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Smart Farming for better productivity using IoT and AI

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Abstract: With the growing population, the demand for food is also growing. Since there are limited resources like land and water for agriculture, the conventional farming methods might fail to deliver such surplus production of food which will result in stalling of development. To meet such increasing needs the Internet of Things and Artificial Intelligence are used to solve the problems faced in conventional farming. This paper proposes an automated farming system which not only senses data but also controls the environment where the crops are growing. Such a method will enable us to obtain a higher productivity.
Keywords: Internet of things: automation; Arduino Uno 328-P; Artificial Intelligence; Moisture Sensor;

I. INTRODUCTION

The climate change and the increasing demand for food pose serious challenges to modern agriculture. The global population is predicted to increase significantly and, therefore, food production must increase by 70 percent by 2050 [7]. At the same time, the scarcity of water and the shortage of arable land is growing. Thus, there is a demand for an adequate selection of crop types, a suitable adaption of farming practices, and sustainability. Fertilization, crop treatment, pest control, and most notably irrigation management need to be adapted to continuously changing conditions. Farming activities have to be conducted in a sophisticated manner to save scarce resources. To achieve this, apart from agriculture and agronomy, research expertise of many other domains need to be efficiently combined. Much effort of using scientific achievements and novel technologies from other domains has already been made. Many countries like India, the majority of the population depends on farming, and its national income comes from farming. In spite of this and even the modern technology is found everywhere, the agriculture area is following the old conventional technology. Our farmers still resort to traditional methods like manual distribution of seeds and plowing, two crops per year pattern, unscientific systems of cultivation. The monsoons are irregular, and unevenness of availability of water throughout the year poses a major problem. All this leads to inadequate yield and low productivity. The implementation of scientific methods in the field of agriculture can bring about radical changes in the productivity of crops, due to improved efficiency in the farming techniques. Of the various advantages that IoT brings to the table, its ability to innovate the current scenario of farming methods is absolutely ground-breaking. Mostly, we come across ideas that suggest a wireless sensor network that collects data from the various sensors present in the field and sends the data to the main central server. This method focuses on studying the environmental factors to improve crop yield. But it turns out, monitoring environmental factors alone are never adequate to increase the productivity of crops since a lot of other factors have a role to play. This may include spraying of insecticides and pesticides to prevent invasion of pests and insects, monitoring the fields at all times to stay aware of attacks by animals and birds, and thefts of crops during the stages of harvesting.We need to implement an integrated system that will ensure increased levels of productivity and crop monitoring at all stages of cultivation and harvesting.

II. PROPOSED SYSTEM

The system is aimed to have two different sections or blocks, and a central computer or mobile application to control and monitor the entire system. Each of these blocks/nodes comprises of different sensors and devices and they are further connected to one central server via Raspberry Pi. The central device sends and receives information from user end using internet connectivity. The system operates mainly on two modes, namely: automatic mode and manual mode.

1) Automatic Mode- The system takes its own decisions while controlling the various devices.
2) Manual Mode- The user can himself operate the system with the help of a web-based application.

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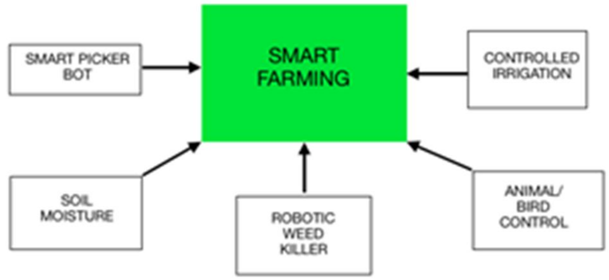

Fig.1 System Design

A. Growing Phase
B. Harvesting Phase
C. Packaging Phase
D. Transporting Phase

The proposed system contains the following modules

1) *Controlled Irrigation:* The controlled irrigation system consists of a hygrometer that checks the amount of moisture in the soil and accordingly sends requests to switch on the water pump. These hygrometers will be placed in three levels of the soil so that we can know the exact amount of moisture in the soil. Before switching on the water to irrigate the farm the system receives feed regarding the weather conditions in the area from the Weather Channel i.e. from TWCi. TWCi provides XML weather feed free of cost which can be run on any web-based application written using PHP. This weather feed will enable the system to decide how much water the soil needs. For instance, if it is going to rain in the evening then the amount of water used for irrigation will be very low as compared to when it is going to be a dry day.
2) *Soil Moisture and Light Control:* The weather conditions such as temperature and humidity are measured using the sensors LM35 and DH11 respectively. The light in the surrounding is measured using an LDR i.e. a Light Dependent Resistor. If the temperature goes below or the humidity goes above the suggested level for a certain crop then the artificial lights are switched on to maintain the temperature and keep the crop warm and dry. Also, the crops are grown under an artificial illumination of the LEDs. Growing crops under illumination of red LEDs supplemented by blue LEDs propel plant growth which makes work of the hormones easier.
3) *Robotic Weed Killer:* Unwanted weed that pops out in the farm where crops are sowed consumes the nutrients of the soil which could rather be preserved. To get rid of this unwanted growth a Bluetooth-controlled bot is used which contains a pi-cam and an extension for cutting out or trampling the weed. The bot can be controlled through the Arduino app using any smartphone.
4) *Smart Picker Bot:* When the vegetables or crops are ripened it takes a lot of man-hours to efficiently pluck it from the plant without harming the plant. This task is accomplished using the smart picker bot which is also a Bluetooth-controlled bot is containing a pi-cam and an extension for picking the fruit or vegetable right from the stem. The picker is guided by an algorithm which uses OpenCV to detect a fruit or vegetable and pluck it from the right distance of the stem. This algorithm can be trained using Artificial Intelligence to detect the ripe color of the veggie so that it makes fewer errors and works efficiently.
5) Animal/Bird Control: The crops and fencing are equipped with IR and PIR sensors so that whenever cattle or any other object comes in the proximity of the crop for more than a few seconds a buzzer goes off and an alert is sent to the concerned authority using the GPS module. Pests are a common crop-destroying entity and call for the sprinkling of pesticides. Using LEDs helps in reducing the amount of pesticide used since it has the capacity to kill pests which disrupt the plant growth.

III. DEVICE DESCRIPTION

A. Temperature Sensor

LM35 is a basic temperature sensor that can be used for experimental purpose. It give the readings in centigrade (degree Celsius) since its output voltage is linearly proportional to temperature. This type of sensor consists of a material that performs the operation according to temperature to vary the resistance. This change of resistance is sensed by circuit and it calculates temperature. When the voltage increases then the temperature also rises. We can see this operation by using a diode.

B. Humidity Sensor

A humidity sensor (or hygrometer) senses, measures and reports the relative humidity in the air. It therefore measures both moisture and air temperature. Relative humidity is the ratio of actual moisture in the air to the highest amount of moisture that can be held at that air temperature.

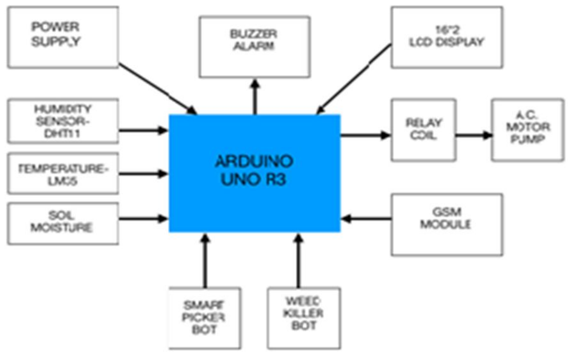

Fig.2 System Archhitecture

C. Soil Moisture Sensor

Soil Moisture Sensor is a simple breakout for measuring the moisture in soil and similar materials.

D. PIR Sensor

Motion Detection using PIR Sensor. A PIR or a Passive Infrared Sensor can be used to detect presence of human beings in its proximity. When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves.

E. IR Sensor

An infrared sensor is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor.

F. LDR

These light-dependent resistors are frequently used as light sensors. These resistors are mainly used when there is a need to sense the absence and presence of the light. These devices depend on the light, when light falls on the LDR then the resistance decreases, and increases in the dark. When a LDR is kept in the dark place, its resistance is high and, when the LDR is kept in the light its resistance will decrease.

G. MQ7 Gas Sensor

This semiconductor gas sensor detects the presence of Carbon Monoxide at concentrations from 10 to 10,000 ppm. The sensor's simple analog voltage interface requires only one analog input pin from the micro-controller.

H. Soil pH Sensor

Measures the pH of the soil for better soil quality.

I. GSM Module

GSM/GPRS module is used to establish communication between a computer and a GSM-GPRS system. Global System for Mobile communication (GSM) is an architecture used for mobile communication in most of the countries. Global Packet Radio Service (GPRS) is an extension of GSM that enables higher data transmission rate.

J. Arduino UNO R3

The Arduino Uno is a micro-controller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button.

K. Raspberry Pi

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python.

IV. SYSTEM ARCHITECTURE

The system contains of a number of sensors and modules all connected by the Arduino board. Given below is the system architecture of the proposed system. The Arduino board is provided an external power supply. A buzzer alarm and an LCD display are connected to it for alert messages or sounds when the situation arises.

With the Arduino board in the centre of the structure every response collected from the the humidity, temperature, and moisture sensor is passed on to the micro controller board so that it can take the necessary action by requesting the correct output or action to be taken for example, switching on the water pump to irrigate the farm when the soil moisture is very low.

V. FUTURE WORK

The proposed model can further be improved by adding certain modules like automatic plowing and automatic sowing in order to make it a completely automated process. This can also be improved by constructing smart picker bot for more crops rather than just some fruits and vegetables and train the bot using AI for detecting ripening color of every possible crop.

VI. RESULT

Thus, this system avoids over irrigation, under irrigation, top soil erosion and reduces the wastage of water. The main advantage is that the system's action can be changed according to the situation (crops, weather conditions, soil etc.). By implementing this system, productivity of the crops can be increased significantly. Thus, this system is efficient when compared to old conventional techniques.

VII. CONCLUSION

The world will need to produce 70% more food in 2050 than it did in 2006 in order to feed the growing population of the Earth, according to the UN Food and Agriculture Organization. To meet this demand, farmers and agricultural companies are turning to the Internet of Things for analytics and greater production capabilities. The IoT is set to push the future of farming to the next level. Smart agriculture is already becoming more commonplace among farmers, and high tech farming is quickly becoming the standard thanks to agricultural drones and sensors.

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