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Design and Implementation of IoT based Smart Horticultural Crop Real Time Monitoring System

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Abstract: This paper presents the design and implementation of a smart horticultural crop real time monitoring system using a microcontroller (ATmega 2560 Mega) which can be monitor from any corner of the world by using GSM network and internet. Horticulture fruit are picked at wrong stage of maturity may give poor quality and not stored for longer period. The ripening of a fruit is expressed in terms of change in its physical parameter like colour, softness, textural properties etc. The final stage of fruit ripening is to attend a maturity level of all its physical parameter as an indication for harvesting the fruit and vegetable crop. The sensing parameters in the proposed design are colour, firmness, temperature & humidity. An embedded program is developed based on decision making algorithm which compares the process values of the sensor output with the reference value of fruit maturity for this we have design. The real time testing on guava fruit shows 99.66% accuracy of the proposed system and the collected data from various sensors through the microcontroller board made available using an online IoT analytics tool known as Thingspeak and display sensor data on mobile screen. This develop system model can be used in farms, as a handheld portable unit to check the fruit maturity status without cutting the fruit from tree.

Keywords: IoT, GSM, Maturity indices, ThingSpeak,MIT app inventor

I. INTRODUCTION

Using IoT, we can control any electronic equipment in open farm and greenhouse farm. Moreover, we can read a data from multi sensor and analyse it graphically from anywhere in the world. IoT authorizes several trend in crop growth monitoring and selection, irrigation decision supports, in Digital Agriculture domain [1]. The aim of IoT means to connect things and people Anything, Anyone, Anytime, Anyplace, Anyservice and Anynetwork [2]. We can also refer IoT the interconnection of uniquely identifiable embedded computing-like devices within the existing internet infrastructure. The idea of IoT was developed in parallel to WSN. While IoT does not accept a specific communication technology, wireless communication technologies will play a major role [3].

At the time of horticulture crop ripping process farmer need to go in farm number of times to check the health of fruit and vegetable they need proper information related to crop maturity to overcome this problem we design decision based Wireless Sensors Network (WSN). Using Arduino Mega 2560 microcontroller, it fetches a data from colour sensor, ultrasonic sensor, temperature and humidity sensor and upload it with the support of GSM to a ThingSpeak. Arduino Mega 2560 microcontroller board fetches a data from multisensory and process it and give it to GSM SIM900. This GSM was a dual band module with features of Message Oriented (MO) and Message Terminated (MT) [4]. It can transfer a data to IoT cloud. Our multisensory module is capable to sense data in the agriculture field as well as from the fruit and vegetable storage plant.

Therefore, considering the current necessity of agriculture we design and implement a system which integrates the control of all the deployed systems in a single system. Which make it informal to handle and better considerate of the results by naive users. As well as it will keep the farmer updated by the notifications for almost every related event that occurs in the field.

II. PROPOSED SYSTEM

Therefore, considering the current need of agriculture framer to monitor maturity stage of fruit and vegetable we design and implement a system which integrates the multisensory and WSN deployed in a single system. Which make it easy to handle and better understanding of the outcomes by unexperienced users. As well as it will keep the farmer updated by the notifications for almost every related event that occurs in the field. We use guava fruit as an object in our project to monitor its various stages of maturity. Guava fruit in its first stage skin colour consist of dark green colour and fruit consist of hardness. When fruit reaches in its final stage the dark green colour lost and achieved light yellow colour and fruit get soften. To measure guava fruit skin colour we use TCS 3200 colour sensor and to show its firmness parameter we use ultrasonic sensor. Fig 1 illustrate a basic principle block of proposed module of smart Horticulture crop real time monitoring system. The sensor module read data from fruit and vegetable surface with the help of programmable Arduino Mega 2560. The MCU process this data and the transmitter pin of Arduino board connected with the receiver pin of GSM SIM 900 board. In similar way the receiver pin of Arduino board is connected with the transmitter pin of GSM SIM 900 board. This process made data to send wireless to thingspeak plate form to data analysis.

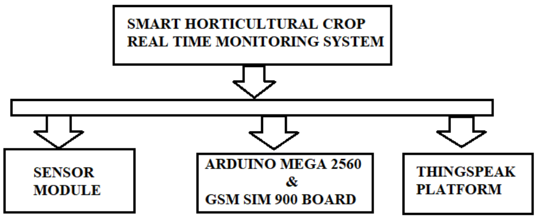

Fig. 1. Principle block diagram for the proposed model

III. CIRCUIT DIAGRAM

Smart Horticultural Crop real time monitoring system circuit diagram shown in fig 2.

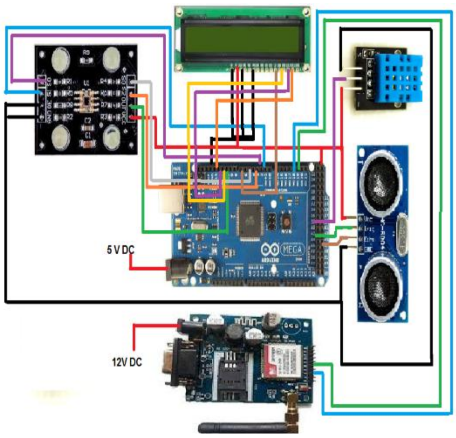

Fig. 2. Circuit diagram for smart horticultural crop real time monitoring system.

In Fig2. various sensor is connected with Arduino Mega 2560 board. The colour sensor TCS 3200 converts light intensity into frequency using photo diode array which gives R, G, B value of different colours. Similarly DHT22 sensor used to sense fruit across temperature and humidity in the form of analog quantity and convert it to digital data and this digital value feed to microcontroller.

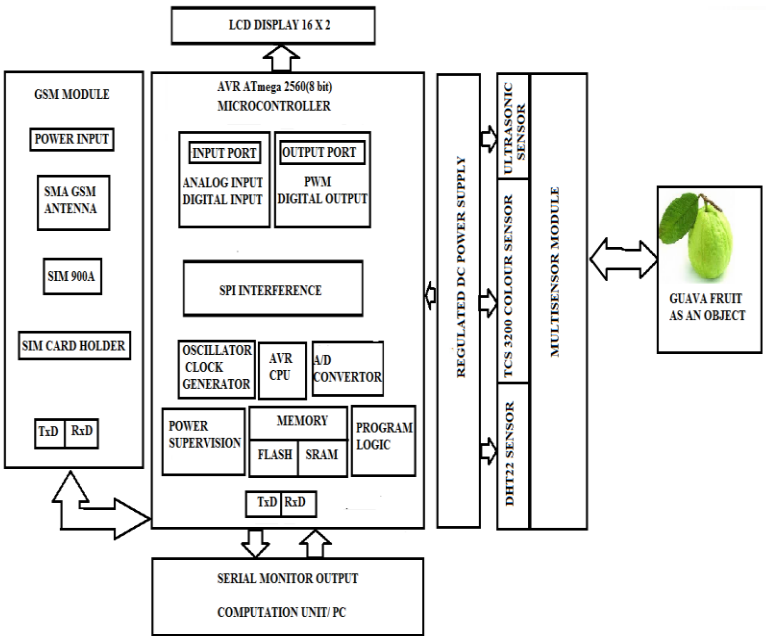

Fig. 3. Experimental set up block diagram

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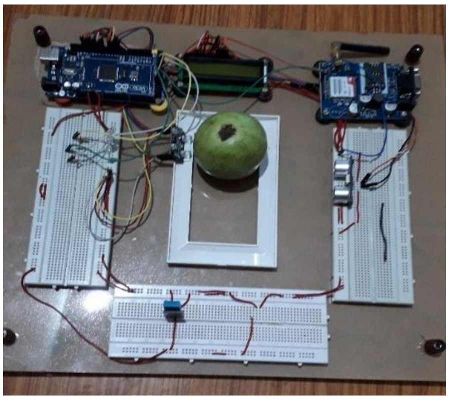

Fig. 4. Laboratory experimental bench set up

Fig 4 shows experimental bench set up for horticultural crop real time monitoring system. The proposed sensor-based system uses non-destructive method to detect fruit skin color, firmness, fruit surrounding humidity and temperature [5]. Arduino Mega 2560 is the heart of this system. Various sensors connected to microcontroller board to access the data from guava fruit skin.

To transmit sensor data from farm system uses GSM SIM 900.Simalarly multisensory output can also be monitor at Arduino IDE software as shown in fig. 5.

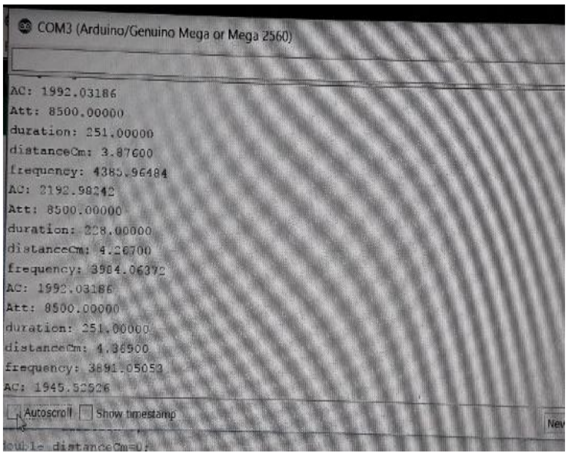

Fig.5 Output Displayed on Serial Monitor of Arduino IDE Software

Table 1. SUMMARIZE MATURITY PARAMETERS FOR VARIOUS STAGES OF GUAVA FRUIT FOR D = 5CM

Guava Fruit Parameter		Maturity stages I	Maturity stages II	Maturity stages III	Maturity stages IV	Maturity stages V
Skin colour		Dark green	Green	Light green	Yellowish green	Light yellow
Colour sensor output freq. (Hz)	R	140	132	106	92	60
	G	161	159	133	120	87
	B	190	188	160	151	115
Received ultrasonic sensor frequency		4247	3995	2880	2776	2750
Attenuation coefficient		2123	1997	1440	1375	1209

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IV ANALYSIS OF SENSOR DATA ON IOT PLATFORM

ThingSpeak provides very good tool for proposed system using Arduino Mega2560 to accomplish the rule of IoT. By using ThingSpeak site, we can monitor our data over the Internet from anywhere using the channels and webpages provided by ThingSpeak. ThingSpeak 'collects' the data from the sensors, 'Analyze and Visualize' the data and send it to our design Mobile app.

IoT based mobile app design using MIT App inventor, it is a free, cloud-based service that allows making mobile apps using a blocks-based programming language. The MIT App inventor servers store sensor data and help to keep track sensor data using internet. By using block base programming language, we design and implement mobile App for the proposed system model as shown in fig. 6. This mobile app displays the real time value of the fruit maturity parameter on the mobile screen such as temperature, humidity, RGB colour frequency and attenuation coefficient computed value.

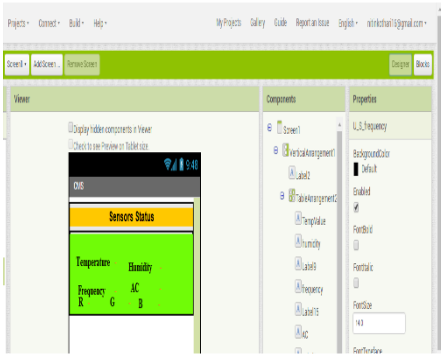

Fig. 6. Screen Designer Output Display Page Which Appeared in Mobile App.

The data can be accessed anywhere in the world through this mobile App. The sensor input data to the mobile screen transmitted through ThingSpeak colud.

V. RESULT

Table 1 summarize maturity parameter for various maturity stages of Guava Fruit. All sensor data received from Guava fruit outer surface transmitted to Thingspeak platform using GSM plus Ardunio Mega board. The transmission and receiving sensor data to long distance without touching and distorting fruit plays a role of IoT using wireless sensor technology. From table 1 what we observed that R, G, B frequency value of colour sensor reduced as the maturity stage of Guava fruit moved from initial stage to final stage. On the other hand, ultrasonic sensor received frequency also decreases as in its final stage. At maturity stage III we can ask the framers to harvest this horticulture crop this stage gives him a better quality of fruit and can be stored fruit for longer duration.

When the experiment carried out the surrounding atmospheric temperature is 18℃ and the value of humidity is 84% recorded through DHT22 sensor. Temperature and humidity play very important role for the horticulture crop in the farm or at the fruit and vegetable storage plant.

VI. CONCLUSION

A portable sensor-based prototype is designed and successfully implemented for real time monitoring of fruit maturity in crop field and in storage. The developed prototype is made IoT enabled and the fruit maturity parameters are successfully transmitted through GSM network via Thingspeak cloud to the end mobile user. The developed prototype is tested for Gauva (Psidiumguajava - 'Amrood') fruit with the accuracy as high as 99.66 % With this project, the current problems related to horticulture crop farming are solved and practically implemented solutions are provided. Using IOT as well as GSM, a whole new concept of farming using networks is introduced reducing labour, updating farmer about the live conditions of maturity stage of Guava fruit on the mobile devices and offering its graphical value using thing speak. This system has several gains in term of fast delivery, zero data lose, low cost, flexibility, user openness and energy efficiency. The guava fruit skin colour and firmness changes easily detected.

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