Agricultural Management using Sensors

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Abstract

Agriculture has been a part of human lives for many years. It is the food source from where we get our energy. Recently, the world population is rising on a massive scale and with that food demands are also rising. Fulfilling of demand is not going to be easy because the world population is about 7.2 billion at the time and experts predict that it will increase to mark of about 9.8 billion. With scarcity of natural resources, climate change, health effects of chemicals used etc the current agricultural methods has a lot of problems. In this paper, new methods of agriculture and new technologies are discussed as a solution for these problems. By using different types of agriculture, sensors and control systems discussed in the study production of conventional farms can be increased. Using these we are going to increase productivity and reduce expenses of the system. The use of sensors helps to use all available resources efficiently. When all the environmental factor, concentration of nutrients, solar radiation etc are known use of chemicals such as fertilizers, pesticides and insecticides can be reduced by great number.

Keywords: *Photosynthesis, UAVs, UGVs, humidity sensors, temperature sensor, sensor control system, soil moisture sensor, IoT, Zigbee, image processing, drones.*

Introduction

We use technology everywhere in our daily lifestyle and made it sophisticated so why can't we include technology in our food production which is very major part of our life and make it simpler and solve all current issues. Malnourishment can only be solved by producing required amount of food. Climate change, food scarcity and increasing population related agricultural problems can only be solved taking strict decisions and adapting enormous technological changes. So in this paper we are going to give a review of different electrical and electronics breakthroughs which can give us the answers to our ever increasing problem of food scarcity. We are mainly going to use sensors for monitoring and control environmental factors using temperature, humidity and light intensity sensors and controlling irrigation system by using soil moisture sensors and controlling these sensors with control system like IoT (Internet of Things) or bluetooth module or mobile application, surveillance of farming area through Unmanned Aerial Vehicles (UAVs) and Unmanned Ground Vehicles (UGVs) for any unwanted thing like weeds, pests and insects. To provide electricity for the control system renewable energy source like solar panels or mini wind turbines can be installed.

Literature Review

Pajares, Gonzalo (2011) in his paper [8] expressed that Sensors allow collecting data of different types of *in-situ* information which can be further used for controlling crop production and monitoring environment by usage of different data, such as light, temperature, humidity and soil moisture. This information can be collected by sensors deployed in different regions of the field uniformly distributed to get data of each segment of the field.

G. Sahitya et.al (2016) in their paper [3] reviewed that Light is a major factor in plant growth from many ages we know the importance of light in relation to agriculture so it is deciding factor in the plant growth. Light can be provided to plants naturally by sun or artificially using LEDs. If light intensity is too high the heating effect of light may damage the crops by reducing their water content or even burning them. There are existing cases where whole fields were burn by just sunlight. If light intensity is too low it may also create a problem because plants need light for their energy producing process called photosynthesis. To monitor the light intensity we use we light intensity sensors or LDRs to measure the amount of light being fallen on the field.

Lakshmisudha K et.al. in their paper [2] highlighted that There is a great effect of temperature change in plants and their quality. In some observation it is found that increase in temperature results in increase in respiration which further results in low sugar content in plants. This is a very effect for crop like fruits which cannot compromise with their sugar content. With decrease in temperature photosynthesis process is slowed down which may result in improper growth of the crop this results in very small sized crops which may look like a bad quality product. So to counter this situation in advance temperature sensors are used to monitor the temperature changes in the field in particular interval of time.

N. Kaewmard and S. Saiyod (2014) in their paper [1] talked that humidity is also a great factor in affecting the crop yield. It is responsible for moisture loss and temperature control of plants. Just like humans sweat to control body temperature plants also lose water from leaves to manage it but in high humid areas this process of loosing water is reduced which results in high content of water in leaves which may lead to growth of fungus. If humidity is too low the environment will become dry and plants will lose more water than normal which may lead to water deficiency and this may make plants dry or maybe lead to their death. So humidity sensors are used to constantly monitor humidity level of the field and this will help us control certain things to save our crops.

A. I. Johnson in his book [4] mentioned that Moisture control is an effective factor in crop production. Amount of moisture controls the respiration as well as other important processes in plants. If moisture level is too high then the pore or passage in roots of plant may clog which results in no flow of gases and nutrients through soil, lack of oxygen will have the same result as it has on humans the plant will die and nutrient scarcity is also a critical factor affecting growth of plant. Low moisture level may not suffocate the plant the water level of the crop will drop because fulfilment of water is done by moisture in the soil. Controlling the moisture level is done by using soil moisture sensors, they constantly tracks the level of moisture in the soil and sends data about it.

Lakshmisudha K et.al. in their paper [2] discussed that all the four sensors listed above give data about light intensity, temperature, humidity and soil moisture. By getting this data we know the different parameters to control our crops. All these factors can be affected by control of irrigation system. When these factors exceed a certain mark of a predefined value irrigation system starts working by controlling valves of water pumping motors and turns off the watering when sensors give signal of sufficient water level.

Y. Kim et.al (2008) in their paper [9] reviewed that the WSN system can be controlled through mobile by using Smartphone with the help of Zigbee. It creates a network in which nearly 65500 devices can be controlled. It contains many nodes in which one node is connected to central hub/device. Others are connected to the processor like arduino, sensor and a zigbee. Zigbee acts a data transreceiver which completes the data transfer cycle and gives WSN (wireless sensor network) and all the information can be send to the required controlling machine like phone. The farmer receives the data and then he can control the motor from his phone through the GSM module connected to the Zigbee.

Pajares, Gonzalo (2011) in his paper [8] expressed that two more important things related to growth of the plants are pH and biomass and chemical concentration of the soil. Use of pH level indicators and sensor can be done to know the acidity or basicity of the soil because different plants needs different pH and not controlling it may have an adverse effect. Biomass or manure adds nutrients in the soil which is further absorbed by plants and chemicals like pesticides protect crops from unwanted animals, insects and fungus. If biomass is lower than required amount plants will not get sufficient nutrients for growth and if sufficient chemicals are not used these unwanted animals, insects and fungus may destroy everything. Higher concentration of these are also harmful as it may eventually mix up in a nearby water body and make it harmful or poisonous or it may enter the crops too much and make the edible plants chemically harmful.

P. Tokekar et.al. (2013) in their paper [7] highlighted that UAVs and UGVs are also being used in fields for monitoring of different things. UAVs can be used for air surveillance and data collection from aerial view like scanning the field for unwanted things such as weeds, birds and concentrated water holes/pots. They can be used for scaring away the birds and rodents. It can also be used for equal dispersion of manures throughout the field from air. They can also be used to check for fires in nearby areas which will spread towards our farm and will also give an alarm for such emergency or a small bonfire or fire sparked due to very hot environment to prevent a big fire which may burn the whole field. LIDAR systems are also being used in fields by attaching them on UAVs for image related data and information of the field. They obtain data like covered area by vegetation on field such as vineyards, number of trees around field and other existing things with their position on field as well as covered area using GPS (Global Positioning System) and size of plants or fruit trees. This image processing and GPS can also be used for cutting and collecting of crops at the end of process, using image process we can find covered area and using GPS placing of produce cutters like tractors and collect crops at a much faster and more efficient way than manual collection.

D. V. Shivling *et al*. (2015) in their paper [5] and S. Qi and Y. Li (2012) in their paper reviewed UGVs can also be used for surveillance of field from ground like detecting weeds, pests, fungus, etc. They can also be used for checking the growth of plants and quality of final products such as checking the colour, height, thickness and other physical features of the crop. We can also use them for crop plucking. UGVs are implanted with different sensors like capacitance detection sensor for detection of pests in grain bulk to save crops. They use this system determine the species of pests and their number. Image sensors or processors can also be used to detect pests and insects by getting an image input like a human eye and act according to it. The crops like tomatoes and lemon can also be scanned for any threats using image processing and hand to hand be plucked out to prevent it from spreading. Quality of crops are also determined in the same way a human guess by looking at it and can determine further actions. [5], [6]

V. K. Agrawal et.al. (2016) in their paper [11] discussed that to run all these electronic system a huge amount of electric power supply will be need which will put a huge load on the power grid, also it will make a huge part of the expenses which will nullify all the cost reduction we have attained by using this technology. So to solve this problem we must install a renewable energy power generator like a solar panel or advanced type mini wind turbines. Many companies that are using these advanced technologies and many other innovative ideas face this issue as a major drawback, many are present in the market that shut down their startups because of this so these generators must be installed.

Conclusion

In this review, we see that agricultures with use of new technologies are the future of food production. The author discussed in their papers that temperature, humidity, soil moisture and light intensity are used to know field condition and water irrigation is done according to that using smart phones through Zigbee, chemical concentration and pH level are also monitored and chemicals are dispersed accordingly. Technologies like UAVs UGVs and image processing are also used and to control them IoT is used. Solar and wind turbines are used to power it. All these improve agriculture on a great

scale and can be the future of food production. Although it still has some major drawbacks like huge area of forests are being cut to create farms and natural abnormalities like hails and uneven weather may still lead to crops. But improvements are still being made and this will help us through solutions like aeroponics, hydroponics and aquaponics for new ways of irrigation that saves water upto 95% than conventional ones, vertical farming is also another solution to counter cutting of forests for new lands for farming. It may have some disadvantages like the automation may decrease human involvement and conventional jobs, but it will create new jobs like data analysts, electronic engineers, ecologists etc.

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