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Internet of Things Based Intelligent Monitoring and Reporting from Agricultural Fields

***Ashwini M **Gowrishankar. S, Siddaraju**

Abstract : This paper aims to provide a viable solution for remote monitoring and control of agricultural activities using Internet of Things (IoT). A robot fitted with sensors is used to monitor agricultural farm in real time based on various parameters. These parameters include humidity, temperature and rain fall. Robot sends this data to a smart phone using internet. A farmer can access ongoing agricultural activities from anywhere by connecting to online network. Commands can be sent to the robot to control parameters or perform activities in the field via the smart phone. Farmer can control this robot and monitor the field remotely from his hand held device connected to internet. Smart phone controls robot by a mobile application based on the instructions received from the farmer.

Smartphone's camera acts as a monitoring device to capture pictures for analytical purposes. These pictures can be analyzed for health of the farm, insect attack or even the presence of intruders to the field. Robot can accept control commands to move in the specified directions. This can be further extended to perform any user specified task.

Keywords : IoT, Arduino, Sensors, Robot, Android, Agriculture, Cam Server, Serial data

1. INTRODUCTION

In India, agriculture is the main activity to increase economy. It provides occupation to about 60-70% of country's population. Agriculture practices in India have largely remained traditional requiring continuous manual labor and monitoring. The yield per unit land in India has not increased much over time. Rapid urbanization and migration of population to the cities has resulted in acute shortage of manual labor which also made the labor expensive. This has further resulted in a dip in the profitability in agriculture sector[2]. Hence there is an urgent need to increase the yield per unit area.

Traditionally agricultural practices like ploughing, harvesting, winnowing, threshing and so on were performed manually. Some of these practices are not only cumbersome but also risky. Effective use of technology to monitor and control the activities can help in reducing manual labor expenses. It can also help to troubleshoot adverse climatic conditions and take preventive actions which will result in increased yield.

IoT concepts are generally used to reduce manual presence in farming activities. In IoT model, various physical objects are made to communicate to a local server [3]. This server is connected to the internet at other end. The physical devices can now talk to each other as well as internet in the way of any other internet enabled computer. IoT concepts are applied to agriculture, to monitor and control activities in farming automatically thereby requiring minimal or no manual supervision.

* Department of Computer Science and Engineering, Dr. Ambedkar Institute of Technology, Bengaluru-560056, Karnataka, India. ashwini.alike@gmail.com

** Department of Computer Science and Engineering, Dr.Ambedkar Institute of Technology, Bengaluru-560056, Karnataka, India gowrishankarnath@acm.org, siddaraju.ait@gmail.com

In this paper, a robot is developed which can move around the field and perform activities that are programmed. The sensors mounted on the robot send real time data to the farmer [4] and this data can provide valuable inputs. The inputs received can be used to check weather conditions and progress in growth of the crops in respective fields. Camera of the smart phone can send pictures of the crop which can be used to detect, stage of development, presence of weeds and even an intruder.

2. LITERATURE SURVEY

The first report regarding automated agricultural activities using IoT was published in 1934 Modern Mehanix journal. This concept tries to bring major changes in agricultural field in which farmers are separated from machines and automation is done using robot. Some of IoT based robots used in an agricultural fields observed in the literature are listed below.

MIT Mobile Robot Gardner was started on January of 1985. The main aim of this project was to construct the machines that could be treated autonomously and robustly in dynamical alteration of environments[5]. Later it was designed for maintaining soil humidity and to pick ripe fruits. This type of robot monitors the sensors attached to each plant for soil humidity.

Agrobot is a mobile robot used to move in agricultural fields automatically. The idea of this type of robot is to increase the fertility of field by mobile automation. Agrobot has the capacity of handling and checking field operations like spraying remedies for exactness agriculture, soil analysis, enrichment, disease identification**[**6**]**.

Spray robot is used for automatic spraying on agricultural fields. The cylindrical shape of spray robot is 30 cm wide and moves throughout the field[7]. It is designed to spray the pesticides for plants like tomato, cucumber, houseplant, etc.

The robot called Autonomous robot tractor is a self-steering tractor is equipped for an extensive variety of moves made with high exactness. In an irregular and conflicting territory, a major issue is raised by the altering of tractor direction. Just sensors or an effective personal computer is insufficient to pass the problems. But this robot uses an effort fit to set the message according to each terrain type[8].

Armadillo is a type of wheel-leg crossbred robot inspired by retracting design of the armadillo. This type of robot has large hand wheel diameter to climb obstructions. [9]. Armadillo has used in many applications such as field inspection, mechanical and chemical weeding.

Vine robot is another traditional robot which uses artificial intelligence technology to operate on vineyards. These robots contain advanced sensors to find out the status of water, vegetable or fruits status. [10].

3. PROBLEM STATEMENT

Today farmer spends a lot of time in activities which include routine monitoring of the field. There is a lot of time wasted in this repeated activities. This paper aims to automate these repeated activities by using IoT model to reduce the time spent by farmer in their fields thereby increasing throughput factor. Also there are activities such as ploughing, seeding, or high risk activity such as tree climbing in agriculture which if automated, can bring down the cost of operations to a large extent. A robot is developed to perform such specialized tasks. A farmer can remotely monitor the field and control various machines from his hand held device.

4. OBJECTIVES

Following are the objective of this paper

- To avoid manual work on agricultural field through automation of various activities including measurement of humidity, temperature and light by using IoT.
- To avoid need of having the physical presence of a farmer to watch over large areas of agricultural field.
- To secure the fields.

5. EXISTING SYSTEM VS PROPOSED SYSTEM

Today, most farmers are dependent on manual operation in agricultural field but these processes are time consuming and needs many workers to work day and night. There is no comprehensive robot existing which can do multiple activities itself and/or by the orders sent through online and report it back to the farmer. In many existing systems, separate robots are used for every operation.

The proposed system [fig. 1] overcomes these shortcomings in the existing systems. It is based on IoT in which physical objects are embedded with sensors, electronics, network connectivity that is used to collect and exchange the data. The system is proposed with a movable robot i.e. placed in field equipped with a smart phone. The smart phone used here will work as a computer device with capabilities of running software and will help to "capture an image" and "use internet" for communication. The robot will roam in field based on user command. The camera attached to robot will capture the images and will send it to the farmer remotely. The user can also obtain information about current temperature or humidity or any other sensor information which will be responded back to the farmer.

Advantages of proposed system :

- It performs multiple operations at a time.
- Time saving as well as energy saving for farmers.
- It gives security to the field by monitoring the field in real time.
- Cost effective.

Fig. 1. The Proposed Model.

6. ARCHITECTURAL DESIGN

In agricultural fields, IoT makes the work simple by automating various activities. It is mainly dependent on internet which acts as a medium of communication between farmer and field. The architecture contains three levels [fig 2.] wherein Level1 contain different devices, which are interconnected with each other and are placed in agricultural fields. In Level2, these equipments perform actions based on farmer request. Storing of images for further process and display of responses based on farmer request is done at Level3. Smart phone sends captured image as well as sensor data (Level2) to web browser/phone [Level3]. Farmer can analyze these sensor data and develop crops based on these data. The captured images can be downloaded and store it in database or can be directly downloaded from browser for viewing purpose. Browser window is also used to send request to the field for robot motions. Based on on-time demand, the robot makes a motion [fig.21].

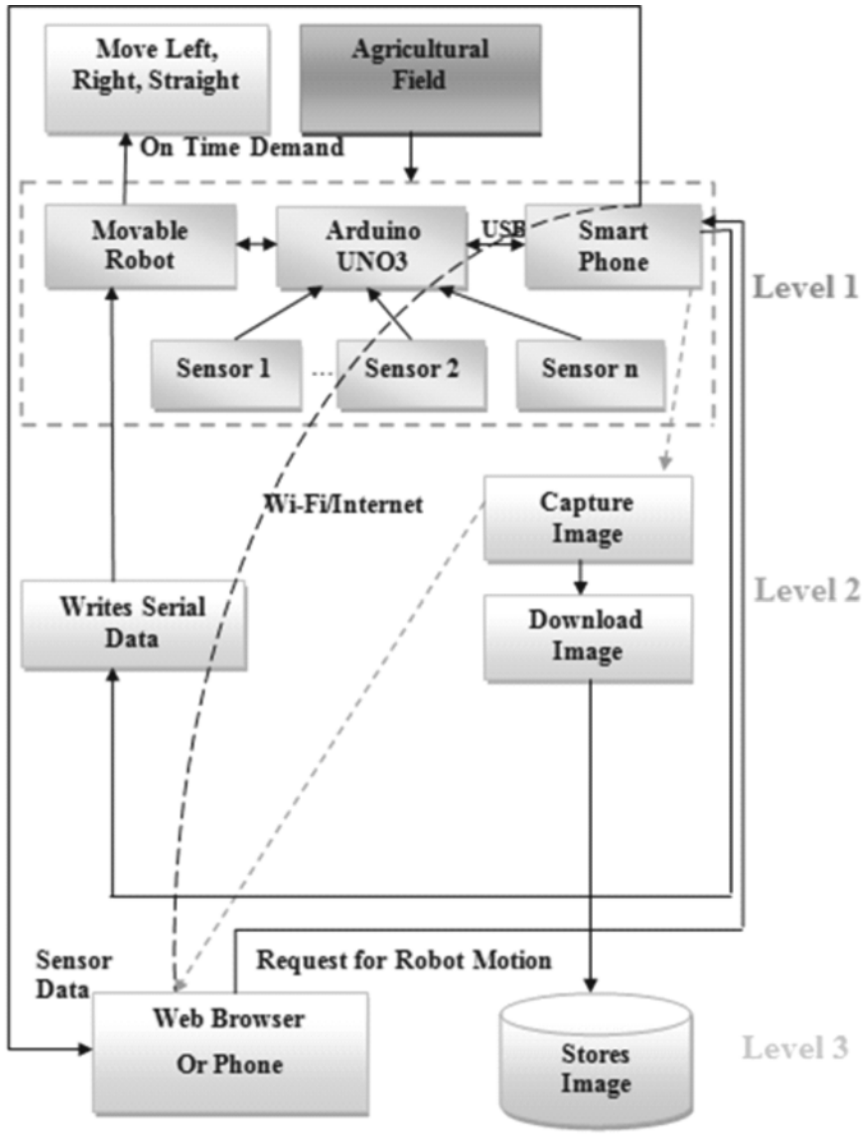

Fig. 2. Architecture View of the system.

The roles of different parts used here are :

A. Arduino UNO3

It is a portable, high-definitiveness, low-discontinuation device[11]. The microcontroller based Arduino board containing 14 input/output pins. It is powered through USB cable. The main function of Arduino is to read and write data from different sensors, and send data from robot. It performs serial data reading from different devices. The Arduino is connected to sensors, robot and smart phone.

B. Sensors

If farmer wants to know the weather information or updates about any activity which is happening in his agricultural field, it can make use of different sensors such as temperature sensor, humidity sensor, light sensor, rain-fall sensor, object detection sensor and other sensors. These sensors are used to monitor the sensor information in an agricultural field. This paper is illustrated using first three of these sensors. AM2302 [15] sensor is used here to find the temperature and humidity. For detecting information about the field surroundings, sensor discharges the digital signal using thermistor and capacitive humidity sensor [12].

The main usage of light sensor is to find the pale levels of light in agricultural field. Value of Light Dependent Resistor (LDR) varies depending on amount of light that falls on the field. Based on this value, we can find the light in agricultural field.

C. Smartphone

The main role of smart phone is to use internet and capturing of images on real time scenarios from agricultural field, so that cropper can monitor the field by using these images. Smart phone is also used to send requested data to browser.

D. Movable Robot

The robot is connected to Arduino and smart phone and its movement depends on user request (straight, back, left, right and stop). The main role of robot with smart phone is to capture photo from different angles. Using these captured photos farmer can view the field remotely and he can take actions if required.

7. IMPLEMENTATION AND RESULT

The architecture mentioned in the previous section was adapted and implemented using Apache Cordova and android platform [13].To install Cordova, Node JS (JavaScript runtime library) is required to develop server side applications such as web page development.

The communication from agricultural field to farmer is using Internet/Wi-Fi. To read serial data, it is necessary to install an Arduino program.

The framework is developed in three phases.

A. Capturing Phase

Capturing images of agricultural field is done by using phone camera. To develop this, a Cam server [17] is used to send captured images to the farmer. Farmer can also download that image for future usage [fig 3].

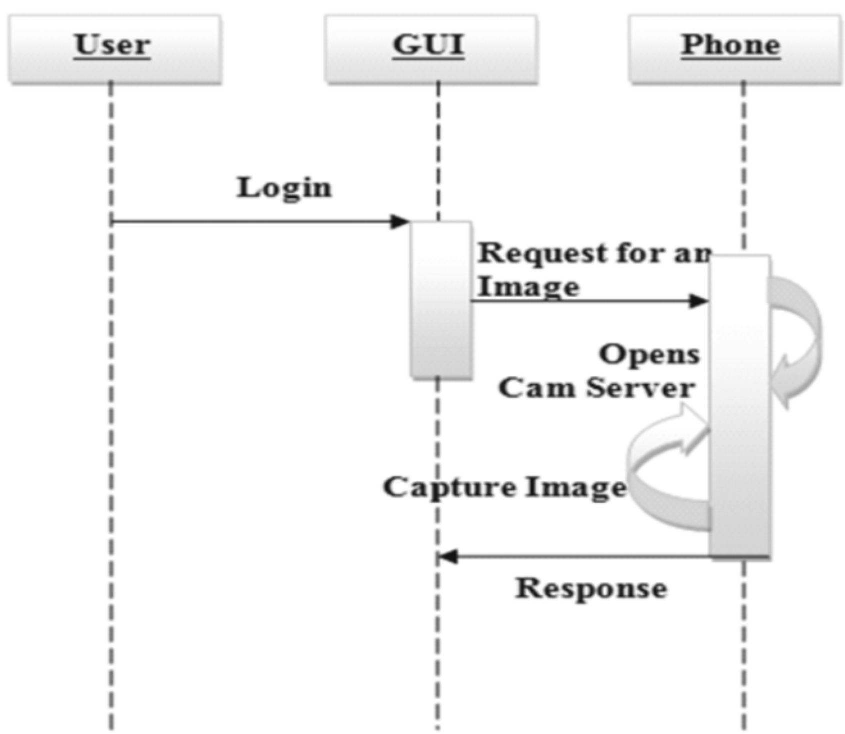

Fig. 3. Sequence diagram for Image Capturing.

B. Sensing phase

Sensors are used to detect current weather of agricultural field. The paper is proposed with temperature, humidity and light sensors. AM2302 sensor is used to find the live temperature and humidity which are in one device and are connected to Arduino through input pins. The "-"pin is connected to GND and "+" pin is connected to 5V. 10K resistor is used for controlling current, which is connected between data pin and "+" pin of sensor. Fig. 4 shows the pin diagram of AM2302 sensor with Arduino.

Once connection is done, power is provided to Arduino which will start reading serial data from sensor [fig. 5]. In this, the smart phone is used to write the serial data and sends it to farmer (Response). Similarly, we can get the intensity of light using light sensor.

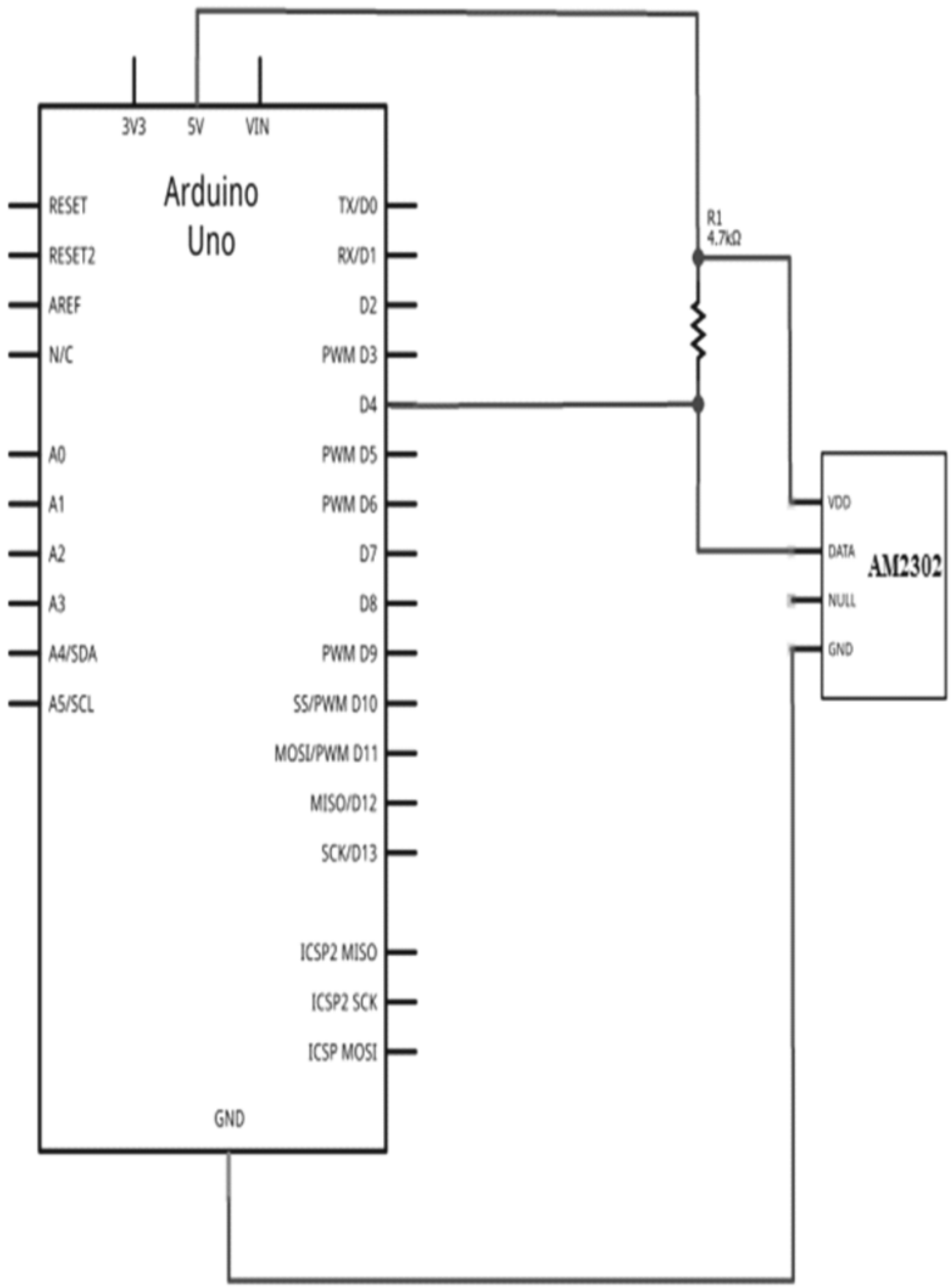

Fig. 4. Pin Diagram for AM2302, Adopted from[15]

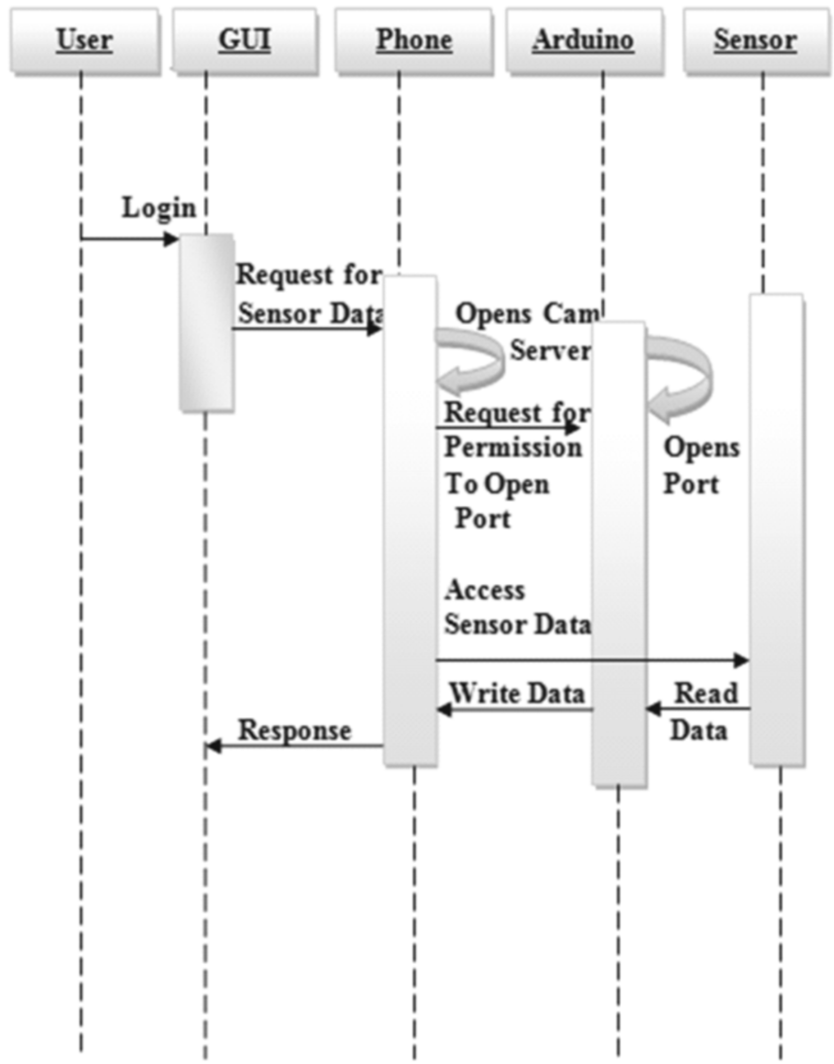

Fig. 5. Sequence Diagram of the Sensor Data

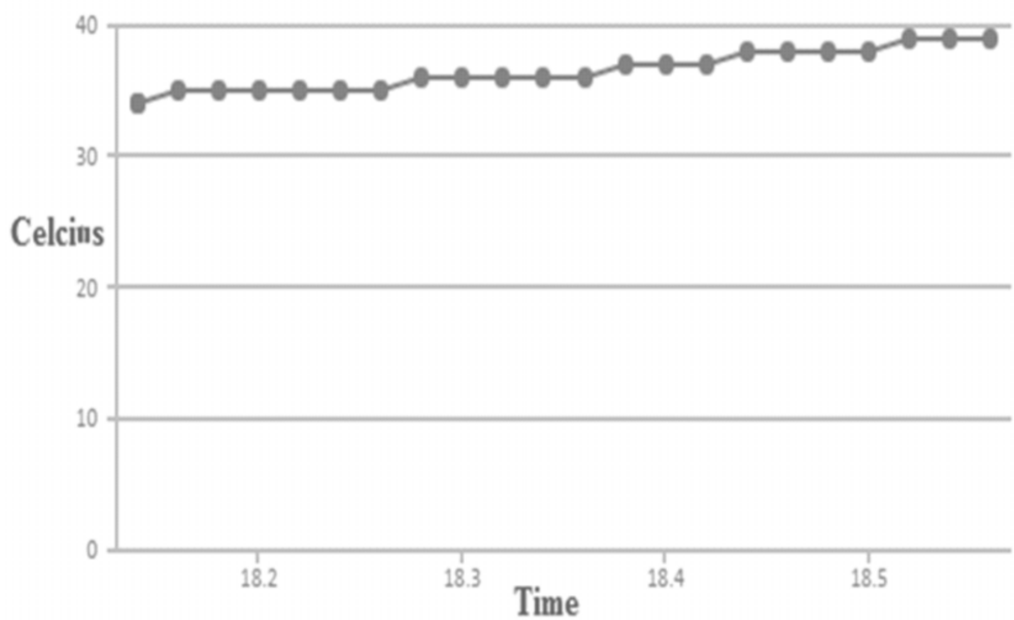

Fig. 6. Temperature Chart.

Android app sends live temperature of the field which is displayed as a chart in browser. Time versus temperature (in Celsius) is plotted in the fig. 6.

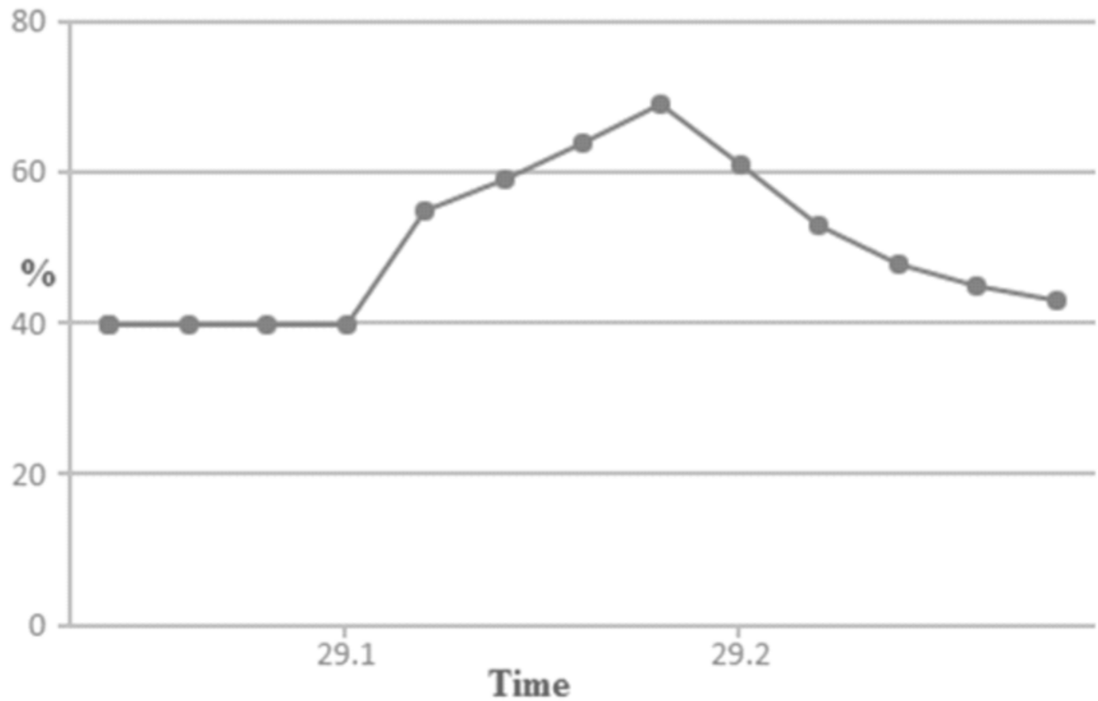

Fig. 7. Humidity Chart.

Fig. 7 shows the humidity chart, which provides live humidity of the field. If amount of water vaporizes in the air is more than humidity of the atmosphere, moisture in air increases and vice versa.

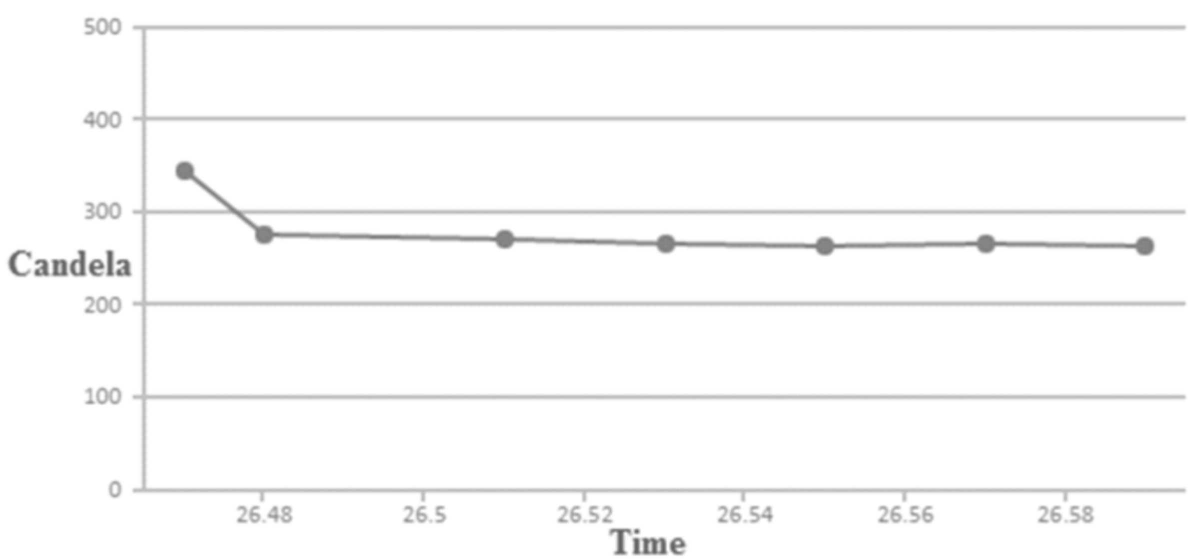

Fig. 8. Light Chart

Fig. 8 represents Light intensity chart. Time versus light intensity (In Candela) graph is plotted. If LDR (Light Dependent Resistor) value is too high (above 500), then the field is dark and if LDR is low, the field has contains light.

C. Robot Motion phase

The connection for two wheel movable robot (consisting L293D dual motor [14]) is shown in pin diagram [fig. 9].

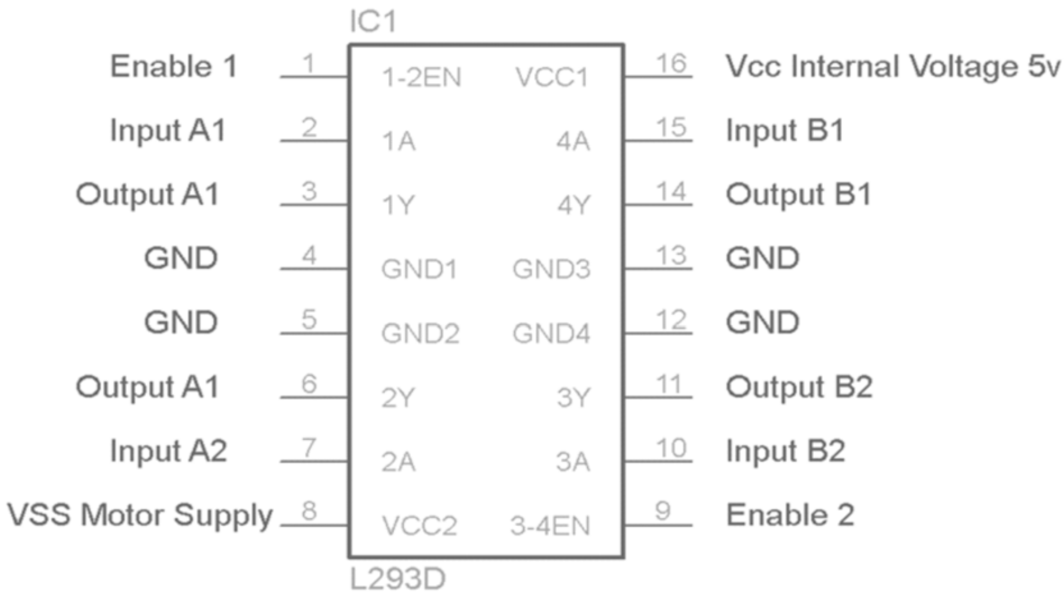

Fig. 9. Pin Diagram for L293D Motor, Adopted from [16]

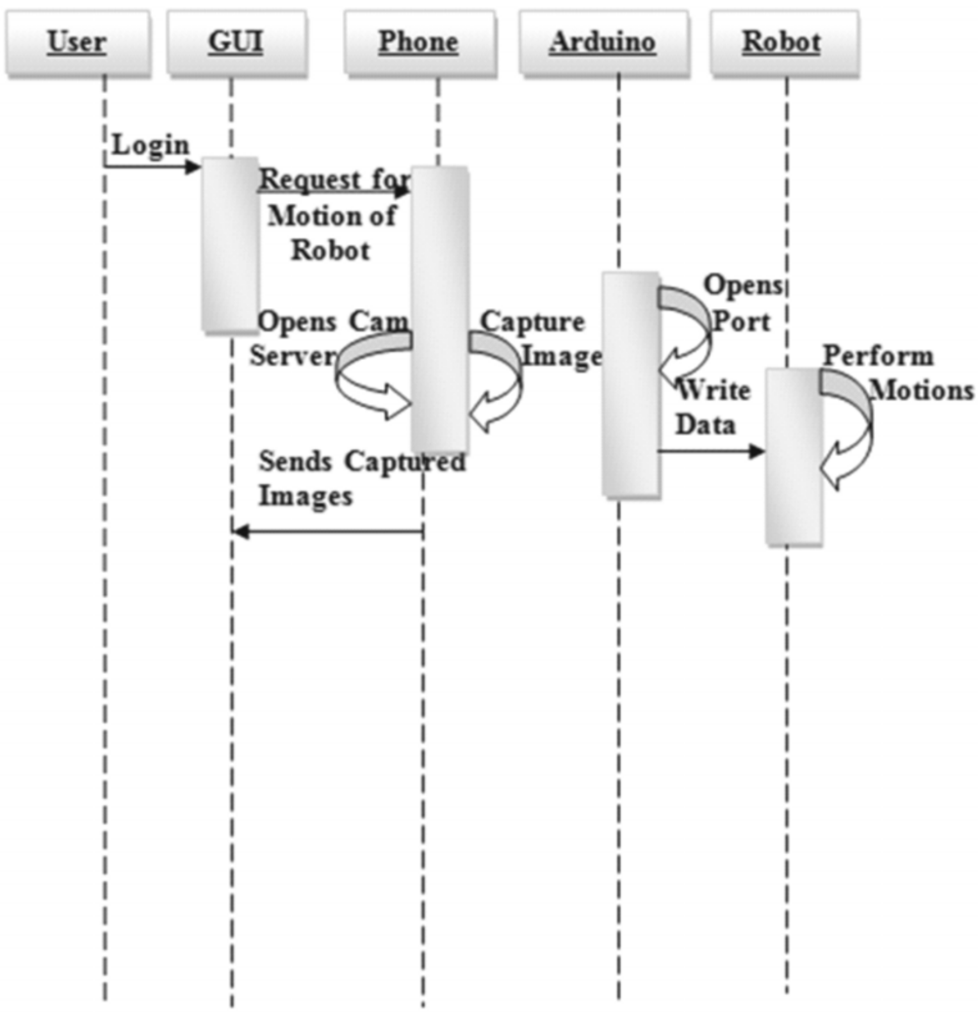

Fig. 10. Working of Robot with various other devices

When user request for robot motion, the smart phone opens Cam server, and will start capturing an image. At the same time, Arduino device writes corresponding data and perform actions with the help of robot. The captured image of different sides is send back to user [fig. 10].

8. CONCLUSION

An underlying result in this paper demonstrates that a large portion of these systems work automatically as compared to conventional system. With the help of IoT, it is possible to monitor the agricultural field continuously instead of manually watching it. This will increase the productivity and safety of field monitoring. Smart phone with camera is connected to the robot that will capture images and send it to user on-demand and on detection of suspicious activity. Sensors devices itself send contemporary information to the farmer. Moreover, the command execution, like “move left” or “capture an image” or “send temperature” can be done using this application.

9. REFERENCES

1. Shaik JhaniBhasha, Shaik Mazhar Hussain, “Agricultural field monitoring and automation using PIC16F877A microcontroller and GSM”, International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), Volume 3, Issue 6, June 2014.
2. P. P. Jayaraman, D. Palmer,A. Zaslavsky, D. Georgakopoulos, “Do-it-Yourself Digital Agriculture applications with semantically enhanced IoT platform”, IEEE Tenth International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP) Singapore, April 2015.
3. Ji-chun Zhao, Jun-feng Zhang; Yu Feng ; Jian-xinGuo, “The Study and Application of the lOT Technology in Agriculture”, IEEE, 2010.
4. Amrita Sneha.A, Abirami.E, Ankita.A, Mrs.R.Praveena, Mrs.R.Srimeena, “Agricultural Robot for Automatic Ploughing and Seeding”,IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development, 2015.
5. Anita M. Flynn and Rodney A. Brooks, “MIT MOBILE ROBOTS - WHAT’S NEXT?, 1990.
6. Durmus, H., Kirci, M., Ustundag, “The design of general purpose autonomous agricultural mobile-robot: “AGROBOT”, IEEE, 2015.
7. Z. Yin , H. Qian, A. Xiao, J. Wu, G. Liu, “The Application of Adaptive PID Control in the Spray Robot”, Intelligent Computation Technology and Automation (ICICTA),Volume 1, March 2011.
8. L. Piyathilaka, R. Munasinghe, “Vision-only outdoor localization of two-wheel tractor for autonomous operation in agricultural fields”, IEEE, August 2011.
9. K. Tadakuma, R. Tadakuma, A. Maruyama, E. Rohmer, K. Nagatani, K. Yoshida, A. Ming, S. Makoto, M. Higashimori, M. Kaneko, “Armadillo-inspired wheel-leg retractable module”, IEEE conference, December 2009.
10. S. Paulin, T. Botterill, J. Lin, X. Chen, R. Green, “A comparison of sampling-based path planners for a grape vine pruning robot arm”, IEEE 6th International Conference, February 2015
11. Y. A. Badamasi,” The working principle of an Arduino”, Electronics, Computer and Computation (ICECCO), 11th International Conference, October, 2014.
12. Wilton Lim, Hans Kaell Torres, Carlos M. Oppus, “An Agricultural Telemetry System Implemented Using an Arduino-Android Interface”, 7th IEEE International Conference Humanoid, Nanotechnology, Information Technology Communication and Control, Environment and Management (HNICEM), November 2014.
13. K. Singh, J. Buford, “Developing WebRTC-based team apps with a cross-platform mobile framework”, 13th IEEE Annual Consumer Communications & Networking Conference (CCNC), January 2016.
14. G. M. Kee, Z. M. Zain, R. H. Salimin, “Design and Development PIC-Based Autonomous Robot”, IEEE, September 2008.
15. getmicros.net, http://www.getmicros.net/arduino-dht11-sensor-example.php
16. communityofrobots.com, http://communityofrobots.com/tutorial/kawal/how-make-your-first-robot-using-arduino, 2011.
17. github.com, https://github.com/Moonware/cordova-cameraserver, 2016