Self-Automated Agriculture System using IoT

K. Swarna Krishnan, K. Jerusha, Poonam Tanwar, Shefali Singhal

Abstract: ***The world populationsupposed to reach 9.8 billion by 2050 and is difficult of feed such population . So for feeding the entire population the agriculture sector should be embed with IOT and farmers also should adopt this technology [1]. It is essential to increase the productivity of farming and agricultural process with the help of technologies like IoT.IoT can make farming easier by reducing the cost by decreasing the intervention of farmers in this field through automation. This paper aim is to develop a self- autonomous agriculture system works by connecting physical devices and systems to the internet. IoT is a very promising technology to drive the agricultural sector, it is the backbone for sustainable development mainly in developing countriesthat are experiencing rapid population growth like China, India etc, stressed natural resources, agricultural productivity reduction due to climate change. Hence the paper aims at making the agriculture smart using IoT technologies. The projects include a GPS based robot to perform tasks like weeding, spraying, moisture sensing, bird scaring, keeping vigilance, etc. This project requires smart irrigation with smart control and best decision making based on accurate real time data. Thisincludes crop management, waste management, warehouse management, theft control etc. Controlling of all the operations will be through a remote smart device like phone or computer connected to Internet and the operations will be performed by using sensors, Wi-Fi or ZigBee modules, cellular, LoRa,camera and actuators with micro-controller and raspberry pi [2].***

Keywords-- Wi-Fi, Automation, Smart farming, IoT.

I. INTRODUCTION

IoT is a combination of data, web associated items, is an integral component of the future Internet. IoT focuses on the automation of processes to reduce human intervention. IoT in agriculture focus is on automating the aspects of agricultural methods to make it more efficient and effective[3]. In traditional approaches of farming does not include livestock management and have many inefficiencies such as higher human interaction, labour cost, power consumption, and water consumptionetc [4] [5] [6] [7].The use of wireless sensor network is done in this project which collects the data from differentof sensors and send it to the main server using wireless protocols. The data that is collected during the process provides the information about different environmental factors which is used to monitor the entire process. Monitoring environmental factors is not the solution to improve yield, quality and production of the crops. It is necessary to develop combined and unique system which will take care of all factors affecting the productivity like cultivation, harvesting and post harvesting storage.

Revised Manuscript Received on February 8, 2020.

K. Swarna Krishnan, Department of CSE, FET, Manav Rachna International Institute of Research & Studies, Faridabad, Haryana, India.

K. Jerusha, Department of CSE, FET, Manav Rachna International Institute of Research & Studies, Faridabad, Haryana, India.

Dr. Poonam Tanwar, Department of CSE, FET, Manav Rachna International Institute of Research & Studies, Faridabad, Haryana, India.

Ms. Shefali Singhal, Department of CSE, FET, Manav Rachna International Institute of Research & Studies, Faridabad, Haryana, India.

This paper introduces a system which is self-autonomous where it monitors the field throughout the process and necessary controls are also taken according to various signals sent by the agricultural devices to a connected system. This process includes a GPS based controlling robot which can work both manually and automatically for doing weeding, seeding, harvesting, etc. It also uses different kinds of sensors to detect the temperature of soil, moisture, humidity, growth control, and many more. Warehouse management is also done in this project by connecting the automatic baler, tractor, harvest machine, crop planting machine to the system through internet. Controlling of all these operations will be through a smart device or computer connected to Internet and the operations will be performed by using sensors, Wi-Fi or ZigBee modules,LoRa, cellular, camera and actuators with micro-controller and raspberry pi [2].

II. LITERATURE SURVEY

The new scenario of decreasing water beds, drying up of rivers, lakes, and severe environmental conditions asks for the urgent need of protection of water by conserving it. To cope up with this issue different temperature and moisture sensors are used and implemented in the field. [8]

The threshold values of temperature and soil moisture is programmed into a microcontrollergateway to preserve and water quantity. The system is powered by photovoltaic panels and have a duplex communication link based on a cellular Internet interface that allows data inspection and irrigation scheduling through a web page. [9]

The technology development in Wireless Sensor Networks made it easy to use monitoring and control of greenhouse parameter in agriculture. [10]

A remote sensing and control irrigation system using distributed wireless sensor network aiming for variable rate irrigation, real time in field sensing, controlling of a sitespecific precision linear move irrigation system to maximize the productivity with minimal use of water was developed by Y. Kim. [11]

In the studies related to wireless sensor network, researchers measured soil related parameters such as temperature and humidity.The system was developed using microcontroller, universal asynchronous receiver transmits interface and sensors while the transmission was done by hourly sampling and buffering the data, transmit it and then checking the status messages. The drawbacks of the system were its cost and deployment of sensor under the soil which causes attenuation of radio frequency signals. [12]

III. APPLICATIONS

In this paper, agriculture IoT applications include farm vehicle tracking, warehouse management, crop management,livestock monitoring, storage monitoring, irrigation management, theft monitoring,

waste management, smart farming, pest controlling, soil management etc. Few applications of self- autonomous agriculture system include the precision farming, usage of agriculture drones, smart greenhouses, energy management, livestock monitoring. In agricultural field by using IoT there will be less use of farmers, human errors are less as everything is automated. By using the sensors in this project, it gives the accuracy of actions. A robot is used to monitor the entire process like cattle management, crop management, birds and animals scaring etc.

IV. BENEFITS

Monitoring and collecting the data ofsoil conditions, air temperature, air and soil humidity and sunlight intensity across fields improves efficiency of usage of water, quality of the crop and crop yield in large farms. As the population of the world is increasing day by day the production of food

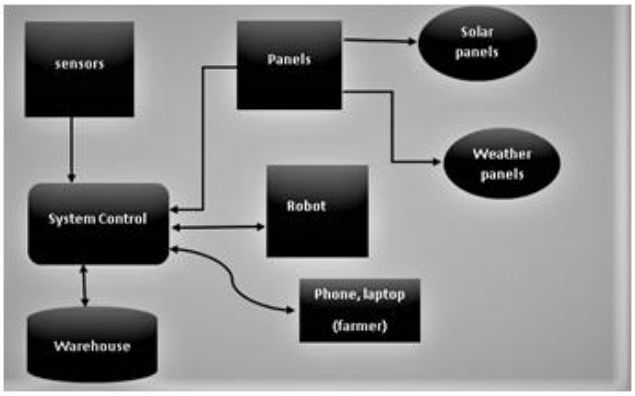

Figure 1 System Overview

for everyone should also increase as a result the farming should opt such a way where the expectations and needs will meet.Low cost sensors, insights of data and IoT Platforms will enable the increase in efficiency and production. The other applications of self-autonomous agriculture system are:

A. INCREASE OF PRODUCTION

As every step that we follow by using this technology is very much accurate like accurate planting, watering and harvesting then the production of the crop increases.

B. CONSERVATION OF WATER

With the use of automated and accurate details of crops and the amount of water needed also the sensors of moisture and humidity the water is used whenever it is required. Hence the water wastage won't be a problem and water will be conserved.

C. LOWERED OPERATION COST

With the use of automated machines and the database containing complete information about the crops there won't be any human errors hence there won't be any excess cost for the operations which reality without accuracy errors occur and have to spend excess cost to cover it up.

D. QUALITY OF PRODUCTION

With the help of accurate results the quality of the crop is increased because the pests, bacteria in soil, etc will be minimised automatically once they are detected and the quality of soil is improved which also improves the quality of the crop.

E. IMPROVED LIVESTOCK FARMING

With the usage of sensors and robot the health and the reproduction of animals are monitored and the necessary steps are taken automatically which improves livestock management.

F. REMOTE AND EQUIPMENT MONITORING

Hence every machine is interlinked the user can use the machines manually or pre-programmed algorithms (automation) can also be used.

G. DRAWBACKS

The smart agriculture based on IoT is basically use of the data collected from different sensors and parameters to take accurate actions and to better predict the crop productivity and quality. The disadvantages are not in the motive to use IoT in agricultural sector but it occurs in technicalities while implementing solutions. Some of the disadvantages of using the smart agriculture are:

- Large amount of money is required to install the smart agriculture in the fields.
- To use the smart agriculture the continuous internet must be a requirement but in the nooks of the country especially in the remote places the internet is not available. Or the speed will be slow.
- The climate conditions cannot always be accurate due to the technicalities of using the smart agriculture.
- The understanding of the technology is a bit complicated for the uneducated people will be tough and not all the people from the corners of the country can use this technology with perfection.

V. SYSTEM OVERVIEW

In this paper, the self-autonomous agriculture system works in different steps. In this project, the main part is the system control unit where all the signals from various parts are stored and the required action is decided either by the farmer who has the built software in his phone or laptop or the control unit work automatically within 5 mins if no decision was taken by the farmer by sending the required signals and commands to the parts required. In this autonomous system the signals of data collected by all the sensors and by the panels are sent to the system control unit and based on the work to be done the signals are sent to the warehouse, robot, farmer. This is how the self-autonomous agriculture system works.

VI. FUNCTIONING OF THE SYSTEM

This step consists of the warehouse. Warehouse has motor driver which contains motors, cutter, sprayer, tractor, mover, harvester, etc. It has light sensors, motion detectors which helps it to understand the day and night and helps the machinery to move. The power for the warehouse to work comes from power supply which is generated by solar panels. There are weather panels to detect the climatic conditions and respond in order with the data and climate conditions collected.

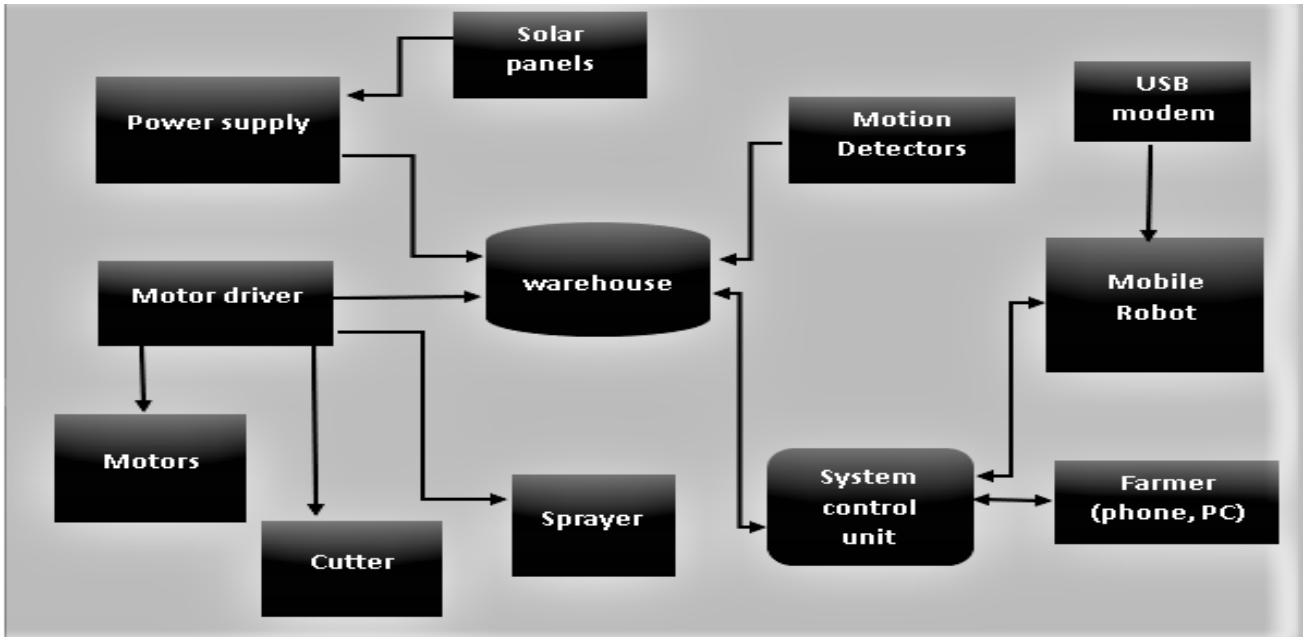

Figure 2 Functioning of Proposed Model

The collected data through the warehouse is collected by the system control unit and from there it is sent to robot which runs with the help of USB modems. The entire data is stored in the PC or the phone that is used by the farmer.The different kinds of sensors used in this system are growth sensors, height sensors, humidity sensors, temperature sensors, soil moisture sensors, light sensors, touch sensors, rain sensor, leaf sensors, water meter sensors. These are all the sensors used to collect the data of various actions that are taking place in field for the accurate farming. It also has cameras in built with the robot and separate cameras for the detection of both crop and livestock. The work of cameras here is not only for collecting data about wellbeing of animals and data of crop but also to make sure they are safe and noone's trying to steal it. In order when the robots are not working because of some problems then there will be a safety commands pre-installed in all the motor driver machines that they can work automatically with all the motion sensors, light sensors, live GPS tracker installed. The theoretical result of Various automated system in shown in table 1.

VII. FUTURE SCOPE

The usage of self-autonomous agriculture system is highly recommended and very effective when look the log term goals like good production, automation. When the self-autonomous system is used the data collected in the process is highly efficient and helps in improvement of the field and can save many farmers from financial crisis and many suicides can be reduced. It increases the quantity and quality of agricultural products. Due the automatic nature of system the labour cost and the human intervention will be less and saved. By measuring variations within a field and adapting the strategy accordingly, farmers can greatly increase the effectiveness of pesticides and fertilizersand use them more selectively.

VIII. CHALLENGES WITH THIS SYSTEM

A. Capturing huge volume of generated heterogeneous data by IoT sensors and performing the same for a large number and other activities involving various studies of crops.[13]

B. Including all commercially available sensors, weather stations, camera, it also Supports theintegration and use of any IoT device leads tobringyour-own sensor model of operations. This will facilitate
farmers to take advantage of more capable IoT sensorsas well as individual preferences and budgets.[14]

C. Integrating historical crop performance data produced by past studies and heterogeneous data from such a great variety of IoT devices.[15]

IX. CONCLUSION

The IOT applications that are being used in the farming and agriculture sector are helping farmers to collect much useful data. As there are many uses of using IoT in agriculture farmers must understand and install this technology for the better yielding and production. With the increasing population there is a need of producing large amount of crops with good quality it can be obtained with the installation of IOT devices in a prosperous manner. The main purpose of this paper is to show that IoT has the potential to dramatically increase the availability of information and it reduces many problems that are faced in the agriculture sector.

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Table 1. Comparative result of various automated system

Attributes	**Self-autonomous agriculture system**	**A sustainable agricultural system using IoT**	**Automated irrigation and advanced seed germination and pest**	**IoT based smart irrigation monitoring and controlling system**	**IoT based crop field monitoring and irrigation automation**	**Mobile integrated smart irrigation management and monitoring system**	**IoT based smart agriculture**
Areas addressed	Water management Weather monitoring Soil management Theft management Warehouse management Livestock management Pest controlling Nutrition management	Water management	Pest controlling Weather monitoring	Water management	Water management Crop management	Water management	Water management Weather monitoring Soil management Theft management Warehouse management
Data collections of sensors for measurement	Soil temperature Humidity Weather conditions Soil moisture Water level Crop growth controls Crop conditions Thievery condition Livestock conditions Warehouse conditions	Environment temperature Humidity Soil Moisture	Soil, moisture and temperature conditions monitoring. Water level.	Management of Water level, Soil, moisture in environment and soil as well as the Environment, temperature and Humidity.	Temperature Humidity Soil management moisture and Light intensity management.	Soil moisturetemperature and Humidity management.	Environment and soil temperature Soil Humidity Moisture Water level Crop condition Thievery conditions Warehouse conditions
Data extraction usage	Involves data extraction of the crop conditions and its state.	No such process involved.	No such process involved.	No such process involved.	No such process involved.	No such process involved.	Involves data extraction of crop information.

Technology used	Wi-Fi, Zigbee, mobile robot, wireless sensor network, mobile technology, automated robot, growth monitors, automated machines, crop field monitor.	Raspberry pi, Wi-Fi, RFID, Bluetooth, Zigbee	Zigbee	Wireless sensor network, Zigbee, Mobile Technology	Monitor crop field, automate the irrigation system	Raspberry pi, mobile technology	Wi-Fi, Zigbee, remote controlled robot, wireless sensor network, mobile technology, automated robot, crop field monitor.
Drawbacks of the system	Need of high internet speed.	Human interaction Cost for labour Wastage of water Abnormal irrigation	Works only when the user gives the commands.	Human interaction High water consumption	High water consumption High human interaction	Overhead sprinklers Wastage of water	No automated machines which leads to further investment when the robot doesn't work.
Database usage	Use of database of crop information which gives the accurate farming.	No database	No database	No database	No database	No database	Uses the database having information of crops.
Livestock monitoring	Contains cameras and sensors installed in the livestock for the protection and continuous management of livestock and contains touch sensors to predict accurate conditions of thievery.	No such installed	No such installed	No such installed	No such installed	No such installed	Cameras are only installed in the robot which cannot give the information and continuous monitoring of livestock also no touch sensors to predict thievery conditions.