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Implementation of IoT in Automated Agricultural System

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Abstract— Global population is increasing day by day. Therefore, the demand of food will be doubled in next 30 years. With limited resources to meet this demand will be a great challenge for human. To increase the production of food, traditional agricultural system needs to be updated. This paper is proposing developed an automated agricultural system with internet of things (IoT) to solve traditional uneven ploughing problem, water management on the field, intruder's attack and temperature effect on crops. This system has two major part. One is automated agricultural system with an automated vehicle for ploughing and another part is storing real-time field data to the ThingSpeak cloud with stream live video of field situation to the YouTube via internet of things (IoT) technology. Several sensors like soil-moisture, temperature, passive inferred ray (PIR), Rain-drop sensor, IR sensor was used in this system. Based on this sensor's real time data from developed prototype system three programmable microcontroller (Arduino Uno, Arduino mega, Raspberry pi 3B) controls the whole system. To stream the live video to YouTube a 5MP raspberry pi camera module was integrated. The automated system has another two key features to solve the problem of improper water management and intruder's inclusion. Those are automated irrigation system and bird repeller. Stored data in the webserver can potentially be worthy for next year operation. By using this system, farmers can also connect multiple farm to the web at the same time and access all of the farms in one webpage and will be able to observe the farm in real time. All the key features and technologies can help to build a sustainable and productive farming system and enter the fourth industrial revolution.

Index Terms— Automation, Internet of things, Agriculture, Raspberry pi, sensors, Arduino, ThingSpeak server, YouTube.

1 INTRODUCTION

Internet of things which is commonly known as IoT is a term that addresses to the technology where machines can interact with each other and make decisions without requiring human intervention. It is an emerging concept of the modern time that is being adopted by many industries. In the future farming system, Internet of things (IoT) can play a salient role to increase the production. United nation (UN) Food and Agriculture organization have estimated that, the food production needs to be increased 70% more by 2050 than the production in 2006 to suffice the imminent food demand [1]. In addition water resources are becoming scarce day by day. Properly utilizing the limited water resource and reducing water wastage is a challenging issue in the days to come. Moreover, factors that increase yields like an improved ploughing method and reducing crop loss by intruder prevention is a great concern. Finally, integration of IoT technology with automated farming procedures can resolve the impending agricultural hazards. IoT provide the farmers with the privilege of constant monitoring of the field condition and weather condition from anywhere through internet connection. Farmers will be able to observe the important field condition in real-time as well as they can compare it with the previous data stored on the server. This paper focuses on performing automated agricultural task like ploughing, irrigation, bird repelling and also storing soil-moisture, raindrop, PIR, temperature sensor data readings on the server that is invaluable for analyzing, monitoring the entire farm in YouTube and developing existing agriculture system. By exposing automation and IoT in agriculture farmers can save time and money. That will be very helpful to increasing production.

1.2 EARLIER RESEARCH

IoT based agricultural works that resemble this project from many aspects have already been published. Authors have taken various approaches and devised many innovative solutions for existing agricultural problems.

In [2], a smart sensor based IoT network has been developed for monitoring agricultural farm. In which, five sensors were used. Those are soil moisture, temperature, solar radiation, humidity and fertilizer sensor. Author approach was to solve irrigation problem and a PV panel delivered whole power supply of this system.

An automated irrigation system using IoT has been designed in [3]. Authors had used soil-moisture, pH sensor and solenoid valve. All the data was send to the ThingSpeak server via Wi-Fi and GSM module. Control of the irrigation system was established using solenoid valve.

Authors of [4] have designed an IoT based intelligent field monitoring system. Where soil moisture and temperature of the soil observed though a web server. To automate the farming system microcontroller has been used. By using GSM module, field data has been send to the webserver.

In [5], judicious irrigation process and soil quality monitoring system have been introduced. Soil moisture sensor helps in data acquisition from the field. The sensor determines the soil moisture level of the ground. Different soil moisture sensor were used to measure different moisture in the soil. Nutrient sensors was used for measuring Potassium, Nitrogen and Phosphorus in the soil. Authors had connected all the system with an smart phone via wireless communication. This system is designed for an effective water management and fertilizer management system by properly utilizing water and fertilizer resources.

Two important soil parameter magnesium and nitrogen monitoring and crop disease detection via image processing are the main focus in [6]. Authors have used temperature and humidity sensor. Raspberry pi was used as microcontroller and solenoid valve was used in irrigation. For image-processing MATLAB was used by the authors. All the data was sent to webpage by raspberry pi.

In [7], Prof. K. A. Patil and Prof. N. R. Kale had proposed a model for agriculture using IoT focusing on real monitoring system (RMS) and short message service (SMS) based on field sensor value. The main feature of the designed system was to monitor soil parameter like soil moisture, pH and temperature. Crop diseases was detected via image processing and send notification to user via SMS.

The authors of [8], focusing on monitoring field data like temperature, humidity, object movement and moisture. Using raspberry pi authors sent data to the customized web server in every 10 seconds. Smart irrigation based on the sensor value was performed.

2 System Architecture and Implementation

The proposed system is divided into two major parts. One is automated system and another is internet of things. Automated system is sub-divided into two parts. One is automated ploughing car and another is sensor based irrigation and bird repeller network. Required hardware components and Whole system design is discussed below.

2.1 Hardware requirements

1) IR sensor
2) Soil-moisture sensor
3) Rain drop sensor
4) Temperature sensor
5) PIR sensor
6) 5v four channel relay module
7) DC motor
8) Water pump
9) Arduino mega
10) Arduino Uno
11) Raspberry pi camera module
12) Raspberry pi 3B

2.2 Software requirements

1) Arduino IDE
2) Raspbian Operating System
3) Advance IP scanner
4) MobaXterm
5) Python IDLE 3

2.3 Web server

The platform used as the server in this system is ThingSpeak. Which is a free online service where collected data can be stored in the cloud and IoT applications can be created. It generates instant visualization of data posted to its server. ThingSpeak is usually used for prototyping and examining the IoT systems that seek analytics [10].

2.4 System design

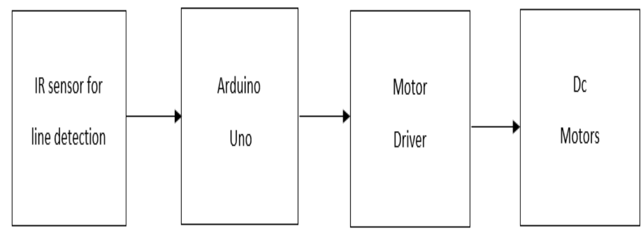


Fig. 1. Block diagram of automated car for ploughing

Fig. 1. represents the working method of the automated car where two IR sensor was connected to the Arduino Uno. Based on the sensor pre-calculated threshold value, previously programmed Arduino Uno controls the power supply of the dc motors. This automated car works based on line following technology. This automated car may solve the improper ploughing problem in agriculture field..

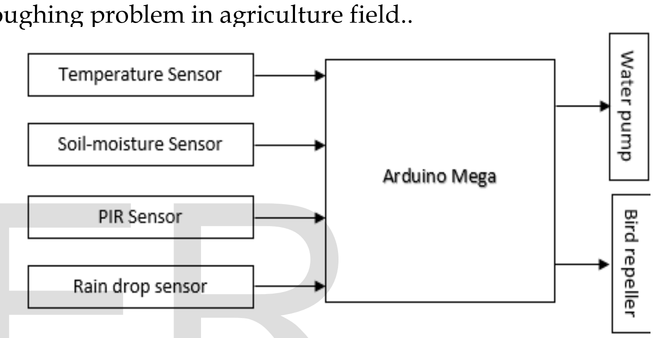


Fig. 2. Block diagram of automated system (sensor based field network)

Fig. 2. Represents the working procedure of the automated field network. Here four sensors are connected to Arduino mega. Based on soil-moisture, temperature and raindrop sensor data, Arduino mega controls the water pump. To operate the bird repeller Arduino observe the data from PIR motion sensor. This automated sensor network sensing the value in real time and respond based on previously installed algorithm in Arduino mega. This system may solve the problem of improper water management, intruders attack problem and harm to the crops due to excessive heat.

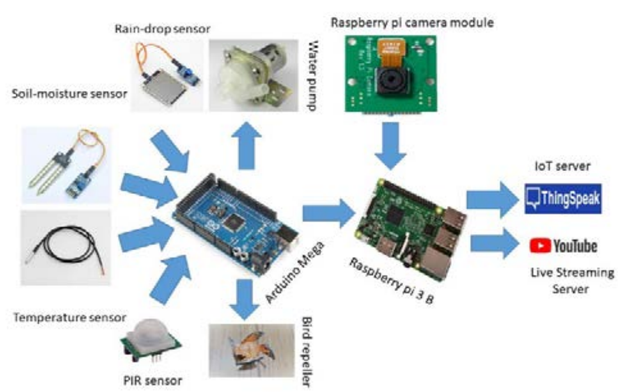


Fig. 3. Workflow of the proposed system

Fig. 3. represents the implementation of IoT in automated system (sensors network). Where Arduino mega in operating the automation part and sending the data to the Raspberry pi over a USB cable. Then raspberry pi sends the data to the ThingSpeak server. To send the data to the Raspberry pi from Arduino mega, byte was used as data type. This two operation is done simultaneously within gap of less than 10 seconds. Time delay may control by the user. To stream the live video camera module was connected to the raspberry pi and by using real time messaging protocol (RTMP) technology live video of field was streamed in YouTube.

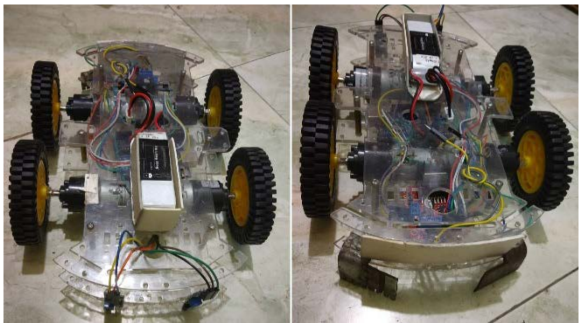


Fig. 4. Implemented Automated Car

Fig. 4. represent fornt(left) and back(right) view of automated car, which works based on line following technology.

Fig 5. Implemented full system

Top view of implemented proposed system prototype is represented in Fig. 5.

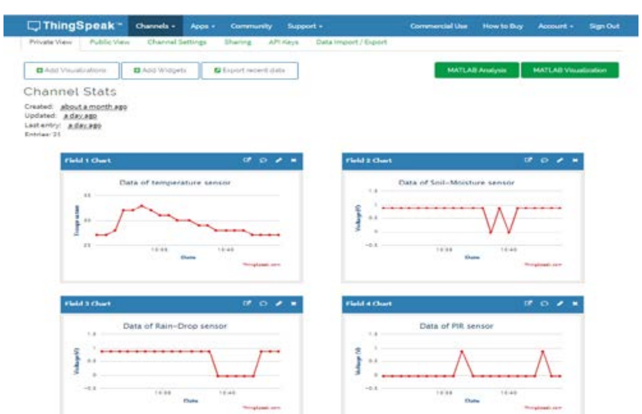


Fig. 6. user interface after logging in ThinngSpeak server

The server side is the segment where the users can seamlessly connect with the system. Here, all the sensor data are stored and user can observe the field conditions i.e. soil-moisture, raindrop, temperature or presence of any intruder in real time using their user account. This gives the user a privilege to supervise their farm condition from any place while being connected on the internet.

3 Results

Soil-moisture sensor, raindrop sensor, PIR sensor and temperature sensor which are the input parameters of this system were implemented in the artificial ground which was prepared to assess the required field data.When the users sign in to their account in ThingSpeak server they get to see the real-time data update from the sensors. Sensor readings are instantly stored and displayed graphically in the server via the Arduino Mega and Raspberry pi module. The graphical data of soil-moisture, rain-drop and PIR sensor are presented as voltage measured vs time and it is temperature vs time for the temperature sensor. The voltages shown are either logical High or logical Low. The small dots in the graph let the user to know about the sensor data stored in a specific date and time.

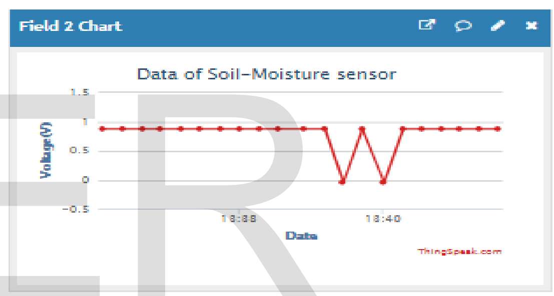
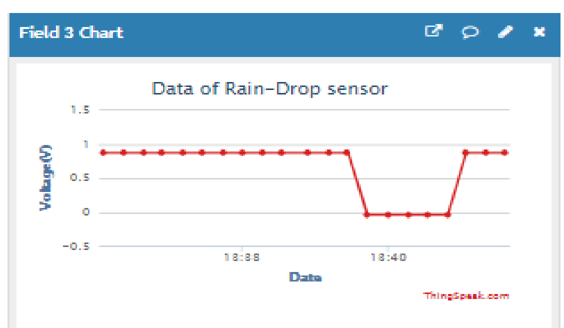


Fig. 7. Real time moisture update from soil-moisture sensor.

From Fig. 7. soil moisture sensor reading can be interpreted. When moisture level in the soil is high it gives high logical voltage that means "1" and when moisture level is low then sensor gives logical low voltage. Based on these logical voltage irrigation process can be operated.

Fig. 8. Rain-drop sensor data stored in the server.



In Fig. 8. raindrop sensor reading is represented from IoT server. In dry condition rain drop sensor produces High logical voltage. If rain drop is detected by the sensor then it produces low logical voltage. This sensor reading also helps to operate the irrigation process. If there is natural source of water no need to irrigate the farm by an water pump. Based on

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this logic combining two sensor soil-moisture and rain drop sensor inappropriate irrigation problem may solve.

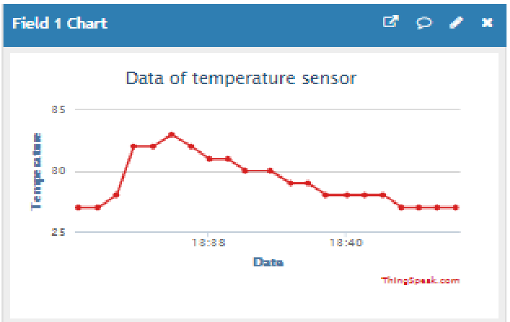

Fig. 9. Temperature variation of water presented in real-time.

From Fig. 9. temperature sensor reading can be observed. This temperature sensor shows the temperature reading of water. For some crops, overheated water is harmful. By observing, the temperature crops can be saved by stopping irrigation from that heated water source.

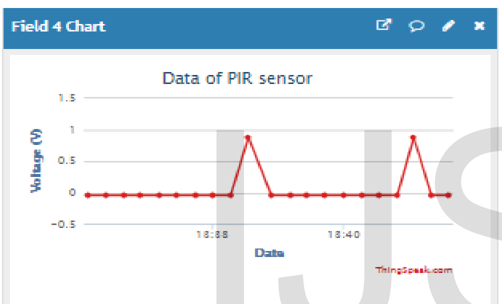

Fig. 10. PIR sensor value presented in a graph in the server.

In Fig. 10. PIR, sensor value is represented. When there is any object movement sense by the PIR it gives high logical voltage and when there is no object movement it produce low logical voltage. By sensing object movement, bird repeller is activated.

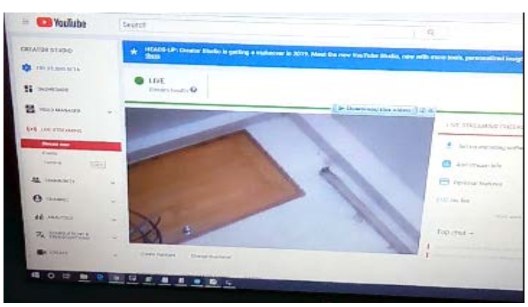

Fig. 11. Test output of Raspberry Pi camera module

In Fig. 11. screenshot of YouTube live streaming by raspberry pi camera module is represented. There is 3 seconds of delay in streaming because of slowness of raspberry pi processor and internet connectivity. By observing the field in real time in YouTube help identifying any object inside the field with more precision. That can help to avoid any unwanted situation in the field and help to increasing the productivity.

The operating voltage of the pump and repeller, which perform the irrigation and repelling process respectively also examined and the results are listed in the following table.

TABLE. 1: VOLTAGE OF WATER PUMP AND REPELLER WHEN BOTH ARE ACTIVATED

Related element	Operating Voltage
Water pump	8V-12V
Repeller	5V

4 CONCLUSION & FUTURE SCOPE

This project has highlighted some fundamental farming procedures like irrigation, ploughing, repelling completely automatically, which are hindering the development of agriculture sector due to the old methods of applying them. A server created for the farmers can store sensor readings for useful observation. This system will be able to increasing productivity. Increase in productivity will ensure the sustainability. Which means, this automated methods with IoT implemented may revolutionize the agriculture system.

For further development, a few agricultural procedure such as seeding, weeding or harvesting the product can be included. Moreover, image-processing technique can be used to detect crop diseases early hence to increase the productivity. Thus, agricultural sector will be more productive to meet the future needs.

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