IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

INTELLIGENT IOT BASED SMART IRRIGATION SYSTEM

[1]Kavyashree T, [2]Shreedhara K.S

[1]M.Tech III[rd] SEM, Department of Computer Science and Engineering, University B.D.T. College of Engineering, Davanagere, Karnataka, India

[2]Professor, Department of Computer Science and Engineering, University B.D.T. College of Engineering, Davanagere, Karnataka, India

ABSTRACT: Intelligent IOT based Smart Irrigation System is an automatic irrigation system developed using IoT Technology and machine learning method using KNN algorithm. The objective of the smart irrigation system is to provide adequate water required by crops by considering the moisture of soil and climate conditions thus preventing over irrigation and under irrigation without human intervention. The GSM module is used in the system to send status of the field to farmer through SMS and to save the parameters on to the cloud.

KEYWORDS: ARDUINO UNO Microcontroller, Soil moisture sensor, Humidity and Temperature sensor, water level indicator sensor, GSM module, K-NEAREST NEIGHBOUR algorithm.

NOMENCLATURES: The Global System for Mobile Communications (GSM), Internet of Things (IOT), Machine Learning (ML), Short Message Service (SMS), Second Generation (2G), Subscriber Identity Module (SIM).

I. INTRODUCTION

The agriculture is one of the most fundamental resources of food production which plays a vital role in keeping the economy running of every nation by contributing to the Gross Domestic Production (GDP). Traditionally the farmers have been using irrigation technique in India through the manual control in which the farmers irrigate the land from time to time. This process sometimes consumes more water and needs continuous human attention. From this intelligent irrigation system it has shown that water can be used effectively by measuring soil moisture and water level in tank that reduces much of human intervention and farmer is also notified with status message without going to the field. The system also saves the parameters on to ThinkSpeak cloud for future analysis.

Based on the sensor values received by the sensors the machine learning method - KNN algorithm predicts weather watering is required or not. Output is send to microcontroller to command the relay to ON/OFF the motor accordingly.

Why Machine learning in IOT?

There are at least two main reasons why machine learning is the appropriate solution for the IoT system are: The first has to do with the volume of data and the automation opportunities. The second is related to predictive analysis.

ML can optimize the entire process through the predictive component of the system can identify the correct input to get the expected output. So that IoT system can work much faster and more accurate and flawless.

In this paper, Section I contains the Introduction of present Irrigation methods, how ML helps in automating IOT, Section II contains the Literature survey of related work of Smart Irrigation Systems, Section III explains Materials and Methods with algorithm – working, input data, eda, block diagram and flow chart used in implementation of the project, Section IV contains the circuit diagram of the system, results, KNN calculations using Euclidean distance formula and screenshots and Section V concludes the project with the future scope.

II. LITERATURE SURVEY

In Intelligent IoT Based Automated Irrigation System, Yuthika Shekhar, Ekta Dagur, Sourabh Mishra says [1]: Intelligent IoT based Automated Irrigation system where Moisture and Temperature sensor been deployed in the agriculture field towards capturing the data for watering the field. Now based on information gathered by the gateway unit from sensor, information sent to control unit which is Raspberry pi. Raspberry pi holds a KNN (K- Nearest Neighbor) machine learning algorithm towards analysis of information extracted from the sensor for actuating the pump for watering the field. This information on data analyzed is recorded in Cloud server which allows the farmer's to access from their mobile handset.

In INTELLIGENT IRRIGATION SYSTEM USING ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING: A COMPREHENSIVE REVIEW, Kirtan Jha, Aalap Doshi and Poojan Patel [2]: This paper encompasses the links which make embedded systems and AI coherent with the agriculture sector. Implementation of AI and expert systems in agriculture is a narrowly defined subject. The paper discusses penetration of AI and embedded systems in agriculture sector via discussing past breakthroughs. The problem of water usage among the farmers leads to the smart irrigation system which will also result in the efficient use of water resources. The irrigation system proposed is fully automated and easily accessible method which will be beneficial to the agriculture automation to future scope.

In IoT-based intelligent irrigation management and monitoring system using Arduino System, Fidaus Kamaruddin, Nik Noordini Nik Abd Malik, Noor Asniza Murad, Nurul Mu'azzah Abdul Latiff, Sharifah Kamilah Syed Yusof, Shipun Anuar Hamzah says [3]: The main aim of the paper is to develop system that includes an Internet of Things (IoT) in Wireless Sensor Network (WSN) environment where it manages and monitors the irrigation system either manually or automatically, depending on the user requirement. This proposed system applied Arduino technology and NRF24L01 as the microprocessor and transceiver for the communication channel.

In Machine Learning in Agriculture: A Review, Konstantinos G. Liakos, Patrizia Busato, Dimitrios Moshou, Simon Pearson and Dionysis Bochtis says [4]: Machine learning has emerged with big data technologies and high-performance computing to create new opportunities for data intensive science in the multi-disciplinary agri-technologies domain. The works analyzed were categorized in (a) crop management, including applications on yield prediction, disease detection, weed detection crop quality, and species recognition; (b) livestock management, including applications on animal welfare and livestock production; (c) water management; and (d) soil management. The filtering and classification of the presented articles demonstrate how agriculture will benefit from machine learning technologies. By applying machine learning to sensor data, farm management systems are devolving into real time artificial intelligence enabled programs that provide rich recommendations and insights for farmer decision support and action.

Disadvantages of existing systems from the study of above Literature surveys are:

- In the papers [1] [2] [3], the machine learning method predicts to ON/OFF water pump by considering only 2 parameters they are: soil moisture and temperature without considering weather water is there in the tank or not.

- Secondly, the predictions and the field status are saved in cloud via Wi-Fi module, the farmer himself has to access the cloud webpage (which needs smartphone) to know what is happening in the field. The only disadvantage with the projects that works with Wi-Fi module is that most of the agricultural land is far from the city i.e. remote places or in the midst of mountains so the internet might not be good or catchy in those areas for a person to know the status. Hence using Wi-Fi technology might not be feasible idea.

Unlike traditional automated IOT systems, our proposed system uses machine learning algorithm to predict the outcome (ON/OFF water pump) by considering the water levels in the tank. Also we have used neither Wi-Fi module nor the smart phone applications; the GSM modem that we are using is SIM800C which works on 2G SIM cards. Any basic handset (mobile phone) which is capable of receiving messages can be used to interact with this system and sends the status of the field to the farmer and through GPRS (General Packet Radio Service) the modem updates cloud. This system can be extended to have direct control on the system by sending commands from farmers mobile to the GSM modem.

III. MATERIALS AND METHODS

In this system we are using ARDUINO UNO microcontroller which is a heart of the system takes input data from 3 sensors, they are: Temperature and Humidity sensor, Soil moisture sensor and Water level sensor. This real time sensor data is the input for the ML algorithm that does predict watering. Microcontroller sends the details to GSM modem that has to be updated on to cloud and to send SMS to farmer / owner.

III.I MACHINE LEARNING ALGORITHM

Machine learning algorithms are programs that can learn from data and improve from experience, without human intervention. ML aims at developing algorithms that can learn and create statistical models for data analysis and prediction. These algorithms should be able to learn by themselves - based on data provided make accurate predictions, without having been specifically programmed for a given task.

There are various algorithms that do predictions based on supervised learning, they are: Linear and Logistic Regression, Decision tress, Support Vector machine (SVM), K-Nearest Neighbor (KNN), Naïve Bayes.

Among these classification methods KNN classification has many advantages,
They are:

- Robust with regard to the search space, don't have to be linearly separable.
- Classifier can be updated online at minimal cost as new instances with known classes are presented.
- Few parameters to tune: distance metric and k.
- Faster than other classification methods.

Hence we are incorporating KNN classification method (that calculates distance of neighbors using Euclidean distance formula) to build our system.

III.II KNN CLASSIFIER

K-Nearest Neighbor is one of the Machine Learning algorithms based on Supervised Learning technique. The main idea behind the algorithm is that the elements that are close to each other would belong to the same category.

Working:

The K-Nearest Neighbors algorithm uses the entire data set as the training set. When an outcome is required for a new data instance, the KNN algorithm goes through the entire data set to find the k-nearest instances to the new instance, or the k number of instances most similar to the new record, and then outputs the mode (most frequent class) for a classification problem. The value of k is user-specified.

The similarity between instances is calculated using measures such as Euclidean distance.

III.III EUCLIDEAN DISTANCE FORMULA

$$d(x,y) = \sqrt{\sum_{i=1}^{n}(x_i - y_i)^2}$$

d (x,y)→ two points in Euclidean n-space

xi, yi→ Euclidean vectors of ith instance

n → n-space

III.IV TRAINING DATA SET TO KNN ALGORITHM

***Table1**: Input training data*

	A	B	C	D	E
1	28	75	76.34	300	no
2	28	63	76.34	330	no
3	27	77	76.44	290	no
4	27	78	76.54	300	no
5	27	78	75.95	330	no
6	27	78	75.12	333	no
7	30	72	43.37	250	yes
8	29	72	36.17	222	yes
9	27	79	27.27	200	yes
10	27	80	39.1	100	no
11	27	89	39.1	90	no

Field A: Temperature in percentage (%)

Field B: Humidity in percentage (%)

Field C: Soil moisture in Percentage (%)

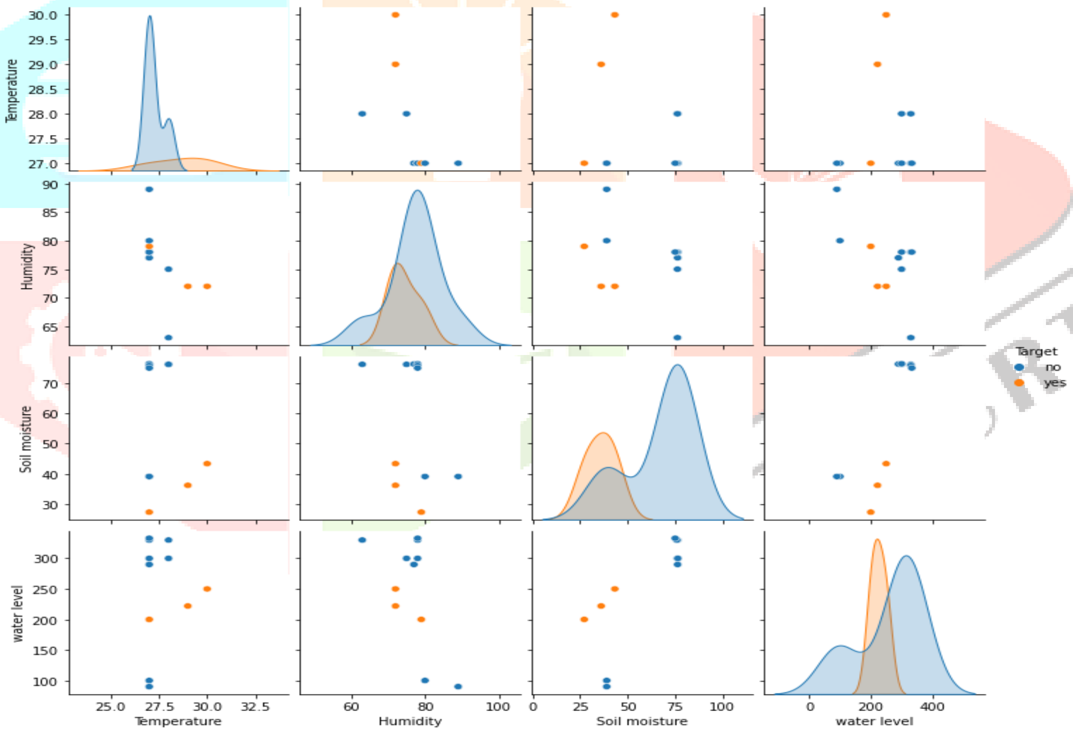
Field D: Water level in Centimeter (cm)

Field E: Target Value

III.V EXPLORATORY DATA ANALYSIS (EDA) OF TRAINING DATA:

Seaborn library in python is used to discover and visualize the relationships between the data. A pairs plot allows us to see both distribution of single variables and relationships between two variables.

The below graph contains scatter plots between each pair of feature columns against the target value column (i.e. yes/no). Feature columns are Temperature, Humidity, Soil moisture and Water level. The target values 'no' is indicated in blue color plots and value 'yes' is in orange color.



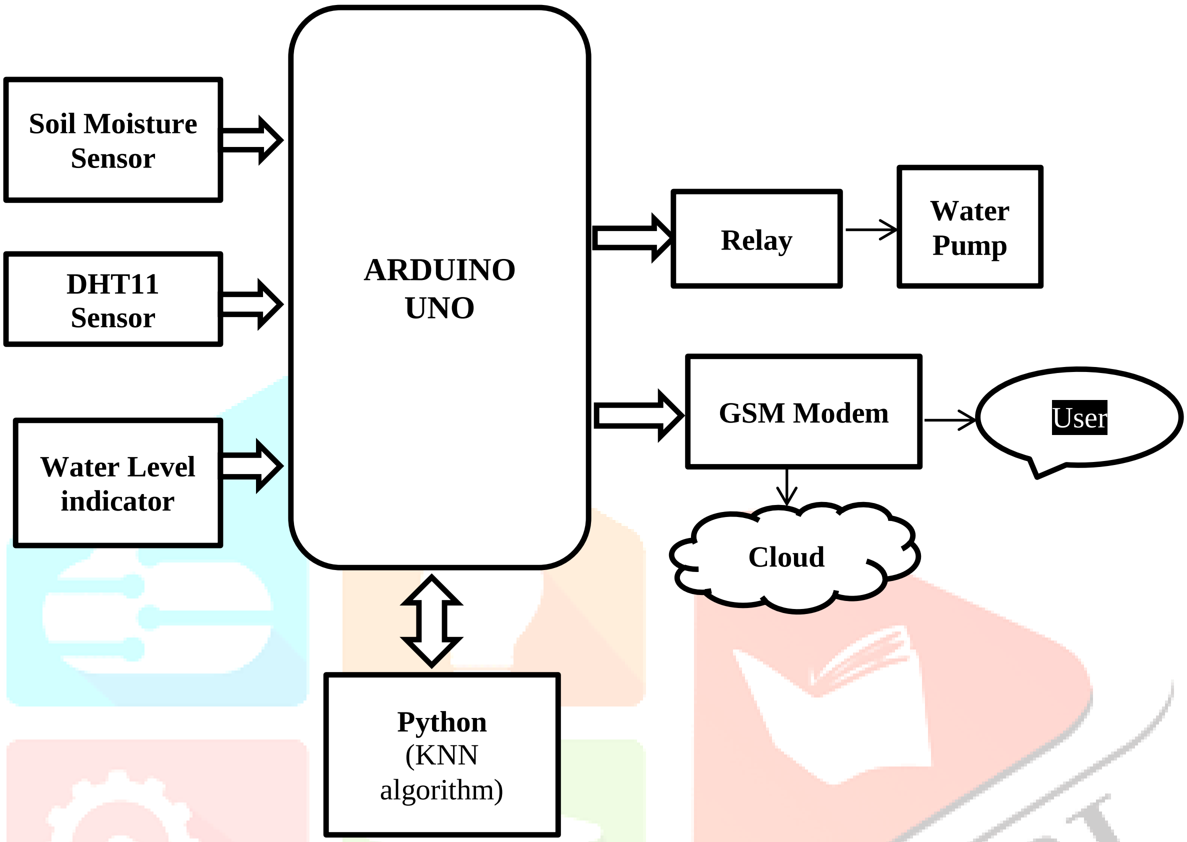
Graph1: Feature Map Graph

We can infer from above graph by considering all numerical attributes, they are:

- When the temperature is between 26% and 28% the target value is most likely *no*.
- In humidity the target value is mostly *yes* when it is around 60% to 90%.
- When it comes to soil moisture, the target value is mostly *yes* when the moisture percentage is less than 60.
- The target value is *yes* when the water level is around 200 to 300cm.

III.VI BLOCK DIAGRAM:

Below diagram shows the blocks that are used to build the smart irrigation system.



The system consists of Arduino UNO micro controller that connects to each and every other components of the system. Three sensors, soil moisture, temperature and water level indicator are inputs to the micro controller. GSM and water pump are the outputs of the system. Water pump is controller via relay module. GSM which consists of SIM in it, updates user as well as Think speak cloud with the sensor values.

III.VII SOFTWARE USED

1. Arduino IDE Tool version 1.8.12

Arduino IDE tool (software) is an open source environment where we can write a code and upload it on to UNO board. It runs on windows Mac OS and Linux OS.

2. Python 2.7

Python is an interpreter, high-level and general-purpose programming language.

III.IV HARDWARE DETAILS

Components used for Implementation of the system:

1. ARDUINO UNO micro controller
2. GSM SIM800C modem
3. Bread board and jump wires
4. Soil moisture sensor
5. Temperature and Humidity sensor
6. Water level sensor
7. Relay module and Water pump
8. Laptop
9. Mobile phone

1. Arduino Board (UNO)

Arduino UNO is micro-controller based on Atmega328, having 14 digital In/Out pins of which 6 are for PWM output, 6 are for analog input. Operates at 16 MHz, with a USB, Power jack, reset button.

Figure1: Arduino UNO Board

2. GSM SIM800C MODEM:

SIMCom offers this information as a service to its customers, to support application and engineering efforts that use the products designed by SIMCom. This 800C works for 2g SIM card only.

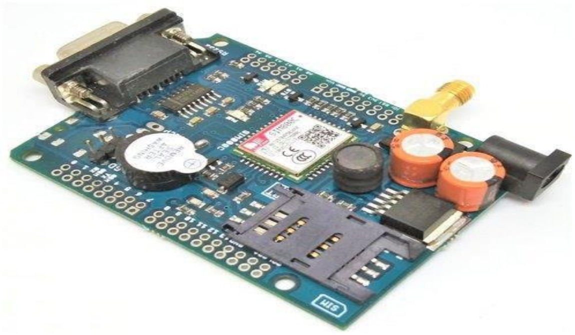


Figure2: GSM SIM800C Modem

3. Soil Moisture Sensor:

Soil Moisture Sensor detects the moisture content of soil; it consists of a plurality of soil moisture sensors. Technology used is Frequency domain Sensor i.e., capacitive sensor, moisture meter characteristic of the use of water in the neutron moderator.

Figure3: Soil Moisture Sensor

5. Bread board and Jump wires:

A breadboard consists of two areas called STRIPS. One is BUS strips and other TERMINAL strips. At most 5 sensors can be connected. Jump wires are used for connections.

6. Temperature and humidity sensor:

This sensor named DHT11 has a resolution of 16bit which measure TEMPERATURE and HUMIDITY of the area that it is used.

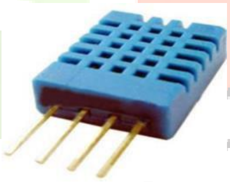


Figure4: DHT11 Sensor

7. Water level Indicator sensor:

This sensor's working is straight forward method. Output result of this will be an integer ranging from '0'and '500'.

Figure5: Water level indicator

8. Relay and Water Pump:

The water pump is the part of the system that delivers water to the soil. The motor drive is used to provide power to the water pump as well as interfacing the pump to the Arduino. Relay is used to control the water pump i.e. to ON\OFF.

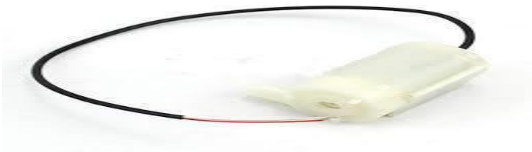
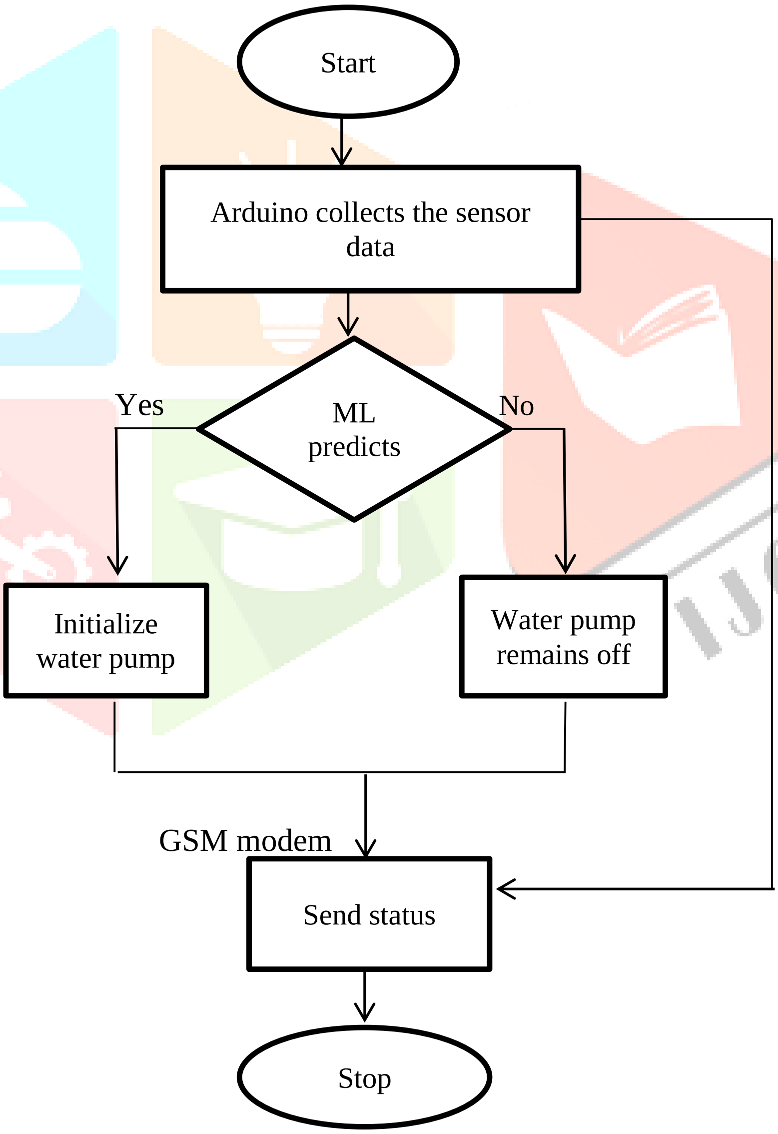


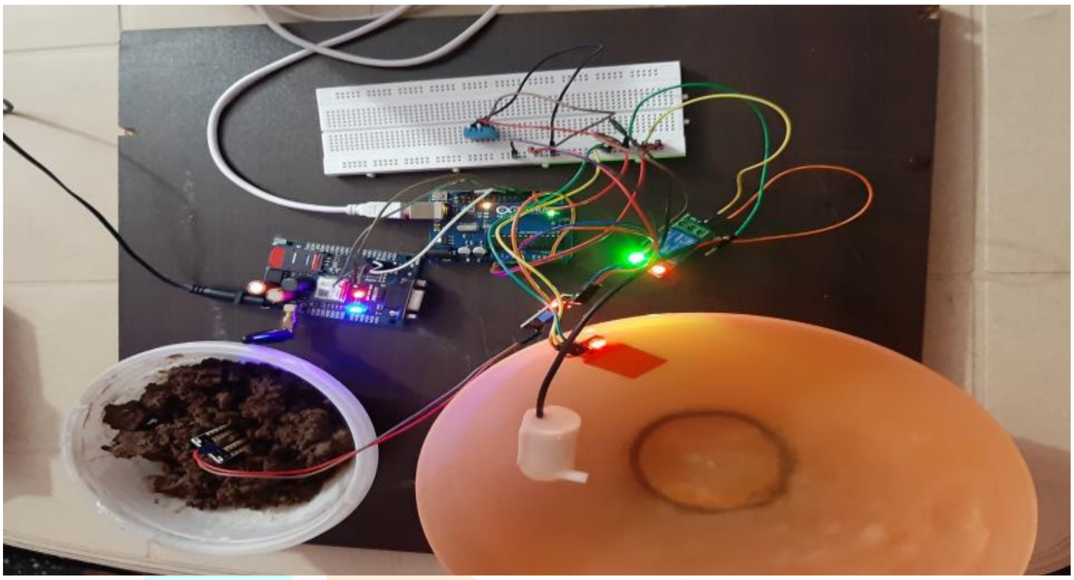
Figure6: Water pump

III.VIII FLOW CHART



IV. CIRCUIT DIAGRAM AND RESULTS

IV.I CIRCUIT CONNECTIONS



IV.II PREDICTION RESULT OF KNN ALGORITHM

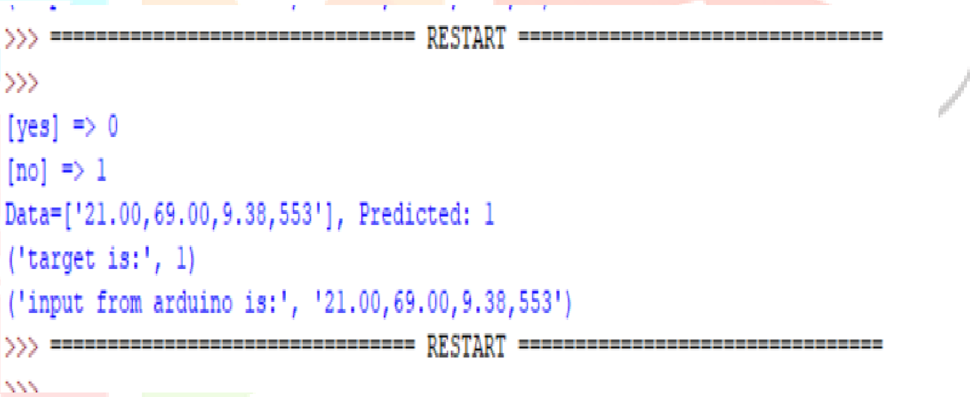


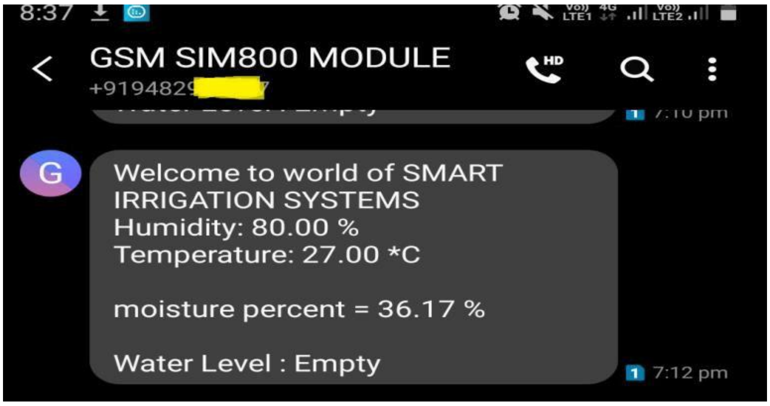
Table 2: KNN calculations for the new instance [21.00, 69.00, 9.38, 553] for k=3

Temperature	Humidity	Soil Moisture	Water Level	Euclidean distance for new instance [21.00,69.00,9.38,553]	Target Value
28	75	76.34	300	261.873	no
28	63	76.34	330	**233.018**	**no**
27	77	76.44	290	271.599	no
27	78	76.54	300	261.985	no
27	78	75.95	330	**232.975**	**no**
27	78	75.12	333	**232.739**	**no**
30	72	43.37	250	305.048	yes
29	72	36.17	222	332.19	yes
27	79	27.27	200	353.642	yes
27	80	39.1	100	454.191	no
27	89	39.1	90	464.422	no

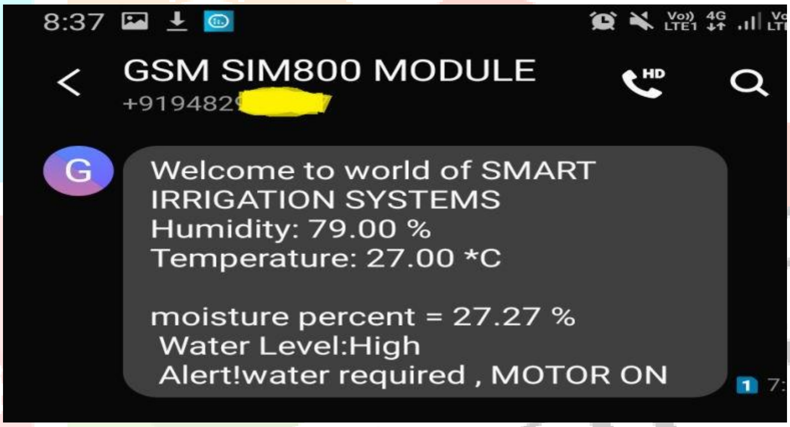
The three nearest values are 2nd 5th and 6th neighbours which have NO as their target value hence the algorithm predicts as NO as the output for the new input data (that is no need for watering).

IV.III SNAPSHOT OF SMS SENT TO USER

- Senario1: Soil moisture is LOW but water level is empty hence MOTOR will remain OFF



- Senario2: Soil Moisture is LOW and hence MOTOR is ON



- Senario3: Soil Moisture is HIGH hence MOTOR is OFF

CONCLUSION AND FUTURE WORK:

The main aim of this contribution is to make irrigation process flexible, time saving and more efficient than the existing automated IOT systems. On basis of real time sensor data ML method will do predictions which enables continuous monitoring of water flow. Farmer or user will be notified by GSM modem so thus he will be aware of what is happening in the field.

Overall this intelligent system eliminates much of the manual works which are a stress free for a farmer and mainly it avoids over irrigation and under irrigation state which in turn reduces the wastage of water and keeps constant soil moisture in the field. The main advantage is that the system's action can be implemented with low power, low cost, small size, robust and highly versatile. In large scale applications, high sensitivity sensors can be implemented for large areas of agricultural lands.

The future scope of this project would be as follows:

- Since the whole circuit works only on power supply, in case of power cuts or damage a battery or solar power unit can be implemented as an alternative source.
- The smoke sensors can used to send emergency information to user in case of fire in field or burning of motor.
- Using the GSM modem we can save the sensor on to the cloud (through GPRS) for future analysis.
- KNN machine learning method which is also called lazy learner can be replaced with eager learner method like decisions trees for more accurate and faster predictions.

REFERENCES

[1] Intelligent IoT Based Automated Irrigation System, https://www.ripublication.com/ijaer17/ijaerv12n18_33.pdf

[2] INTELLIGENT IRRIGATION SYSTEM USING ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING: A COMPREHENSIVE REVIEW. http://www.journalijar.com/article/25589/intelligent-irrigation-system-using-artificial-intelligence-and-machine-learning:-a-comprehensive-review/

[3] IoT-based intelligent irrigation management and monitoring system using Arduino. https://pdfs.semanticscholar.org/660e/5e4db0af85924691e6fa2f363343813cec43.pdf

[4] Machine Learning in Agriculture: A Review. https://www.mdpi.com/1424-8220/18/8/2674

[5] Machine Learning by Tom Mitchell. https://books.google.co.in/books/about/Machine_Learning.html

[6] https://www.arduino.cc

[7] Arduino Soil Moisture Sensor: https://create.arduino.cc/projecthub/MisterBotBreak/how-to-use - a-soil-moisture-sensor-ce769b

[8] SIM800 Series_AT Command Manual_V1.09

[9] https://www.youtube.com

[10] https://www.google.com

[11] Python in practice, www.it-ebooks.info