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IoT Based Smart Farming by Using Autonomous Rover and Crop Monitoring Tool

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Abstract - *Automation is one of the vital parts of the industry in the 20th century. We are living in a world with a busy schedule we don't have any time to waste, our automated crop monitoring system's objective is to make our crop fields smart and help farmers to manage their time by reducing the human effort by the efficient tools of computer vision and machine learning. As Thomas Jefferson said "Cultivators of the earth are the most valuable citizens. They are the most vigorous, the most independent, the most virtuous, and they are tied to their country and wedded to its liberty and interests by the most lasting bonds". Our project is to implement a system that will help farmers to identify the fruits which are ready to harvest and to give warnings for emergencies etc.*

1. INTRODUCTION

The amount of efficient for automated farming solution available in the market is in a lower degree. With this project, we are introducing a highly efficient form of farming automation by utilising modern solution like machine learning, cloud computing, etc. So we are introducing an IoT based farming monitoring solution with the help of autonomous rover and a third party smart plant monitoring tool and with help of a lot of other small sensors are integrated through a cloud platform and also controlled through an android application. Our project can provide information like the health conditions of crops, whether the fruit is ready to be harvested, the deficiency of minerals in the soil for each specific plant and amount of fertilisers needed to be supplied, the humidity of surrounding, temperature, the moisture content in the soil, the sunlight availability, etc. Our project helps to automate irrigation, will help to avoid animal intrusion and fire hazards and give notifications about these emergencies in mobile and also provide detailed graphic daily, weekly month growth analysis in the application and web portal.

2. PROPOSED SYSTEM

Considering, the project has a lot of small sensors which are placed distantly, we can classify the overall system into 4 main subsystems.

1. Autonomous Rover
2. Smart Crop Monitoring tool
3. Warning circuits and sensors
4. ThingSpeak Platform and android app

2.1 Autonomous Rover

The autonomous Rover is small rover which is programmed to move through the pre-defined path in specified time interval to take pictures of crops plant through the camera implemented on the rover and process the image through machine learning by using the single-board computer placed on the rover to identify the fruits are ready to be harvested. The rover consists of four geared dc motors which are rotating at a speed of 100 rpm that is slow enough to capture images that can be used for image processing. The single board we used in our project is a Raspberry pi4 with 4GB Ram is a 64-bit computer which process and controls the rover and its connected modules. The camera sensor is 5 MP sensor which is capable of taking full-HD videos. We have used the tensor-flow lite from google for the image processing tool.

In our project, we only use the pc to analyse the harvesting time, but the pc capable to do more programmes, so in future, with proper programming, we could use this to identify diseases in the crop plants and for other use cases. We also implemented a Wi-Fi module in the rover to transfer the data collected to the IoT platform through the Router and modem network placed in the control centre of the farming land.

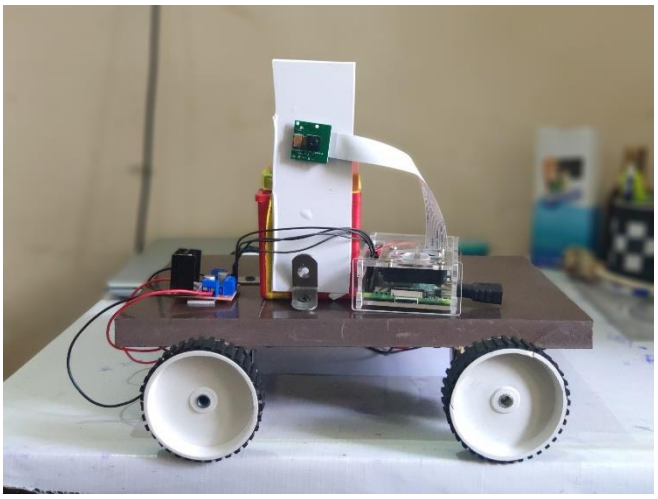

***Fig - 1**: Autonomous Rover*

2.2 Smart Crop monitoring tool

Initially, we think using our crop monitoring tool for the project, but we have to collect details of every plant to if are looking for the global scale of our project. So we decided to use the one of market best plant database for this purpose. The crop monitoring tool is from a Xiaomi's ecosystem brand, but we are using an international model of this sensor from a different brand "VegTrug" which modify the Xiaomi's monitoring tool for the international audience. We are not using their app, we only utilising their cloud database in our web portal.

We place the crop monitoring tools randomly in our crop field and are connected to the cloud through the router. Crop monitoring tool only has Bluetooth low energy support, so it could only transmit up to 10m, but considering the range, we needed we have to utilise a Wi-Fi module ESP8266 to boost the range.

The module itself containing sensors to detect light, temperature, soil moisture and nutrient detection and it is powered by a CR2020 Button battery which can provide around 1-year power for the module. It can detect light intensity up to 1 Lakh LUX and detect temperature ranging from -20 degree Celsius to 50-degree Celsius with 0.5-degree temperature error control. The module comes with an inbuilt app which is available in Play store and it will display various data from the module in an easily understandable way. It also provides daily, weekly or monthly plant growth rate.

The required conditions for each plant are different, so the app also comes with a cloud database which has growth parameters of 900 ornamental plants and includes the encyclopaedic knowledge of over 3000 plants, so we use this database to set the growth parameters in our web portal or app for each specific plant.

Fig - 2: Crop Monitoring Tool

2.3 Warning circuits and sensors

The various warning circuits and sensors used for automatic irrigation and put out the fire in emergency condition are included here. All of these sensor networks is connected to the cloud through Arduino and ESP8266 Wi-Fi module with a power supply in each unit.

2.3.1 PIR Sensor

PIR (Passive infrared sensor) is a low-cost sensor which can detect the presence of human beings and animals, so this can be used to avoid animal intrusion. There are two important materials present in the sensor one is the pyroelectric crystal which can detect the heat signatures from a living organism and the other is a fresnel lenses which can widen the range of the sensor. Whenever it detects the intrusion it will trigger the alarm which produces a sound which irritates animals and also farmer being notified through the app

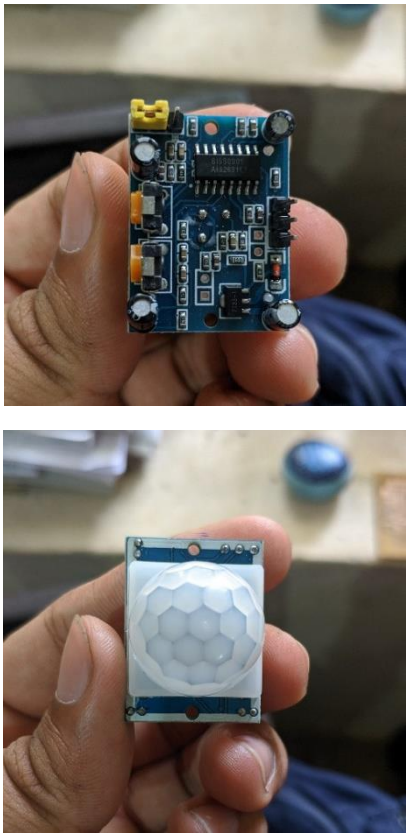

Fig- 3: PIR sensor

2.3.2 Fire Sensor

A flame sensor designed to detect and respond to the presence of fire, here we are using an IR based flame sensor, when it detects the fire it will instantly notify the farmer through the app also trigger automatic water sprinkler placed in the farmland to put out the fire.

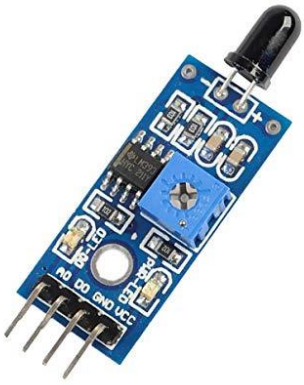

Fig-4: Fire Sensor

2.3.3 Water level Sensor and Automatic irrigation

We are using the hydro sensors in the various height of water tank to detect the water level and also uses automatic water filling system, based on the moisture level in the soil (which is detected through the smart crop monitoring tool we will automate irrigation and will automatically shut down when moisture level reaches the required level for the specific plant, in terms of fire it also trigger the irrigation system until the fire is put down.

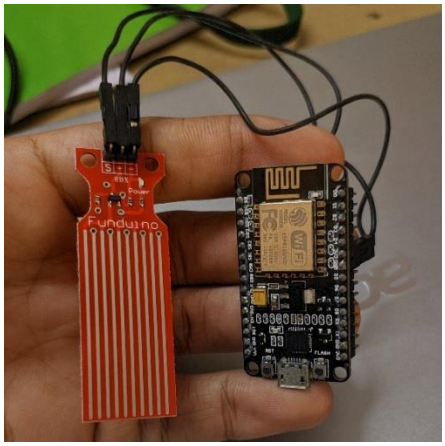

Fig- 5: Water Level Sensor with NODEMCU

2.4 Web Portal and App Development

We are using ThingSpeak platform for web application and mobile application development. ThingSpeak is an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP and MQTT protocol over the internet or LAN. This platform helps us to aggregate, visualize, and analyse live data streams in the cloud.

In our platform we visualize the data from moisture, fertility, sunlight, temperature sensors, also visualize the number of fruits ready to be harvested, the water level in the tank and daily, weekly and monthly growth analysis, etc. in a simple form for the ease of understanding. To set the required level of each quantity for the specific plant we use our third party crop monitoring tool cloud database. Our android application is working from the live data from the cloud database.

3. OVERVIEW

The overall implementation of our project can be simply displayed in the Block diagram, which is shown below. Here expect Camera Module and Motor Drivers are directly controlled from Cloud and above two are directly controlled by the Raspberry Pi

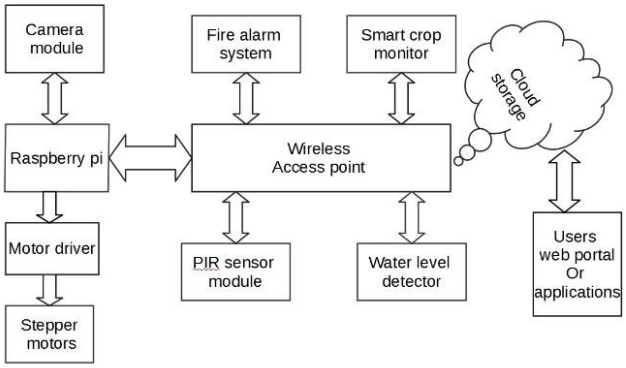

Fig- 6: Block Diagram

Fig-7: ESP8266 WIFI Module

4. CONCLUSIONS

The existing farming solution used by the farmers are obsolete and they do not meet the expected yields. It also faces a lot of difficulties like a daily visit to the plant, the limited amount of water supply in critical conditions, various type of diseases to the crop plant due to the nutrient deficiency, animal and fire intrusions may affect the expected yield, also late harvesting of fruits cause to fall in profit. Considering all these situations we are introducing our IoT based smart farming by automated rover and smart crop monitoring tools helps the farmers to identify the fruits to be harvested, it gives a detailed analysis of growth, the health of the plant and various key parameters like temperature, the fertility of the soil, the moisture content in the soil, sunlight availability, etc. it also helps to avoid water and nutrient deficiency, it will protect the field from fire and animal intrusion, and it will enable the farmer to get all the information about his field in a mobile application, web portal and store the data collected in a cloud database for a long period time, so it will help in future analysis. So our smart farming solution is a very affordable but yet very effective solution for most of the difficulties faced by farmers today.

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