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Smart Agriculture Approach Using Internet of Things

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Abstract: A solar powered smart approach is proposed which is connected to the internet to elucidate the real-time problems in agriculture, diminishing the labour cost in weeding and monitoring the field conditions through telemetry. Corroborating easy communication between the farmer and the field to ascertain appropriate action depending upon the sensor data fetched from the robot via internet.

Keywords: Internet of Things, Raspberry Pi, Sensing, Telemetry, Machine Learning, Cloud Computing

I. INTRODUCTION

The Sub Continent farmers are not having enough expertise to use latest technologies like IoT, Automation, Cloud Computing and Machine Learning in order to elucidate their challenges in agriculture or to make agriculture more efficient and cost effective [6]. The smart phones are altering the human life-style but there isn't any visible impact on farmers (especially in India). This project drags sensor technology, cloud computing, micro-controller based development boards on to a single platform to assist farmers to resolve their basic problems and also multiply their profits by spiking up the efficiency in consumption of resources. The sensors in the field accumulate the raw data from the environment and remit it to the development board [1]. The development board in response remits the acknowledgement through submerged mini-motors or water pumping motors, solenoid valve, etc., and also remit the data to cloud via internet in order to communicate with the farmer. Employing machine learning and video processing it can spot the weed in the field while watching through webcam [5]. Through mobile app we can analyse the stored cloud data by employing software intervention. The farmer can monitor the field or the data from the cloud by employing a mobile application. The mobile application employed in the approach is interacting by using chatbot technology which is localised to native languages for the farmers who are illiterate [4]. The farmers can also trigger action based on the data fetched from the field via mobile application.

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II. RELATED WORK

The techniques for smart farming are being changing day by day for more accuracy, efficiency and precision. There are many ways to recharge a battery but this work is based on solar power, According to Evan Ackerman [1], in order increase the efficiency of solar panel we can use solar tracking technique which can be implemented using LDR Sensor or Image Processing or Artificial Neural Network. The most efficient way of solar tracking is by using visual feedback. The main challenge of the work is to remove weed from the field which can be done by drilling, Laser, Cutter, etc., But according to P. Diament robotic arm can used for repeated action accurately in telemetry applications [2] and it is safer than other methods. So, the work uses robotic arm for weed removal. Collection of the sensor data from is a simple task using a control unit but the real challenge lies in sending data from field to server. MQTT and AMQP protocols are the widely used protocols in Internet of Things based projects. According to G.O. Young [3], Message Queue Telemetry Transport (MQTT) protocol, the publish/subscribe lightweight messaging protocol, is considered to provide the interconnection between sensors and the server. Since MQTT is based on the TCP/IP protocol, we can collect the used data from the sensors in the field via internet [7].

III. PROBLEM STATEMENT

After exploring the literature we have listed few of the worse effects of weeds on healthy agriculture as listed below:

1. Decrease in crop yield: Weeds consume most of water, nutrients and light that should have been used up by the crops. They consume more of water and nutrients than crops and also grow quicker than crops.
2. Cost of cultivation increases: Tillage cultivation is performed in order to control weeds and it is generally approximated that on an average about thirty percent of the total expenditure of crop production is on tillage operations but still more labour is being employed for weeding. This results in increased cost of cultivation and reducing the margin of net profit.
3. The quality of product is reduced: When the crop is sown in a weedy field the seeds of weed get intermixed with the main crop which results in lowering the quality of the produced good e.g. seeds

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of weed in wheat, gram etc. Similarly, bundles of many leafy vegetables like Methi or Palak contain green plants of weeds. They are sold for lower prices in the market.

4. The quality of the livestock products is getting reduced: There are many types of weeds e.g. Hulhul when eaten by cattles gives an undesirable flavour to milk. Similarly weeds like Gokhru get attached to the body of the sheep and damage the quality of wool. Certain poisonous weeds like Datura may even cause death of cattle if they are by chance eaten by cattle.

5. Weeds are safe haven for insects, pests and diseases: Weeds either give shelter to various insects, pests and diseases or act as alternate hosts which further leads to loss of wealth of farmers.

IV. METHODOLOGY

This approach comprises of a chassis in which sensor, USB camera, gripper, sprinkler, Raspberry Pi 2, Controller, Lead-acid battery and solar panel are stowed. The sensor block comprises of DS18B20 waterproof digital temperature probe, KG003 soil moisture sensor and DHT11 Digital Humidity Temperature Sensor. The gripper whose movement is controlled using DC motor is stowed in front of the robot for detaching weeds and other gripping applications. The USB camera is placed behind the gripper for real-time streaming of the passage through which robot advances. All the sensors, gripper, sprinkler and USB camera are interfaced with raspberry pi 2 for import and export of data. A TP-Link Wi-Fi USB 802.11n Transceiver is connected to Controller and internet in order to establish bi-directional communication between farmer and field. The robot is then attached to a rechargeable lead-acid battery for power supply. After that rechargeable battery is connected to a dual axis solar tracking system for recharging process. The sensors data is then redirected to private cloud portal for Internet of Things using available Wi-Fi connection. In this portal we can fetch the sensor data, analyse the fetched sensor data from the robot and acknowledge to the sensor data collected using Trigger app in the portal. The triggering action to the sensor will be a tweet which will assist in initiating the sprinkler or motor in the field depending upon the sensor data fetched. The motion of the robot is controlled by an android application and the same application is used to monitor the collected sensor data and assist in triggering action manually.

V. CIRCUIT DIAGRAMS

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Figure 1 presents the connection diagram of motors and lead acid battery with controller unit to control the rotation and speed of motors for movement of the arm in order to remove weeds. Also, connections of DC motors has been represented.

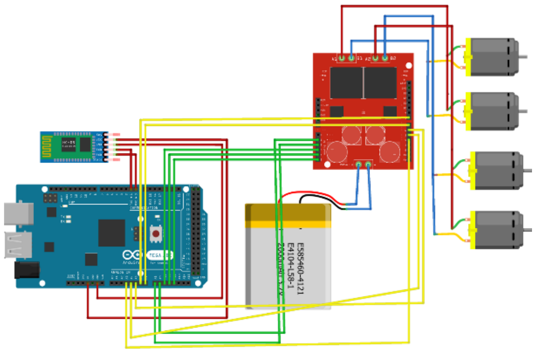

Fig. 1: Schematic diagram of Interfacing of Controller with Bluetooth Module, Motor Shield, Lead-acid Battery and DC Motor

The connections of USB webcam and Wi-Fi module used in this work have been shown in figure 2 below. Figure 3 represents interfacing of controller unit with various sensors used for this work.

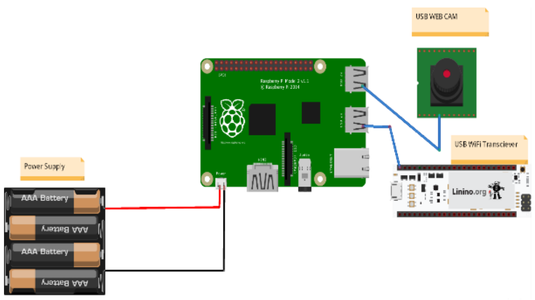

Fig. 2: Schematic diagram of Interfacing of Raspberry Pi with USB Webcam and Wi-Fi Module

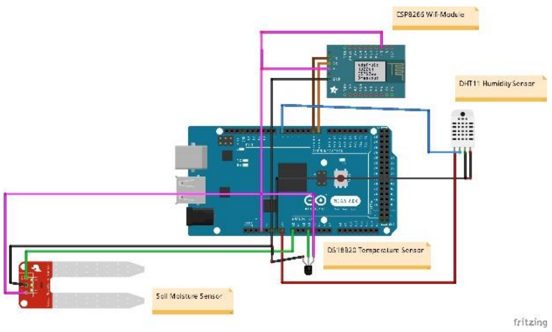

Fig. 3: Schematic diagram of Interfacing of Controller with Wi-Fi module, Soil-Moisture senor and DHT11.

As discussed in the previous sections, we have also deployed a solar system to power the complete device. Figure 4 represents the connections of solar tracking module.

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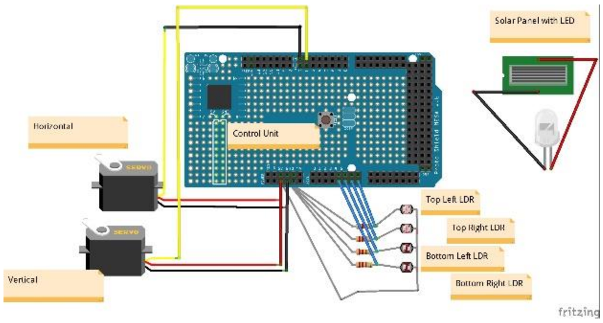

Fig. 4: Schematic diagram of Solar Tracking module.

VI. WORKING

The Robot comprises of a chassis in which sensor, USB camera, gripper, sprinkler, Raspberry Pi 2, Controller, battery and solar panel are placed. The Sensor block comprises of DS18B20 Waterproof digital temperature probe, KG003 Soil Moisture Sensor and DHT11 Digital Humidity Temperature Sensor [5]. The gripper whose movement is controlled using DC motor is placed in front of the robot for detaching weeds and other gripping applications. The USB camera is placed behind the gripper for real-time streaming of the passage through which robot advances. All the sensors, gripper, sprinkler and USB camera are interfaced with raspberry pi 2 for import and export of data. A TP-Link Wi-Fi USB 802.11n Transceiver is connected to controller and internet in order to establish bi-directional communication between farmer and field. The robot is then attached to a rechargeable lead-acid battery for power supply. After that rechargeable battery is connected to a dual axis solar tracking system for recharging process. The sensors data is then redirected to private cloud portal for Internet of Things using available Wi-Fi connection. In this portal we fetch the sensor data, analyse the fetched sensor data from the robot and acknowledge to the sensor data collected using Trigger app in the portal. The triggering action to the sensor will be a tweet which will assist in initiating the sprinkler or motor in the field depending upon the sensor data fetched. The motion of the robot is controlled by an android application and the same application is used to monitor the collected sensor data and assist in triggering action manually.

We are connecting webcam and driller to the smart bot and powering it with the help of Lead-acid rechargeable battery and solar panel. We will capture the video of the crop through webcam and convert it into digital signal with the help of Raspbian Operating System and PuTTY [8]. In

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Raspbian Operating System we will do the programming and convert the video to the digital signals. It has various inbuilt algorithms which is used for video processing. We will connect Controller with the Wi-Fi module and send the digital signal to the Wi-Fi module. Wi-Fi module will help in connecting to the Wi-Fi network. Then we will send the digital signal to the hotspot. Then it will go to the database for online view and we are using ThingSpeak for cloud storage of the signal. After that we can instruct the Smart bot to do required operations. Controller is a single board computer it will control all the signals. Motor drivers are connected to Controller is used for controlling the motor speed and direction. DC Motor will be used for providing continuous movement to the driller and stepper motor will be used for precise step angle movement of the driller. USB power cable will be used for transferring data from computer to Controller. Ethernet cables are used for connecting devices within a local area network. For weeding we need Robotic Arm which is controlled through Controller, Motor driver and Motors. Robotic Arm need to make precise angle for weeding otherwise it can cause damage to crops.

The dual axis solar tracking system consists of a solar panel of 6V, 0.5A and four LDR sensors. This panel is placed on a servo motor. The sensors, motors and rest of the system are connected to controller. Logic prepared in Controller such that when light falls on LDR the servo motors rotate to that direction. It will be connected to lead acid rechargeable battery. The current supplied by Solar Panel is less but still it can be utilized in the project as it is a clean source of energy.

We will be sending sensor data to cloud using Controller and Wi-Fi module. In Controller we have power and sensor channels, we are connecting it to internet through Wi-Fi module and we will be sending data to the private channel of ThingSpeak. Through this we will be sending Temperature, Humidity and Soil Moisture data from the field to cloud and analysing on that data using various applications. If the Soil Moisture Sensor value is less than 400 then it is placed in water. If its value is 400-700 then Soil is “moist” and if Soil moisture Sensor value is 700-1000 then soil is “dry”. Waterproof temperature sensor and Humidity sensor will tell us about the current field temperature and humidity values directly on ThingSpeak portal. So, we can analyse about the condition of the field where we are growing crops living far away from it.

Android app consists of web page and various buttons like front (w), back (s), right (d), left (a) and

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stop (f). In this app if we press right arrow then the app will send “d” from our android phone Bluetooth to the Bluetooth module which we have connected on bot. The Controller which receives the symbol from Bluetooth and code for movement of motor is processed. Similarly, in other cases. But in stop button when we press it then the servo motor starts and the brushless motor work to pluck the weed. In web page go cam we will enter the required IP and press the go cam button so that we can see the video. If we want to take a right turn then after press of right turn then the left motors will start to rotate and there right turn. Similarly, same logic applies for the left turn.

VII. APPLICATIONS

This can successfully remove weeds from crop field without manual intervention. It is useful for farmers as it saves cost for growing crops. It can be installed for domestic purpose (e.g. gardening). It is completely useful for agriculture purpose and for horticulture. It can be helpful to farmers especially in rural areas where they are unaware of such technologies. It is helpful in giving information about health of the soil. Successfully keeps a check on the humidity and temperature in crop field.

VIII. ADVANTAGES OF THE APPROACH

- Very cost effective compared to the contemporary conventional technologies
- Very small and portable to any location
- Very easy to use
- Selective treatment of weeds without herbicides
- Very low power consumption
- Rechargeable from solar panel
- Reduced workload in comparison to manual weed control
- To know about the temperature and humidity of crop field
- Charge through solar panel and work on batteries
- Less pollution, reduced environmental impact
- Most important of all almost eliminate human intervention.

IX. RESULT AND DISCUSSION:

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The project's aim is to cut down the cost of farmers as they tirelessly work for longer duration for growing crops because of which we can get food. This project will help the farmers because if RoboKrishi is used then farmers need to use less water, nutrients, herbicides, pesticides, etc. in order to grow the crops. There is shortage of freshwater in our country if we use RoboKrishi then we can reduce the amount of water used for irrigation as previously weeds was soaking most of the water used up by the crops. Here, we are also sending sensor data to cloud which will help the programmer or normal farmer to analyse about the temperature, humidity and soil data through various applications. The graphs consist of sensor data received from field through wireless sensor network. The data shown in the graph is received from sensor in one hour in day with a delay of fifteen seconds as it is the minimum time required for the database to get updated. But this delay is tentative it may change depending on the speed of the internet we provide and the delay given in the Controller Code. Using twitter backend services the robot sends a tweet to turn-on or turn-off water sprinkler whenever the temperature or humidity or soil-moisture data reaches certain threshold value. Figure 5 below represents the data captured by web interface and mobile interface along with message notifications received by user.

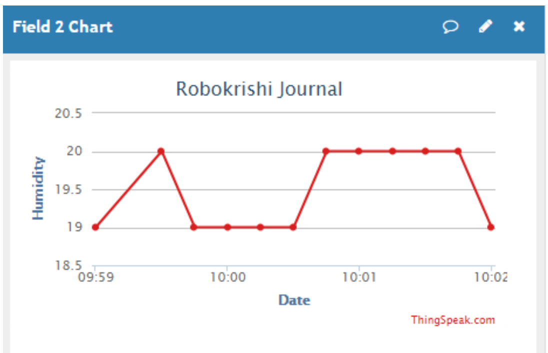

Fig. 5a: Sensor Data for Humidity

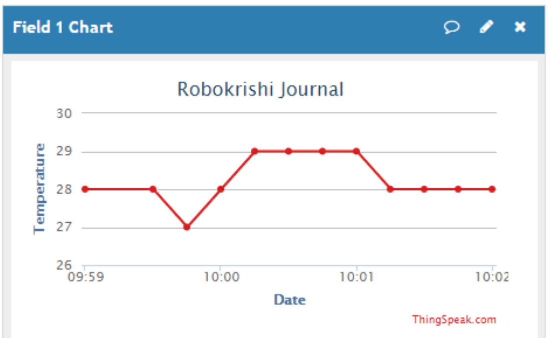

Fig. 5b: Sensor Data for Temperature

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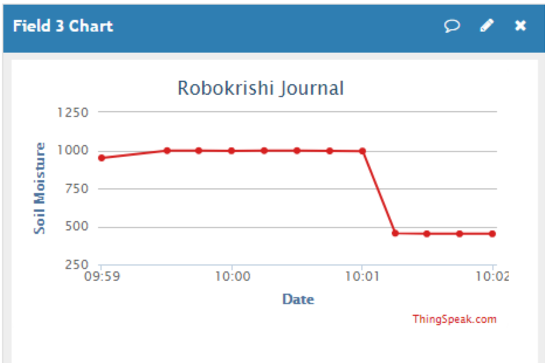

Fig. 5c: Sensor Data for Soil Moisture

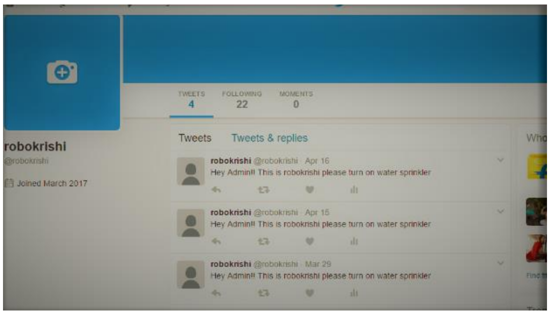

Fig. 5d: Tweet Sent by Robokrishi

X. FUTURE SCOPE

The field we have chosen to work is an ever evolving platform for experimentation and innovation as farmers are the reason we are getting food. If by any means we can do something to protect the crops and save the money of the poor farmers, it would be really helpful for them. Through RoboKrishi we are using robots which will remove the weeds without manual intervention; it will have great scope in the future because of the savings in the water and nutrient requirements which was previously taken up by the weeds. The robot needs to upgrade to add more applications like seeding, automatic weed detection and Machine to machine communication. We need to establish connection between ThingSpeak & Controller and trigger the reaction in real time. We need to create a trigger which sends SMS or message to mobile phones directly.

XI. CONCLUSION

The use of electronics is increasing exponentially across various segments of human life. The components used in this project, like Raspberry Pi and Sensors are slowly becoming an

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indispensable part of our daily routines. So, it is apt that we use them to improve efficiency in every sphere of life. Keeping in mind the urgent need for removing weeds through robot, RoboKrishi is an excellent and effective solution as it also uses solar panel for recharging. The system altogether combines conveying report to farmers regarding their crop field using minimal power which is rechargeable at a very low cost of manufacturing and installation. The future scope in this area is very huge and ever evolving and additionally we could add more modules that could give more precise and perfect information on prescribed parameters of temperature and humidity. If the soil moisture sensor data is above 850 it means the sensor placed in air, if the data ranges between 600 and 849 it means the soil is humid and if the data is less than 600 it means the soil is having excess water content or the moisture is present in water or any conducting liquid. The temperature should range from 65F-75F for good yield.

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