Infrastructure for Smart Agriculture for Cotton Crops Based on The Internet of Things

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Abstract. With the introduction of information and communication technologies, the agriculture industry is evolving. Steps are being taken to increase performance and minimize costs using state-of-the-art technologies and facilities. As most farmers are ignorant of the technologies and the current techniques, in order to encourage farmers, several expert technologies have been proposed worldwide. However, the stored information base depends on these expert structures. We suggest system built on Expert Firmware as well as Internet of Things (IoT) that can use collected information in real time. To minimize the loss due to pathogens and insects and pests, it would help to take constructive and protective measures.

1. Introduction

IoT is a general concept that explains the internet's interconnectedness of various everyday items. Each object is linked to each other by a unique identifier such that without a human being, it can pass data to human contact over the network. IoT has been defined as a network of pervasive computing of everyday objects. By combining any object with an embedded framework for interaction, the ubiquity of objects has improved. It links people and machines across a network that is highly distributed[1]. The worldwide interconnection of computers is effectively the IoT. The purpose of IoT is to link across the internet to every entity and every object[2]. A unique identifier is assigned to every object in the IoT, so that any object is accessible on the internet.

The Internet of Things has three capabilities: knowledge, interaction, and illustration. Sight is truly the capacity of smart objects to sense other objects and sense them. Illustration tends to be the capacity of the objects to present, according to the programming theory. The desire to communicate with one another is contact.

Day by day, IoT is evolving, growing, and being popular; in today's world, over five billion objects have been linked through the internet. Around fifty billion items are expected to be connected to the internet by [3]. IoT presents promising applications for emerging innovations that are actually widely used in many fields of life, such as smart home control systems, food supply chain monitoring, precision farming, and so much more[4].

That used Wireless Sensor Network (WSN)[5] “a self-configured and infrastructure-less wireless networks to monitor physical or environmental conditions”, as well as Radio Frequency Identification (RFID)[6] or other stuff, any object found in the IoT is visible, readable, addressable, and locatable via the internet. In many different fields, such as precision farming, product supply chain management, cloud computing, pollution control, smart grid[7], and many more, the IoT concept is used. These days, the IoT is gaining a lot of popularity when any item in the network becomes a machine. Due to the innovation of recent technology such as RFID, Sensors, as well as WSN, the IoT concept has been successful[8].

Most farmers are aware of technologies and lacks experience in agriculture. They focus on conventional practices as well as processes. Nevertheless, thanks to developments in technologies and machinery, the sector of agricultural in the advanced world has grown with lot. Because of the following variables, farmers face massive agricultural losses.

This is a concern in agriculture because of the poor quality of the crops. Hazards to the community.
Attacks on insects and disorders.
Poor irrigation or also no water makes poor crops.
Inopportune harvesting.
Misuse of insecticides and manure.
Lacks machinery as well as supplies.
Poor treatment of crops.

Agricultural goods make up a big share of the economy, and that they also care for crops[9]. Also defined as white gold. Every year, heavy casualties occur due to bad agricultural methods, insect attacks at multiple levels, and disease attacks[10]. In 2018, 38% of crop losses occurred due to insect attacks, according to a study. According to another study, 15% of crop failure occurs every year due to viral attack. Any fungal infections, bacterial, rodents and insects, are affecting crops. Before and after sowing, the humidity and temperature conditions for the crop vary from those for other crops. Crop development is also influenced by the timing of spraying of insecticides, chemicals, and the application of fertilizers. So, to keep the crop safe, monitoring the crop is very required.

The majority of farmers are illiterate, and they are ignorant of the most current agricultural studies. Farmers typically take advice from professionals in agriculture and other seasoned farmers. The specialists, though, are not necessarily available at all times and wherever. So, for various crops like fruits, and vegetables in the resent world, Expert Firewall have been developed. An Expert Firewall (EF) is essentially a computer program that solves problems like the problem is solved by human beings. It is an instrument that uses its information base to produce output, so it replicates human actions. The EF will identify the challenges as well as find out the answers. This incorporates the same subject expertise with numerous professionals. The aggregation of information from multiple sources in the EF is a very significant aspect.

Once it has provided input, the EF will provide output. This suggests that it should be readily accessible to producers. Are proposed based on the definition of the IoT in this article. Sensors can collect the information and transmit it to the EF automatically. The EF will manage the information and send it to the mobile Farmer's, to get the reports or decisions. In this way, crops can be tracked constantly, and it is easy to make timely decisions. It would help to minimize the losses by prompt constructive and protective measures due to unexpected disease and pest attacks[11]. Initially, the proposed EF is established for the crop and assessed by the farmer group. It is possible to make use of the proposed framework.

- Effective Management of Crops. Controlling Irrigation.
- Environment Alert system.
- Application of fertilizers, insecticides, and pesticides optimally.

2. Expert Framework Based on Smart Farm
We try to design an original IoT based architecture to solve the problems of agriculture. The suggested solution may consist of three major elements, the first of which is the field deployment of sensors; humidity, soil, and field temperature as well as leaf wetness sensors are installed. Those sensors collect the information and submit it to be detached. We deploy the Expert Firewall on the serving side that processes the data and sends farmers recommendations on crops.

2.1. A) Sensors Deployment
Sensors used in the fields to collect data from the soil moisture, environment, humidity, and wetness of the leaves. The waspmote[12] agricultural sensor board is used for data collection since it is primarily designed for the handling of agricultural operations. The sensor board consists of a 2GB micro-SD-card and an AT super 1281 microprocessor[13]. Four different types of sensors are used in each sensor board: soil sensor, humidity sensor, temp, leaves. For the reliable and precise calculation of soil quality, Atmospheric temperatures, at the same time, humidity level in the atmosphere, and wetness of the leaves, those sensors are used in synchronization. The connectivity module is present in the agricultural board waspmote. The transmitting frequency is close to around 500 meters. The bridge between both the sensor nodes as well as the server is the gateway. It can connect with the sensor wirelessly and with a device via a USB port. Under controlled environmental conditions, we
performed this experiment. The overall connectivity architecture of sensors has been illustrated in Figure (1) and communication sensors.

![Figure 1. Communicating details from sensor based IoT devices.](image)

### 2.2.B) Expert IoT-based framework for crops

The IoT-based expert framework for inputs varies from conventional Expert Firmware. With the assistance of sensors, it utilizes real-time input data obtained. After a given time interval, the sensors direct information to the gateway. Via the USB port, the server collects data. The cool word program is used for saving and copying. In the server process, the Expert Firmware deploys the data is sent to the farmer’s phone. The System that is based on IoT was proposed in Figure 2 to solve the problems in smart farming[14].

![Figure 2. Expert Framework Based on IoT](image)

The remainder of the suggested EF work is close to that of conventional Expert Firmware. It is introduced using The National Aeronautics and Space Administration (NASA)[15] built a language called C Language Integrated Production System(C-LIPS)[16]. Instead of LISP, C-LIPS is a C-based approach that supports three different approaches to engineering: object oriented, rule based, and procedural. It’s compact, expandable, it can be quickly implemented through, and promotes communicating growth. It also has authentication and validation features for Specialist Firmware. The proposed expert firmware consists of the core sections below. Figure 3 demonstrates the layout of the Expert Firmware.

- Foundation of Information
- Agenda for Inference Engine
- Memory for Working.
- Facility for Clarification
- Interface with the Consumer

![Figure 3. Expert Firmware for smart farm](image)
The process of development of a firmware is started by learning domain knowledge. What sort of information we need for the expert method is the most crucial factor in the acquisition of knowledge. We need data regarding rodents, insects, diseases, weeds, and the growing climate needed for cotton crops in the proposed framework. The learning of information can be done in three different ways. Domain experts are interviewed. Domain research papers are reviewed. By measured data, information is gained.

Owing to the uncertainties surrounding this disease, this field assessment could not have been easier. A second aspect that weakens field observation is that not all kinds of viruses, rats, weeds, and insects are seen in the same season. We gather much of the results from interviews conducted with experts. We collect knowledge about the nature of the disease, the causes of the disease, the effects of the disease, the insects that invade the crop, the weeds that damage the crop, and the insects that transmit the disease from one plant to another.

The data is obtained from various sensors like soil sensors, temperature sensors, and a number of other sensor types that gather information pertaining to the environment. Sensors send the data to the computer where it is analyzed to assess the illnesses. The C-LIPS makes a list of facts, a list of rules, and a list of active goods. Any of the evidence is based on something rational. We host the Expert Firmware on the cloud for it to process and analyze the data and advice for the farmer. Sensors transfer data to and from the server.

2.3. C) Send Suggestion to Farmer by Server
Server procedures process the sensor information, sending the suggestion to the mobile of Farmer's after processing it. So, we are creating an application for farmers' convenience. The application is installed by farmers on their tablets. The suggestion is submitted data by the server to the mobile. The server sends the suggestion and the recommendation in English language; and other language recommendation can be protected in its comfortable language by the Farmer.

2.4. The proposed solution is feasible and efficient.
Our suggested solution will not require expensive smart devices and actuators, but it might not be as costly as one would expect. Evidence suggests that farmers are wasting money on fertilizer, seeds, and insecticides. The firms are using these methods to manipulate the cotton crop and are oblivious of the cotton crop's true needs. These investments can be minimized with one-time investments in sensor technology. The cotton crop can be monitored 24/7 through sensors and cameras, providing input for preventive behavior and efficient use of sources such as water, fertilizer, insecticides. Until the IoT and EF are checked, customers are not yet able to accept the IoT-based EF. 100 respondents come from diverse classes, such as producers and agricultural specialists. Farmers are illiterate, so we conduct surveys to ensure the feasibility of acceptance of the scheme and assess the need for the scheme after findings and tradeoffs of implementation.

3. Conclusion
Tring to have an EF for crops based on the IoT theory. And have attempted to create a primary IoT framework for agriculture. And try to create an IoT-based EF. It consists of three EF-based elements, the first component being the implementation of WSN in the cotton fields. The state of the cotton crop was used by WSN for monitoring. For the control of the state of the cotton crop, the Wasp mote agricultural sensor board was used. It consists of sensors for temperature, humidity sensors, sensors for high rainfall, and soil sensors.

In the IoT principle, the server can give commands to the field actuators so that the field actuators can make reasonable decisions. It must find good choices., the server should be knowledgeable enough. We deploy an EF for this reason so that it can automatically make decisions. The distinct EF formed during a different period but we combine IoT and EF in this paper. On the server-side, the sensors transmit the data to the server; we have implemented the EF, which processes and analyses sensor
data. The data is fed to the EF, which uses the knowledge base to interpret it and generate conclusions and recommendations. The EF consists of a user interface, an inference engine, and a knowledge base. We are deploying the idea of smart irrigation on the server-side. Sensors control the humidity of the soil, the wetness of the plants, the temperature and humidity of the atmosphere, and give the Farmer a suggestion on the irrigation of the cotton crop. In this paper, we are trying to classify various weeds, pests, and various insects that target the cotton crop. Such results are sent to the Farmer’s mobile to take the appropriate measures in the field. An initial concept for Smart Agriculture’s (SA) work was suggested.

We execute the survey before designing the definition of SA and ask the form recipient whether or not the new framework would be approved by users. In this study, farmers and experts are also questioned about the shortcomings of the new system and whether they are happy with the work of current agriculture. 100 separate users such as farmers and Agri domain experts were analyzed after the suggested method, and 65% of respondents are pleased with SA's work and are ready to adopt the SA definition. As we know, farmers are illiterate, so we get 65% results. The production rate of cash crops can be improved by deploying the IoT based on EF, and the issue of farmers can also be minimized. The proposed prototype was evaluated by 100 resource persons and found to be beneficial for farmers.

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