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Safety Mechatronics System for Farming of Fruits and Vegetables

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Abstract— **In recent fifteen years, operations in grading systems for fruits and vegetables became highly automated with mechatronics, and robotics technologies. Automatic technology has proved the ability to handle agricultural products delicately and with a high degree of precision and to gather information to create a database of products every season. This information is then utilized as traceability data for consumers and as farming guidance for producers. The proposed system is development of a safety mechatronics system for farming of fruits and vegetables by spreading a sustainable blanket automatically over plants of fruits and vegetables, which will take care of fruits and vegetables in condition of heavy rains, humidity and any other unfavorable weather conditions. The system can also be controlled via mobile phone by using GSM module through which operator can remotely control the system operations in the real time. The field system can also inform the operator about the covering or uncovering of the blanket by sending a message to the care taker of the field.**

***Index Terms*—Agricultural Automation, Agricultural Safety, Field Control System, GSM modem, Mechatronics technology**

I. INTRODUCTION

The foundation of modern agricultural management is monitoring field conditions, in order to improve the efficiency of the data collection procedure and the precision with which agricultural operations are managed, it is necessary that we should have an automated system that collects environmental data, especially to record long-term and up to the minute environmental fluctuations. The objective of this study was to design and control of safety mechatronics system in real time, based on wireless communication technology.

The system consists of four components, a remote monitoring platform (RMP), a host platform (HP), a GSM modem and mechanical system for covering and uncovering of blanket. The system can work properly based on the effective coverage of base stations, no matter the distance from RMP to HP. The RMP is group of microcontroller unit, sensors and transceivers forming a wireless sensor node (WSN), and the function of RMP is to sense climate conditions at every predefined time if any significant event is not occurred and for occurrence of any significant event RMP will sense climate conditions for factors of interest at that particular moment when significant event has occurred and send the signal to HP instantaneously. Significant event is moment when value of any parameter of interest changes significantly. While HP is a central computer database system and the function of the HP is to receive and store, analyze and display the database information on computer screen whenever asked by user. The action taking place can be intimated to user by GSM wireless modem, also user can make action to happen in the real time field by giving a missed call to GSM placed at RMP [1].

When generating the idea for this project, the aspect considered was deployment of system in agricultural environment like real time farm. Also WSN overcomes the problem of manual collection of data for parameters of interest which can be sporadic and produce variation from incorrect measurement. The data sent by WSN is securely collected and logged in into the central computer database therefore there is no chance of data being misplaced or lost.

A mechanical system has been developed whose operation is based on values of environmental factors of interest. The actual system has two sections, electronic circuitry and mechanical arrangement. The electronic circuitry includes RMP, HP, GSM, while mechanical arrangement includes vertical columns (for supporting the structure), shafts and couplings, which takes care of actual covering and uncovering of sustainable blanket over the field of fruits and vegetables.

II. GUIDELINES FOR MANUSCRIPT PREPARATION

Several authors proposed and developed a novel architecture for greenhouse monitoring through WSN, various paper addresses the design and development of WSN for agricultural environment by monitoring various factors temperature and humidity etc. and logging of data to a central server and analyzing detail change in parameter. The data transmission from sensor node to central server is carried out using CC2500 module [2].

Whereas S. P. Kaliban, used a system in which sensors are used to sense climate parameters and GSM-SMS (Global System for Mobile Communication – Short Message Service) to transmit the data from measuring unit to host control unit. There are several projects in which Zigbee and Bluetooth modules are used, but their ranges are limited therefore GSM modem is used which can cover total globe [3].

Sometimes due to rapid weather change or heavy rain lot of damage can occur to crops and plants, so Sumit Khandelwal proposed a system for fully automated management of greenhouse based on GSM modem. He also mentioned a slider mechanism which can cover the field in order to prevent the field from unfavorable weather or heavy rain [4].

Ajay Bhardwaj from CYPRESS PERFORM (Semiconductor Corporation) has mentioned about sensor network and classification of sensor network like data acquisition network and data distribution network. The basic network topologies used are star, ring, bus, tree, fully connected and mesh [5].

III. SYSTEM ARCHITECTURE

The project overview is shown in figure 1. The present paper describes the development of safety mechatronics system for farm, based on WSN.

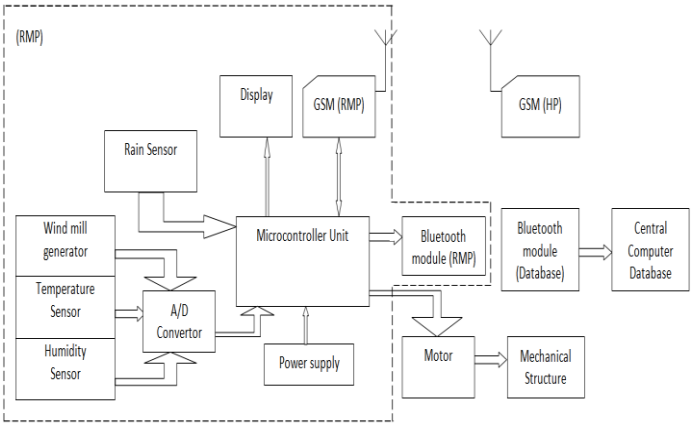

Figure1: Project overview

A mechatronics system has been developed which is based on environmental factors of interest, where data can be sent or received by WSN present at RMP and an operator (HP) who is based at remote location can receive parameter values just by giving a missed to GSM present at RMP. The wireless connection is implemented in order to reduce set up difficulty. While on the mechanical structure space is provided for mounting different sensor and transceiver.

IV. SENSORS AND TRANSCEIVERS

The sensors are used to sense the essential environmental parameters of interest and the transceivers are used to transmit and receive the data to central computer database and to operator via SMS.

A. Rain sensor
B. Wind Mill Generator
C. Temperature sensor
D. Humidity sensor
E. Bluetooth module (hc05)
F. GSM module (SIM900)

A. Rain sensor:

Rain sensors are used for detection of water beyond what a humidity sensor can detect and sometimes also called as raindrops sensor module.

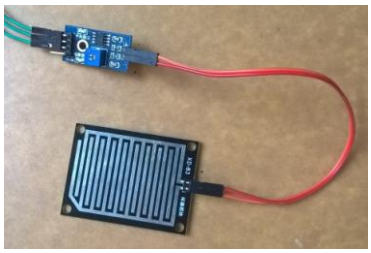

Figure2: Rain sensor module

The rain sensor detects water that completes the circuits on its sensor boards printed leads as shown in figure2. It has four output terminals; VCC, GND, D0, A0. The sensor board acts as a variable resistor that will change from 1k ohms when wet to 2M ohms when dry. In short, the wetter the board the more current that will be conducted. The sensor will have three different reactions for three different actions that are taking place according to rain fall.

- Not raining
- Rain warning
- Flood

When water drops fall on the sensor board, then an acknowledgement message is sent to operator's mobile phone through GSM module present at RMP and simultaneously automatic mechanism will provide necessary shade by exploring the sustainable blanket over the crops and fruits in order to protect them. The message alerts are set only for 'Rain warning' and 'Flood'.

B. Wind Mill Generator:

Wind mill generator is used as wind sensor which detects the speed of the wind, and proportionally generates the electrical energy. It has three parts; blade, shaft and generator.

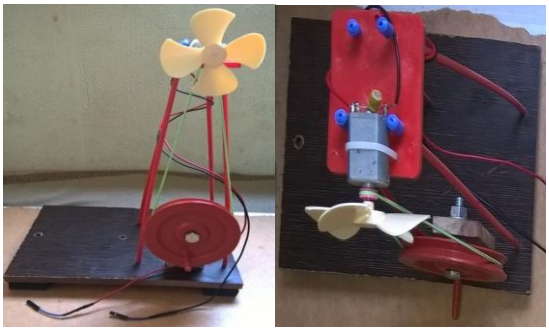

Figure3: wind mill generator

As shown in figure3, there are two option of usage. One to generate electricity by manually rotating pulley with handle which in turn rotates fan mounted on a tower, like wind mill and secondly remove rubber band from pulley and then blow against windmill blade. The passage of air through blade implies spinning of blade which implies rotation of shaft and then generator converts mechanical energy of moving wind into electrical energy. The output voltage of generator is

dependent on wind speed. For higher speed higher output voltage, lower speed low output voltage.

C. Temperature sensor:

Depending upon the agricultural product being grown temperature can affect growth, germination, sprouting, flowering and fruit development. In this paper LM35 is used for measurement of field temperature. The minimum and maximum temperatures set are 8^{o}C and 42^{o}C respectively.

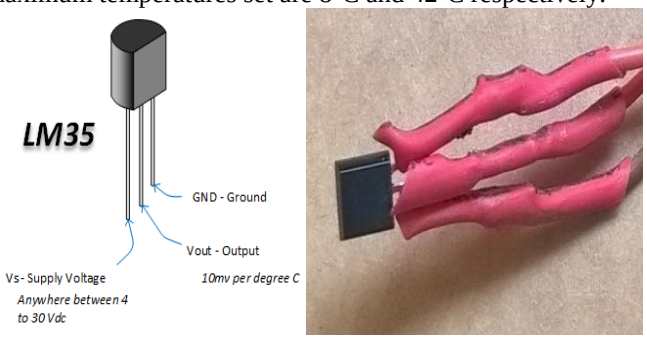

Figure4: Temperature sensor

When temperature reduces below 8^{o}C or rises beyond 42^{o}C, then microcontroller gives signal to motor which starts the safety mechanism for covering the field with blanket.

D. Humidity sensor:

Humidity plays vital role in production and quality of fruits. If humidity is kept below 40 percent for extended periods, growth can suffer as loss of water from leaves can be more rapid than replacement. Similarly, if humidity is above 85-90 percent for extended periods, risk of disease can increase.

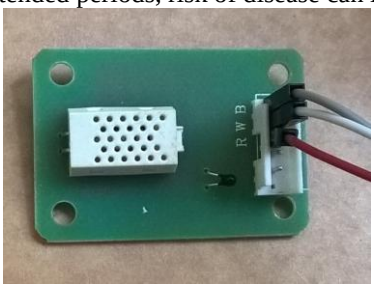

Figure5: Humidity sensor

Figure5 shows SYHS220 module of humidity sensor. The operating temperature range for this module is 0-60^{0} C and operating humidity range is 30-90% relative. When the humidity drops down below 30% relatively or rises beyond 90% relatively, then microcontroller sends signal to motor to turn on the mechanical mechanism so as to cover the blanket over the field so as to act as baffle in between field and humid.

E. Bluetooth module:

Bluetooth module is transceiver used for transmitting and/or receiving the data. There are various Bluetooth modules which act as either master and/or slave. Bluetooth module hc06 act as only slave but module hc05 act as both master and slave. It uses SPP (Serial Port Protocol) and used to set wireless serial connection setup. It transmits the values of each sensor to central computer through cp2012 module which is integrated USB transceiver. The data transmitted are stored into .csv (comma-separated values) format file for ease of access.

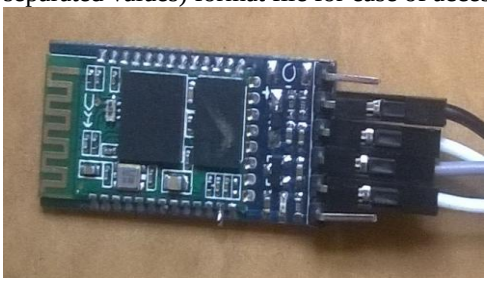

Figure6: Bluetooth module

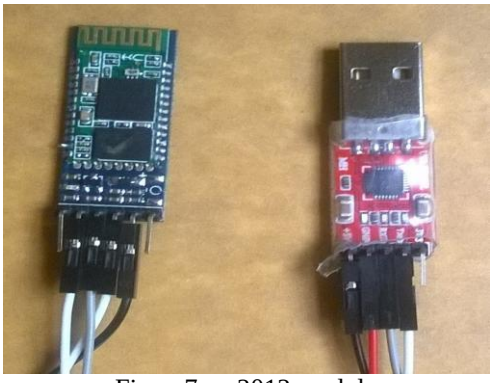

Figure7: cp2012 module

Figure6 represents master Bluetooth module while figure7 shows slave Bluetooth module with cp2102 module which are connected with pin-to-pin connector so as to transfer the data to central computer.

F. GSM module:

GSM SIM900A is used for intimating the operator about values of environmental parameters of interest and the action taking place like covering and uncovering of blanket over field, when operator is away from the field. The mobile SMS (Short Message Service) can be used to communicate between RMP and operator. As long as there is network present for GSM modules, communication is carried out.

Figure8: GSM SIM900A

GSM Modem-RS232 is built with Dual Band GSM/GPRS engine- SIM900, works on frequencies 900/ 1800 MHz. The Modem is coming with RS232 interface, which allows connecting PC as well as microcontroller.

V. DATA STORAGE AND FILE FORMAT

The values of environmental parameters of interest are sent by master Bluetooth module present at RMP and received by

slave Bluetooth module present at central computer database. The received data are stored into the system so that there is no chance of misplacing of data or data being lost. A code is being written in PYTHON so as to store incoming data into .csv file format which can even imported or exported into database; excel file or other software in order to perform analysis and displaying of data into graphical form over specified time period. The system creates a CSV file with a file name of current date on which reading are taken and stored in the form of 'DD-MM-YYYY.csv'. The MAC address of slave Bluetooth module is provided to master Bluetooth module so as to identify sender. The CSV file created for temperature is shown in figure 9 which represents temperature variation over 3 days and the login interval time is set as 1 hour.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	Time	12am	1am	2am	3am	4am	5am	6am	7am	8am	9am	10am	11am	12pm	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11pm	
2	day1	25	23	22	21	21	20	19	20	23	26	30	33	37	38	39	38	37	37	36	33	31	28	26	25	
3	day2	27	27	26	27	26	25	26	24	26	27	31	32	32	34	35	36	35	34	33	32	30	28	27	27	
4	day3	26	25	23	26	24	23	25	22	24	26	31	33	35	37	38	38	38	37	37	34	32	29	27	26	
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Figure9: capture of CSV file of temperature reading

Similarly data values of rain, wind and humidity are stored into .csv file.

VI. EXPERIMENTATION WORK AND RESULTS

The prototype model is prepared by integration of sensors, transceivers and mechanical system for covering the field. Figure10 shows the experimentation set up. Sensors like wind mill generator, temperature sensor and humidity sensor gives analog output so they are interfaced with microcontroller through analog-to-digital convertor. Whereas rain sensor has separate integrated circuit with it which give digital output to microcontroller. To cover and uncover the blanket, dc motor is provided with motor driver.

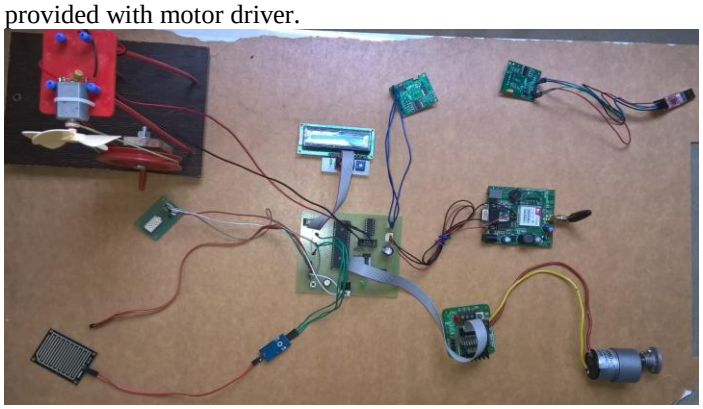

Figure10: Experimentation set up for Safety mechatronics System for farming of Fruits and Vegetables

The proteus simulation is shown in Figure11, which representation the working simulation of experimentation. The sensors are considered as switch; it is assumed that switch produces the same output as the sensors.

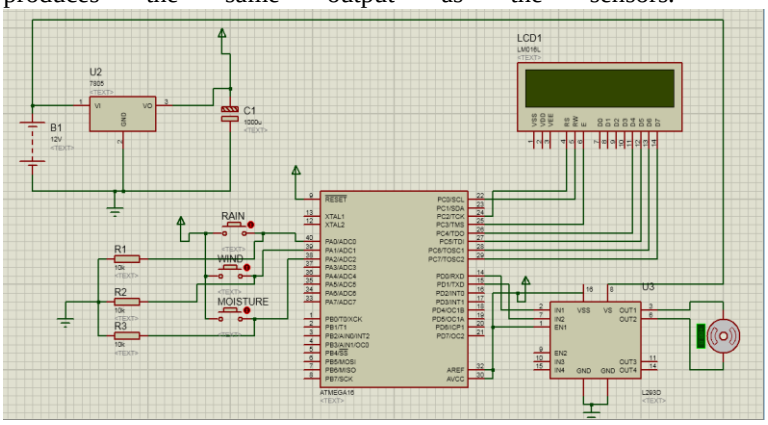

Figure11: Proteus simulation of s Safety Mechatronics System for Farming of fruits and vegetables

A. Sensor status through GSM module.

Rain is considered as main concern for this experimentation. When rain is detected, conductivity of lead board increases, microcontroller analyze the output voltage coming from lead board and accordingly makes decision

The voltage ranges are defined for 'Rain warning' and 'Flood'. By default the system is kept under no raining condition, so output voltage is negligible.

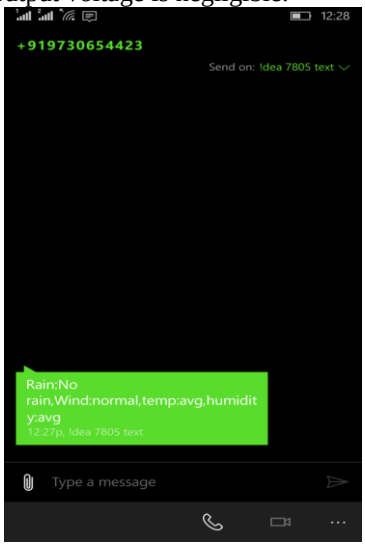

Figure12: Experimental results

Figure12 shows the capture of SMS sent by GSM module present at RMP to the operators' mobile phone, which contains status of rain sensor, wind mill generator, temperature sensor and humidity sensor.

When wind mill is rotating, it generates voltage and accordingly the speed of wind can be calculated. The wind speed is also categorized into two sections; normal wind, high wind. Second parameter from Figure11 represents wind mill generator status.

B. Mechanical Mechanism for covering and uncovering the blanket:

A stable mechanical structured is designed and developed for the experimentation. When a significant event is detected by

sensors then microcontroller gives signal to motor to cover the field or uncover the field.

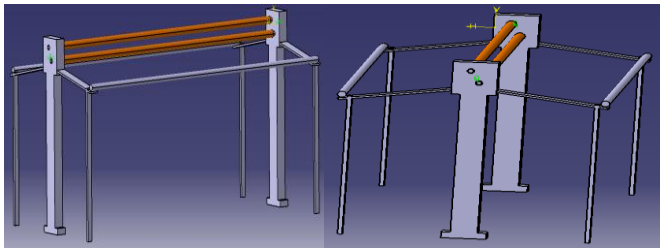

Figure13: Safety mechatronics system while uncovered condition

Initially the system is put in uncovered conditions considering all the environmental parameters to be stable. The structure consists of shafts on which blanket is wrapped, gearing mechanism to rotate the shafts, the motor to provide power to gear, rollers to provide rolling contact for shafts, space for mounting electronic circuits and vertical columns to support total mechanical structure.

When any significant event is detected in environmental parameters then microcontroller send signal to motor, to cover the field and unwrapping of blanket starts and simultaneously a SMS is sent to operator to intimate uncovering process. Figure14 represents the SMS sent by the GSM module present at RMP to operator.

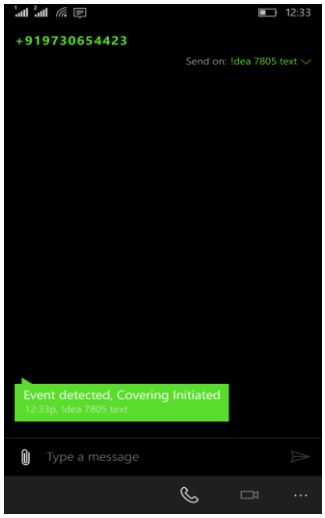

Figure14: SMS sent by GSM module when event is detected

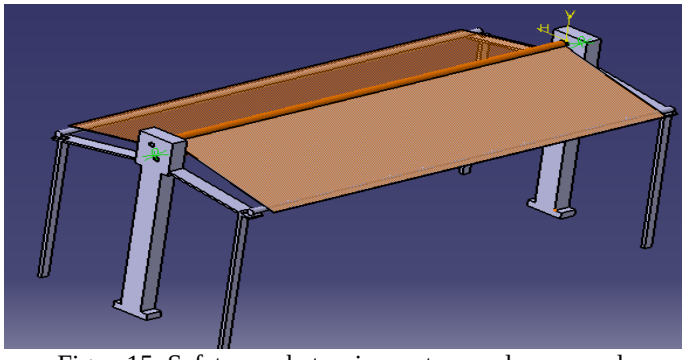

Figure15: Safety mechatronics system under covered condition

Figure15 shoes the complete unwrapping of blanket showing that it has covered the local fruits and vegetables.

The system will remain in covered situation unless all the environmental go to stable conditions. When all parameters are stable then safety system will again go to wrapped condition and as soon as total unwrapping is done then again confirmation SMS is sent to operator telling that Uncovering completed as showed in Figure16.

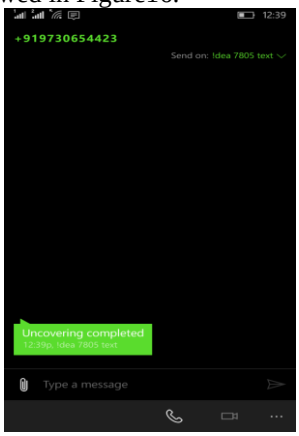

Figure16: SMS sent by GSM module when Uncovering is completed

VI. Conclusion

This paper represents design and development of mechatronics system based on WSN. Prototype operates on environmental condition and accordingly starts the automatic covering mechanism or retracts the mechanism and simultaneously intimates the status of operation to operator. The test proves that the developed prototype is capable to protect fruits and vegetables from heavy weather change and so as to minimize the upcoming damage. The established GSM network is highly efficient and the mechanical mechanism with structure is highly stable.

In future, weather forecasting information can be provided in prior to system so that system will predict the action needed and the operator also receives system prediction.

VII. References

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