on detecting the moisture content of the earth. When moisture is detected, the sensor uses the two probes, that by activating allows current to pass through utilization appropriate means of the soil and then derives that resistance. The soil sensor conducts electricity poorly due to high resistivity. The moisture content obtained by giving input signal to an Arduino board is programmed to collect the input signal dampness.. Solenoid vaults are difficult to clean and tend to get contaminated quickly. Use Orbit irrigation as it is more efficient and covers a wide area. An Automated Irrigation System for Greenhouses by Hatem Elaydi proposes a monitoring system that is designed and tested to automate drip irrigation. The project uses openings called the valves that in turn are used to turn irrigation ON and OFF. It contains self-driven controllers and solenoids that provide correct ,measured amount of water at the right time. Thus, automating this pocess reduces wastage of water and nutrisionizing soils. This process is basically divided into two major parts The first part involves a study of IOT components while the second part is the design of the control circuits. Bifurcation devoids the real time data update. Software and interface used is a desktop version and hence project cannot be utilised from remote. Use Stream-Buffer to perform bifurcation that enables real time update.

Smart Irrigation System using IOT by Arif Gori et al. This project aims to save time. It also helps devoid the problem of constant check. It also helps in preserving water by automatically providing nature's wonder to the field depending on the requirements. This system also proves to be helpful in watering parks and lawns. This research tries to automate the process of irrigation in the farmland by regularly checking the soil water level soil relative to the plant and the adaptively provides sprinkling to simulate the rain. Requires manual ON/OFF. Hence complete automation is not achieved. Mesh Topology leads to complexity and futile load. Use an interface to allow remote access to the users. Medical Sentiment Analysis using social media by Madhavan P uses a prediction mode that uses rain forest algorithm to predict the medical sentiments using the social media activities of the subject. Solar Powered Automated Irrigation system for agriculture by N. Prakash et al. When the soil moisture falls below a certain level, the sensor sends the detected value to the micro-controller. As per the value derived by sensor, the water is supplied to the crops automatically to the desired level in order to maintain the required dampness in the soil. The System comprises of a solar powered panel as the main source of energy which in turn charges controller at different irradiation. Water conservation is controlled using micro-controller encoupled with soil moisture sensor. Soil moisture sensor is inserted into the soil for moisture detection and also it indicates different moisture level for different crops. Being associated with solar energy, the proposed system takes up lot of space. Since solar energy is weather dependent, crop monitoring cannot be done on a regular basis. Use electro-mechanical motors like servo motors which are accurate and weather independent. Intelligent IoT Based Automated Irrigation System by Yuthika Shekhar et al. Proposed an aotumated irrigation system that uses IOT concepts to accurately capture sensor data corresponding to soil moisture and current soil temperature and according to that it performs what is known as "KNN (K- Nearest Neighbor)" which is a classification machine learning algorithm which is deployed for analyzing the sensor data for prediction of irrigating the soil based on the inputs from the sensors.

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The system captures input from a micro-controller where moisture and temperature data is stored for further analysis. The sensor input is then transferred serially. A machine learning algorithm is used to predict the conditon of the soil based upon the training from the previous data sets used for the training of the model. Accordingly , the control signal is then sent to Arduino to initiate the actuators which would then initialise the pums and allow the flow of water. The data set is stored in Cloud server which can be accessed via mobile app.. Inculcation of ML can be costly. Data set has to be trained for all minute weather circumstances which are great in number leading to a bulky data set.

V.FUTURE PROSPECTS AND CONTINUED WORK

This project aims to build a system to analyze the current temperature of the soil and also the pH of the soil to predict the suitable crop/plant for the particular soil that is being tested as a sample. This can be majorly helpful as some plants are alkali loving in nature while some plants are acidic loving plants which grow better on the respective soil and provide a better yield. For example plants like broccoli , asparagus and bluebell are alkali loving plants whereas plants like daffodils and marigold are acidic plants and provide a better yield in acidic environment.This project uses a pH meter referred as (SKU: SEN0161) which compatible to be interfaced with arduino to capture accurate pH readings from the soil. Th epH meter includes a built in led which acts as a power indicator. It also includes a BNC connector and PH2.0 sensor interface. The sensor module takes power of 5v and provides output in the range of 0-14 pH with a temperature measuring range of 0-60 C.The data from the pH sensor, temperature sensor and the soil moisture sensor is used to create a training data set that will be used by a machine learning model that uses a classification algorithm – Random Forest to predict the the plant/crop suitable for the particular type of soil based on its pH , temperature and soil moisture content.The algorithm predicts the output with an accuracy of about 76% having 75 rows and two features namely – climate temperature and pH of the soil in which the the crop/plants are planted in. The accuracy can be improved by increasing the number of entries in the dataset. As shown in figure 3, the suitable pH data is collected from varios sources and has been compiled into a single dataset which allows to train the odel and predict the suitable crop based on the pH of the soil.

VOLTAGE (mV)	pH value	VOLTAGE (mV)	pH value
414.12	0.00	-414.12	14.00
354.96	1.00	-354.96	13.00
295.80	2.00	-295.80	12.00
236.64	3.00	-236.64	11.00
177.48	4.00	-177.48	10.00
118.32	5.00	-118.32	9.00
59.16	6.00	-59.16	8.00
0.00	7.00	0.00	7.00

Fig 3: pH sensor characteristics

VI. SOCIAL RELEVANCE AND EFFECTIVENESS

Agriculture has been an integral occupation in human civilization. Traditional methods of irrigation like overhead sprinkler and flood type, are no longer efficient in the fast paced 21st century. Their usage results in wastage of loads of water. Adding onto, they also promote disease such as fungus formation due to moisture in the soil. Our Automated irrigation system will be beneficial for conservation of the water and simultaneously help agriculture flourish with ease of access. This projects aims to develop a product that can be used to monitor soil moisture of the plants and automatically irrigate them. This involves cutting the cost of the product and making a cheap and reliable solution to the hassle of watering the plants way to often. The product has been designed keeping in mind the life style of urban farmers who don't have proper time and resources to take care of a plantation of small size that can be maintained indoors. The product will have a simple plug and play functionality for the convenience of the user and multiple language support may be added to the application in the future. This product can have a huge impact on the society as it aims to solve a basic but big problem of urban farming . With this product the user will never have to worry about watering their plants as long as the system is connected to a water reservoir. The product has also been designed to keep the cost of manufacture as low as possible using just one sensor and one micro-controller board. Apart from cutting the cost it is also designed to be effective and a reliable product. The product can also be used by farmers in a crop field but the IOT functionality will be lost due to unavailability of a proper internet connection at a farm. However the automated irrigation irrigation part can work flawlessly in these conditions and the cost of operation can be brought down even further. These modules will be incredibly helpful for the farmers in harsh weather conditions where several of these modules can be installed within the farm with certain separation to automatically irrigate the farm. Use of these modules will not only make a farmer’s job easier but it will also stop over irrigation and thus conserve water.

VI.RESULT ANALYSIS

The sensor network consists of the components namely – soil moiisture sensor (FC 21) , temperature and humidity sensor and pH sensor that are programed to work together to provide an output that is further analysed by the machine learning algorithm to predict the plant/crop that should be planted for optimum yeild. The screenshots below show the output from the sensors as recorded in a soil sample that is known to have a neutral pH and is god for growth of plants that have more water content.

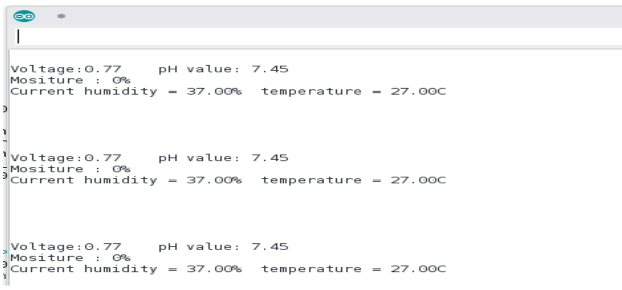

Fig 4: Output from the sensor modules

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The output from the above screen is then fed into a prediction model that uses naive-bayes classfier and is designed and trained to predict the soil type and the plants suitable for that particular soil. This prediction is done on the basis of two feature sets namely the pH of the soil and the climatetemperature. The figure below shows the working output of the prediction model. This model as stated above uses Naive-Bayes classifier to predict the output with an accuracy of 78%.

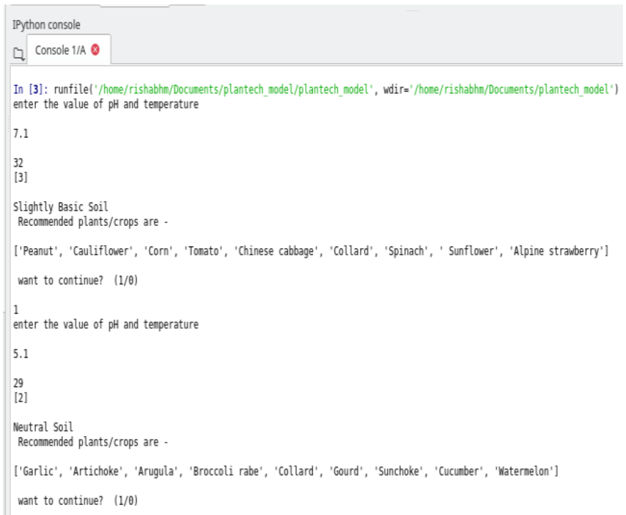

Fig 5: Output from the prediction model using Naive-Bayes classifier

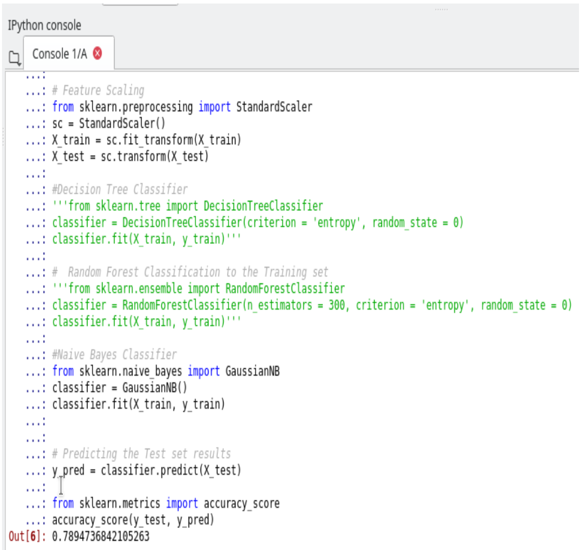

Fig 6: Accuracy of the Naive-Bayes classifier

The graph below is a representation of different data points in the dataset. The dataset containd a total of 75 different plants with teir pH and optimum temperature for growth.

VII.CONCLUSION

This project involves the fine designing and advanced development of the smart and automatically configured irrigation system which is backed by fine software and hardware architectures blending together with the interfacing purposes of common users.It is useful and practical for the

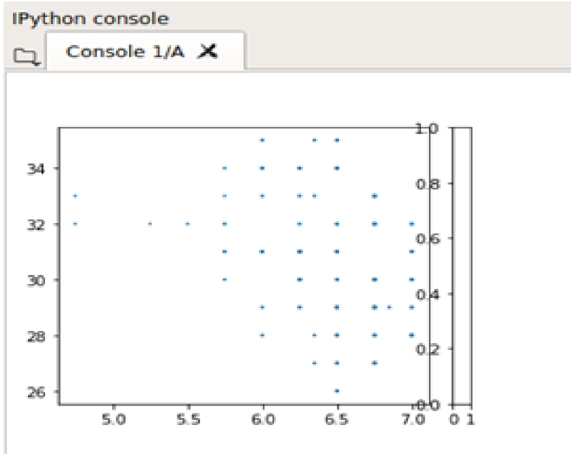

Fig 7 : Plot of datapoints int the dataset as trained by Naive-Bayes Classifier

The graph below shows the segregation of data and the while the model is trained by Descision Tree. Slightly acidic soil is represented in RED colour, neutral soil is represented in GREEN colour and slightly basic soil is represented in YELLOW colour. The plotted graph does a good job of clasifing datapoints into three classifiers as slightly acidic, neutral and basic.

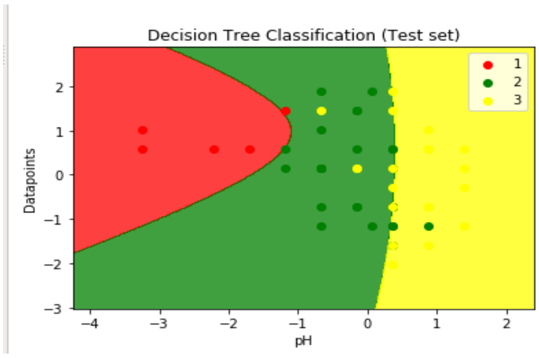

Fig 8: Classification plot of datapoints in descision tree

IX. DIAGRAMS

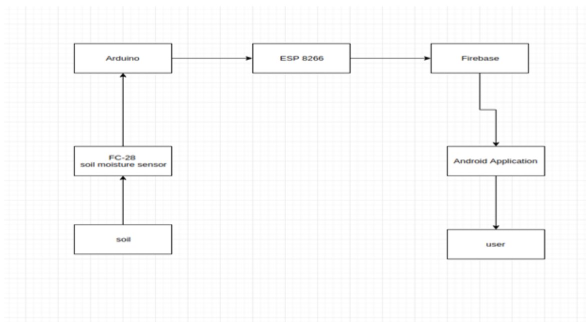

Fig 9: Modules and workflow of the project

urban farmers and remote monitoring and maintenance of plants. The biggest challenge in the project is to synchronize the values coming from the sensors into the application that will be used to remotely monitor the soil moisture level. Another challenge is to present the project in form of a usable product.

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As the project has a lot of different modules , it can be easily disintegrated and can cause a catastrophic failure of the product.That is why it is important to present the project in form of a single module an as a complete product.

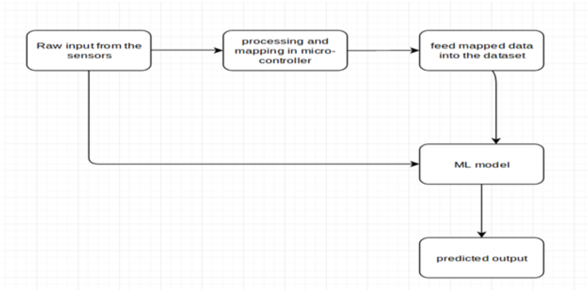

Fig 10: Workflow for the machine learning model

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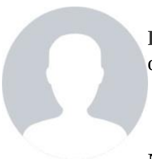
Rishabh Modi is an UG student studying Computer Science Engineering at SRM Institute of Science and Technology. His dareas of interest are Android Application Development, Java and Linux.



P. Madhavan, Associate Professor, SRM Institute ofScience and Technology was awarded his PhD in 2017.

Notable publications:

1. P.Madhavan,J.Beschi Raja, " Robust and Auditable Secure Data Access Control in Cloud Computing" ,International Journal of Computer Engineering & Applications," 7(2), 2018

2.P.Madhavan,Dr. P.Malathi ,"Intelligent Framework for QoS optimization in MANET using Soft Computing Models" , International Journal of Advanced Engineering Technology," 7, 2016

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