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Smart Agriculture using IoT and Machine Learning

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Abstract – *Agriculture is huge sector and has a major impact on the economy of the country. As the world is getting smart and digitalized day by day, we need to implement smart agricultural practices also. IOT and cloud-based technologies are getting trending now a days, so implementing those technologies into agriculture can help in improving productivity and also reduce the wastage of resources in the farm. The main aim of this paper is to gather important data from the farm like the moisture content in the soil, temperature in the farm and humidity. By developing some machine learning models which can predict whether farm needs watering based on all these soil parameters, we can reduce the amount the water wastage. Rainfall predicting models have been developed which can assist farmers in deciding the type of crops they can grow and also providing them with a good surveillance system of the farm and to use all these systems, a telegram bot user interface has been created so the farmers can handle all these operations wirelessly.*

Key Words: **Smart Agriculture, IoT, Machine Learning, API, Cloud computing, Telegram Bot**

1.INTRODUCTION

India is a country based on agriculture. The agriculture sector of India has occupied almost a 43% of India's geographical area. Nearly 70 percent of the rural people depend on agriculture. Agriculture is the backbone of the Indian economy as it contributes about 17% to the total GDP. IOT is a trending technology which we can use in the field of agriculture and can help in increasing the productivity of the crops.

IoT (Internet of things) is nothing but the interconnection of electronic devices which can collect and transfer data without human involvement. The role of IoT in agriculture has a major impact that increases the efficiency and productivity of the crop. The main variables we are taking into consideration are the moisture content in the soil, Temperature in the farm and humidity. As we all know that excess water content in the soil leads to wastage of water and also results in the destruction of crops in the farm. To reduce the burden of farmer checking water content manually, we can implement sensors in the farm that can read these variable values. In our project we are even using cloud computing to store the data and also to run various machine learning algorithm like the watering predictor model, rainfall predictor model and also the object classifier model.

We collect all the variable data from the farm and input it to the machine learning model in the cloud which then it predicts whether the farm needs watering or not based on the sensor data it has received. All the sensor data are collected by the Arduino Nano and sends the data to the raspberry pi, which then forwards it to the cloud. To provide efficient dataflow between hardware systems and the cloud, we have developed an API (Application Programming Interface) server which handles all the POST and GET requests by different modules.

To provide surveillance to the farm we have developed an Intruder detection system which alerts the user through the Telegram Bot interface we have created. The Telegram Bot is the main user interface of the system where the user can monitor the real time data of the farm and also can control the farm wirelessly just by connecting to the internet.

2. LITERATURE SURVEY

Smart Agriculture Using Internet of Things with Raspberry Pi by Z. Muhammad, M. A. A. M. Hafez, N. A. M. Leh, Z. M. Yusoff and S. A. Hamid, 2020 [1]

In this paper Smart agriculture using IOT is implemented by using sensors like soil moisture sensor and DHT 11 to get temperature and humidity. Here the collected values are sent to cloud like thingspeak and they retrieve the data from the cloud. A threshold value is already set for the soil content in the soil and accordingly when the moisture reduces below the threshold value then the raspberry pi turns on the motor and waters the farm. There is no machine learning models involved and only works based on the threshold values. This project helps in reducing the water wastage in the farm to a certain level. This doesn't take the weather conditions of the area into consideration.

Intelligent IoT Based Automated Irrigation System by Yuthika Sekhar, Ekta Dagur, Sourabh Mishra, Rijo Jackson Tom, Veeramanikandan. M and Suresh Sankaranarayanan, 2017 [2]

This paper focusses on implementing intelligent irrigation using IOT. Here the data and parameters like the soil moisture content and humidity is recorded from the farm

using nodeMCU and is sent to the cloud for processing. They have KNN machine learning algorithm to predict whether the farm needs watering or not and the values of soil moisture temperature and humidity is taken as inputs to this algorithm. This study works by focusing on the parameters in the farm and does not predict any rainfall based on the weather data. This study even has a small web dashboard where the user can get info related to the farm.

Smart Intrusion Detection System for Crop Protection by using by S. Yadahalli, A. Parmar and A. Deshpande, 2020 [3]

Production of crops in a farm depends even on the protection of those crops from outside animals which may destroy the crops inside the farm/ In this study they proposed a model to detect intruders in to the farm using an Arduino and PIR sensors and ultrasonic sensors through which they can detect any animals entering in to the farm. The PIR sensors are placed at different angles at the entrance of the farm. Based on the triggering of PIR sensors and the output values from the ultrasonic sensors are taken into consideration and accordingly they detect if any animal had entered in to the farm. They implemented an alert system to alert the user by sending the snapshot taken at the time the sensors are triggered.

3. METHODOLOGY

The system that we are proposing consists of both Hardware and Software components. Entire system is divided into different modules which are assigned with specific tasks.

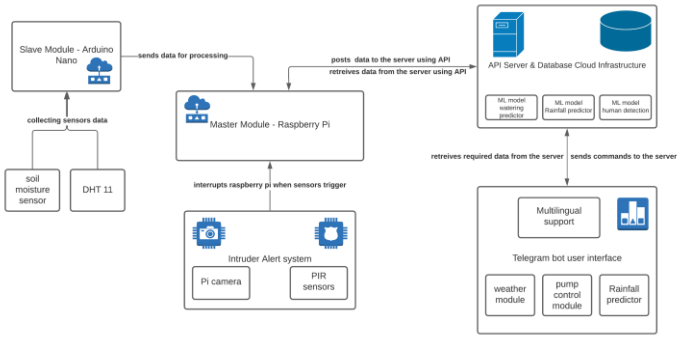

Fig – 1: System architecture

The hardware components include the sensors for collecting data like soil moisture sensor, dht11, and components like Arduino Nano and raspberry Pi for running specific tasks. The Software's we used are the Arduino IDE for developing the code for Arduino Nano and we used python programming language to write code for the entire system and used FastAPI framework for developing the RestAPI server.

The entire system is divided into various Modules. They are:

a) Slave Module

b) Master Module

c) API server

d) Front end Telegram Bot

The working and the tasks of each and every module are explained below.

a) Slave Module

This module consists of Arduino Nano which is interfaced with the sensors like the soil moisture and DHT11. It collects sensor data from the sensors in regular time intervals and prints it to the serial monitor from which the master module collects the data.

b) Master module

The Master module is the main module and consists of Raspberry Pi. This module also consists of the intruder system that contains PIR motions sensors and a Pi camera module. The main task of Master module is to run 3 different functions using Multiprocessing.

The 3 functions include:

1) Reading sensor data from the Serial Terminal and post it to the API Server
2) Checking the Pump Status by continuously fetching the API Server and sends the signal to relay which switches on/off pump
3) Checking the PIR Sensor signals, take snaps from the pi camera and post it to the server for detection and post processing.

c) API Server

This is the central part of the project which handles pretty much everything from storing sensor data to detecting objects in an image. The functionalities of this module include:

- Can store Sensor data in the database and return whenever you want
- Get the weather from Open-weather API for your region and returns only the needed parameters
- Detects objects in an image and saves the image to the database and returns it when requested
- Predicts the rainfall in the particular region by taking two input parameters State and Region
- Pump status can be updated by POST request and can be fetched using GET Request
- Object detection is done using YOLOv3 which is written in C and then ported to work with TensorFlow which is a Python3 framework
- There are two routes for posting an image written in the API, one is for the instant detection which returns the image detections and the image UUID using the complete coco dataset which has about 80 classes and the other method just takes in the image but never returns anything, this is for the intruder module and

only detects wild animals and humans (11 Classes) and stores them in the database and can be fetched later.

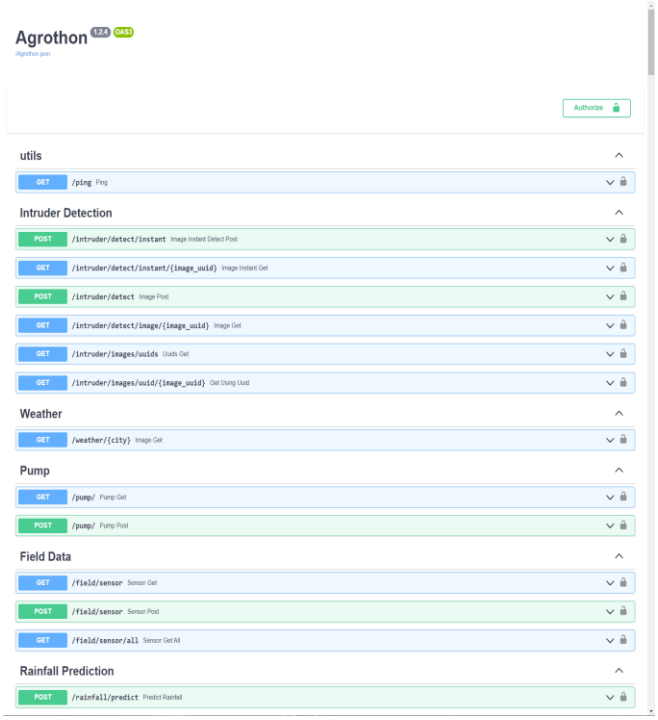

Fig -2: List of all API commands

d) Telegram Bot

As we have already developed APIs to request any data, we can display that data into any application or website etc. we haven't chosen an app or a website because farmers have less knowledge about them and they should first learn how to use them. These days everybody is on social media and everybody got used to it. There are many social media platforms like WhatsApp, Telegram, Instagram etc. but out of these Telegram provides a great bot API. So, what we have chosen Telegram Bot as a frontend application to the API. The functionalities available in the Telegram Bot are:

- It fetches weather, rainfall prediction and the Sensor data on user request
- There is also an involuntary function which continuously fetches the API (Intruder Module) for the latest detections and posts to the Alert channel.
- If only people are detected in the farm, user will get a silent notification, where as any animals are detected, user will get a sound notification.
- For Managing Pump, we managed to Provide an inline keyboard through which user has to just press a button to switch it on/off or switch on pump prediction.
- This has an optional method which returns detected objects when a photo is sent to the bot
- There are other commands like help, ping, stats and log which will return the corresponding things.

Machine Learning models

As discussed earlier, we have developed some machine learning models for our system for various functions.
The machine learning models that we have developed are:

1) Watering Predictor Model

This model takes the sensor data as input i.e., soil moisture content, Temperature in the farm, humidity around the farm and decides whether there is any need of watering the farm. We have trained this model using Logistic regression and this takes into consideration of weather conditions as well and takes a decision of turning the water pump ON or OFF.

2) Rainfall Predictor Model

This model is developed with the idea of providing the user with an option to get prediction of rainfall for their regions. To train this we had collected rainfall data of each and every district in India for the past 110 years. We explored the data and trained various models using various algorithms like support vector machine, Linear regression, Random forest regressor and keras deep learning model. Among all those models, the one trained with keras deep learning technique was found to give accurate results and therefore we finalized that model. This model predicts the amount of rainfall for a particular region from the months of April to December as those months are found to have unpredictable rainfall patterns.

Table -1: Comparison of various models

Algorithm	Mean observed error
Linear regression model	94.2567063
Random forest regressor	85.6973883
Support vector machine	116.6067151
Keras deep learning model	44.2819812

3) Object classifier using YOLOv3 [4]

This model is created in order to provide surveillance to the farm. This was developed using the YOLOv3 object classification algorithm. This version of algorithm is an improvement over the previous in terms of accuracy and faster than the previous versions. It uses a variant of Darknet which is a framework for training neural networks. It consists of 106 large fully convolutional architecture where as the previous versions had only just 30 layers. When an image is sent to this algorithm it down samples it into 3 different sizes and then uses 3 different anchor bounding boxes per layer. This algorithm can detect and classify various objects and we have modified it with whatever objects we are needed with.

4. RESULTS

The entire results of the system can be viewed through the Telegram Bot that we have created as a user interface.
As mentioned in previous section about what all the telegram bot can show and do, the results of those functionalities are:

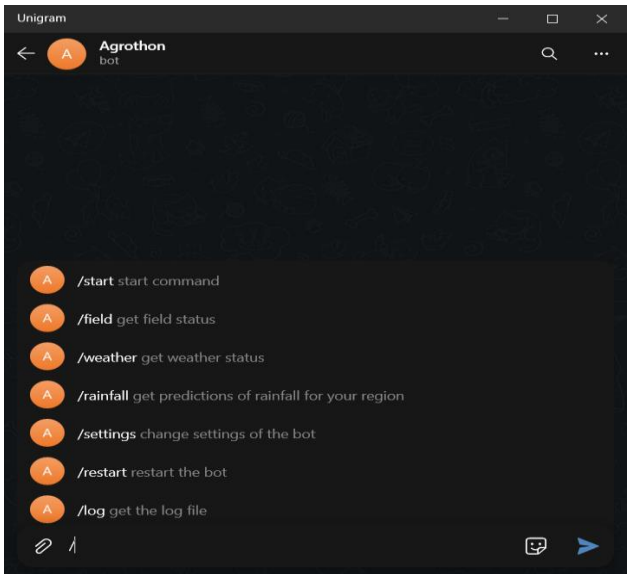

Fig -3: List of commands in the Bot

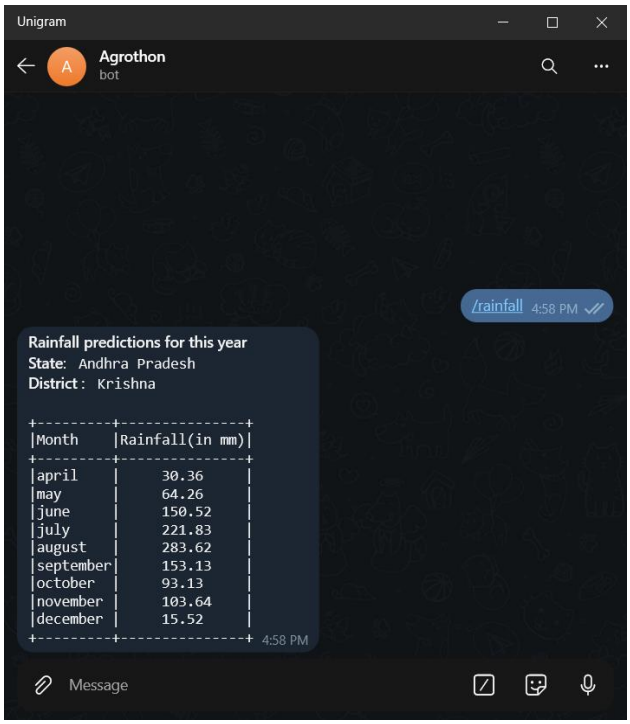

Fig -4: Rainfall prediction

Fig -5: Animal detected alert

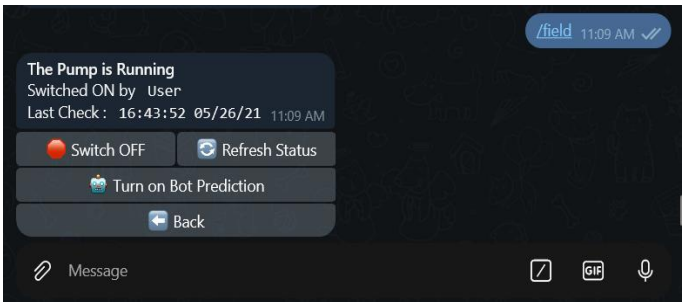

Fig -6: status of the water pump

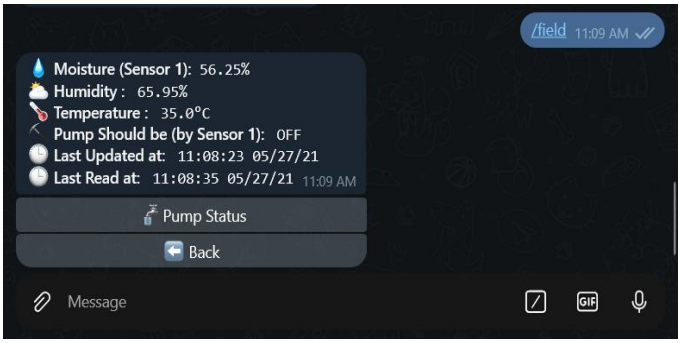

Fig -7: Real time complete data of the farm

5. CONCLUSIONS

Through the system that we have developed in this paper we have reduced the amount of water being wasted in the farms and also, we have reduced the amount of manual work being done by the farmers in maintaining the farm. With the system we have developed the farmers can control and monitor the farm wirelessly using the telegram bot just by connecting to the internet. In the future we can improvise the surveillance system by attaching the camera and the motion sensors to a serve motor and increase the field of view of this system by rotating the servo motor.

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REFERENCES

[1] Z. Muhammad, M. A. A. M. Hafez, N. A. M. Leh, Z. M. Yusoff and S. A. Hamid, "Smart Agriculture Using Internet of Things with Raspberry Pi," 2020 10th IEEE International Conference on Control System, Computing and Engineering (ICCSCE), 2020, pp. 85-90, doi: 10.1109/ICCSCE50387.2020.9204927.

[2] Yuthika Sekhar, Ekta Dagur, Sourabh Mishra, Rijo Jackson Tom, Veeramanikandan. M and Suresh Sankaranarayanan, “Intelligent IoT Based Automated Irrigation System”, in International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 18 (2017) pp. 7306-7320.

[3] S. Yadahalli, A. Parmar and A. Deshpande, "Smart Intrusion Detection System for Crop Protection by using Arduino," 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA), 2020, pp. 405-408, doi: 10.1109/ICIRCA48905.2020.9182868.

[4] Joseph Redmon and Ali Farhadi, “YOLOv3: An Incremental Improvement”, 2018 in arXiv, eprint: 1804.02767

[5] J. Gutiérrez, J. F. Villa-Medina, A. Nieto-Garibay and M. Á. Porta-Gándara, "Automated Irrigation System Using a Wireless Sensor Network and GPRS Module," in IEEE Transactions on Instrumentation and Measurement, vol. 63, no. 1, pp. 166-176, Jan. 2014, doi: 10.1109/TIM.2013.2276487.

[6] M. Ayaz, M. Ammad-Uddin, Z. Sharif, A. Mansour and E. -H. M. Aggoune, "Internet-of-Things (IoT)-Based Smart Agriculture: Toward Making the Fields Talk," in IEEE Access, vol. 7, pp. 129551-129583, 2019, doi: 10.1109/ACCESS.2019.2932609.

[7] I. Mat, M. R. Mohd Kassim, A. N. Harun and I. M. Yusoff, "Smart Agriculture Using Internet of Things," 2018 IEEE Conference on Open Systems (ICOS), 2018, pp. 54-59, doi: 10.1109/ICOS.2018.8632817.