Risk Index Monitoring of Powdery Mildew on crops using Wireless Sensor Network and warning SMS through GSM

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Abstract- The main aim of this paper is to propose a state of art wireless sensor technology in agriculture, which can show the path to the rural farming community to replace some of the traditional techniques of decision making. INDIA an agriculture based highly populated country needs high yield from crops including grains, vegetables and fruits. It has been observed that most of rise in yield of crop is based on use of pesticides and fertilizers which are harmful to health of crops as well as human beings. To avoid that we need precision agriculture through early detection of diseases on crops based on theory prevention is better that treatment. In this paper we try to emphasize on early detection of one particular disease i.e. Powdery Mildew as a prototype which monitors Risk Index of powdery mildew.

A Wireless Sensor Network with THREE nodes and ONE Base station monitors Temperature, Relative Humidity, Wind Speed, Light intensity and Soil Moisture. ATmega168 Microcontroller based automated wireless sensor network system receives conditions of environmental parameters through Sensor Nodes and send it to Base station which is interfaced with a computer system inbuilt with a software tool called Risk Assessment which assesses environmental conditions and compare it with UC Davis Powdery Mildew Risk Index Model. When risk Index reaches above 60%, GSM based automated system warns to all registered farmers in the database through SMS once in a day for three consecutive days, stating that an index reaches above 60% means pathogen is reproducing every FIVE days. This will definitely helps the farmer to decide when to use pesticide, instead of going irrelevantly sprinkling pesticide with time interval. This methodology helps to avoid inappropriate use of pesticide which ultimately reduces cost as well labour along with that it helps to save Environment from hazardous pesticides.

Keywords- Powdery Mildew, Precision Agriculture, Relative Humidity, Temperature, Wind speed, Soil Moisture, light intensity, Wireless Sensor Network.

I. INTRODUCTION

Agriculture plays a vital role in India's economy. 54.6% of the population is engaged in agriculture and allied activities (census 2011) and it contributes 17% to the country's Gross Value Added(1). Key issues affecting agricultural productivity include the decreasing sizes of agricultural land holdings, continued dependence on the monsoon, inadequate access to irrigation, imbalanced use of soil nutrients resulting in loss of fertility of soil, uneven access to modern technology in different parts of the country, lack of access to formal agricultural credit, limited procurement of food grains by government agencies, and failure to provide remunerative prices to farmers(2). Imbalance in the use of fertilizers in soil may also result in a loss of fertility. The consumption of chemical pesticides in the country has increased over the past few years, from 55,540 tonne in 2010-11 to 57,353 tonne in 2014-15(2). Major reason is lack of knowledge about necessity of spraying pesticides. Here we are trying to develop a system which helps farmer an early detection of disease by monitoring environmental parameters with the help of wireless sensor network and GSM based communication system. This will help to avoid unnecessary usage of pesticides in farming.

II. LITERATURE REVIEW

Most of the research papers are based on green house monitoring and control farming through WSN. Wireless Sensor Network in Precision Agriculture can be classified in to different schemes like network of scalar sensor, multimedia sensor network, Tag based network etc. (4). The crop management system using Wireless Sensor Network (WSN) is a kind of an autonomous solution to enhance the agricultural technology. Precision agriculture could raise the crops yield, labour cost saving and environmental protection against over pesticide or fertilizing. Therefore in this project we would like to propose a wireless sensor system that will communicate each other with lower power consumption(6). Powdery mildew, caused by the fungus Uncinula necator, has been a problem on many crops more than a century ago. It is, without a doubt, the most enduring and persistent disease problem faced by pulses, cereals and fruit producers (3).

III. REQUIREMENT OF WSN BASED MONITORING

We have proposed an information and advisory system which collects information about environmental parameters namely Temperature, Wind Speed, Light intensity, Humidity and Soil moisture which affects growth and development of crops. Basic requirement of proposed system is

a. Real time environmental data collection.

b. Monitoring and analysis with Risk Index of Powdery Mildew and warning SMS if risk index reaches above 60%.

c. Cloud storage on server and real time view of different parameter online.

d. Open access to all to observe current weather conditions in real time.

For realization of the proposed system data is kept on web server with graphical user interface (GUI). Five environmental parameters along with battery status is uploaded through

Master node using GPRS and GSM based mobile communication on web server. This is open access url, so any farmer can monitor current status of environment of specific region where the WSN based system is installed.

IV. SYSTEM ARCHITECTURE

Wireless Sensor Networks basic architecture comprises a group of spatially dispersed and dedicated sensors i.e. Sensor node, for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location.

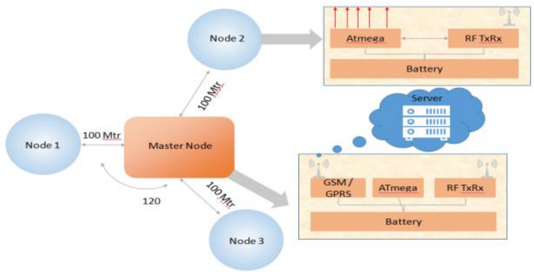

Fig.1: Architecture of Wireless Sensor Network

WSNs measure environmental conditions like temperature, relative humidity, wind speed, soil moisture and light intensity as shown in figure 01. In this system, THREE sensor node each having FIVE sensors to monitor different environmental parameters are organized with a star topology, where each node is kept 100 meter away from Master/base node with an angle of 120 degree far from each other. Relative Humidity and Temperature helps in monitoring onset and growth of powdery Mildew pathogen based on risk index model of powdery mildew developed by UC Davis. This model was developed by monitoring Powdery Mildew pathogen on grapes in California[(3)].

Fig.2: Symptoms and signs of powdery mildew on soybean plants.

In addition to Temperature and Relative Humidity, Wind speed is also monitored which helps to identify possibility of spreading of pathogen. We also incorporated soil moisture as additional sensor for precision agriculture which gives status of water level in soil. Irrigation necessity is monitored with the help of Soil moisture, helps to keep adequate water level in to soil by monitoring and sprinkling water as need arises. Entire system is built on ATmega168 microcontroller and cc1101 RF transceiver with SIM-800 module. All three nodes send data to base station with a gap of 20 minutes each. At the end of data received from all three node average is calculated to reduce error in sensing and loss of data, if any. This sensed information with the help of signal conditioning given to microcontroller ATmega128L, which is sent to Master / Base station through cc1101-Low-Cost Low-Power 1 GHz RF Transceiver which is located at remote location. This Master / Base station is composed of SIM-800, with the help of which we can send SMSes to ultimate end user i.e. farmer and also information can be gathered at server and Desktop or Laptop or any other compatible handheld communication device. Analytical study of received data can be done using disease model. Here we are going to analyze this data for "UC Davis model" for early detection of disease Powdery Mildew on crops, as a prototype for detection of disease before its onset.

V. WIRELESS COMMUNICATION TECHNOLOGY

CC1101 is a low-cost sub-1 GHz transceiver designed for very low-power wireless applications. The RF transceiver is integrated with a highly configurable baseband modem. The modem supports various modulation formats and has a configurable data rate up to 600 kbps. CC1101 provides extensive hardware support for packet handling, data buffering, burst transmissions, clear channel assessment, link quality indication, and wake-on-radio.

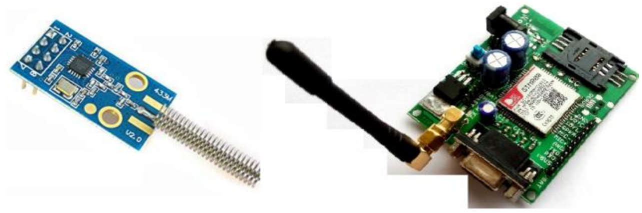

Fig.3: cc1101 RF Transceiver and SIM-800

SIM800 is a complete Quad-band GSM/GPRS solution in a SMT type which can be embedded in the applications. SIM800 support Quad-band 850/900/1800/1900MHz, it can transmit Voice, SMS and data information with low power consumption. With tiny size of 24*24*3mm, it can fit into slim and compact design. Featuring Bluetooth and Embedded AT, it is suitable for different applications.

VI. SENSORS AND HARDWARE DESIGN

The **Pt100-sensor** is used for precise temperature monitoring applications. The linear relationship of the resistor to temperature, simplifies its use. Pt100-sensor is a temperature dependent component.

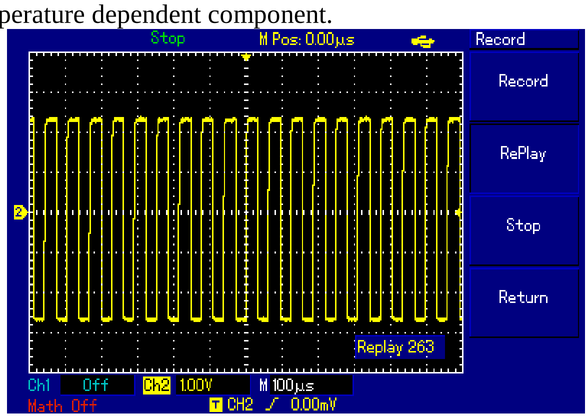

Fig.4: Temperature Sensor Pt100 testing results on DSO

The resistance of the Pt100-sensor rises linearly with the temperature. PT100 is very precise measuring temperature with an error of ±0.5°C with short response time. Nominal resistance offered is 100 Ω at 0°C (Pt100) with measuring range lies in between 50°C to +230°C and maximum current of 1mA.

HTF3000LF is a dedicated humidity and temperature transducer. Its response time is fast and highly resistance to chemical.

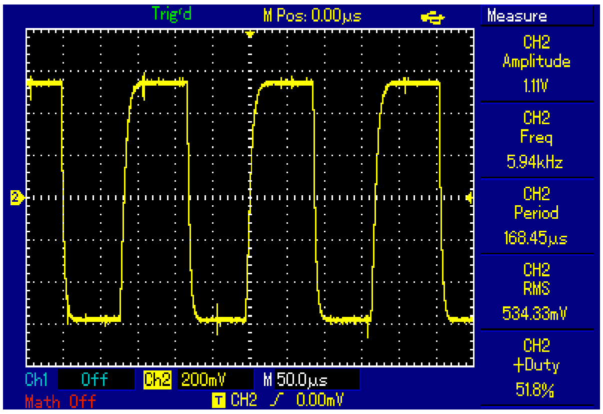

Fig.5: Humidity Sensor HTF3000LF testing results on DSO

Modeled Signal Output Equations

Fout = 7314 – 16.79*RH + 0.0886*RH^2 – 0.000358*RH3.

Fout in Hz and RH in %

BH1750FVI is an digital Ambient Light Sensor IC for I2 C bus interface. It is possible to detect wide range at High resolution. (1 - 65535 lx).It has small measurement variation of up to +/- 20% and has negligible influence of infrared rays.

An anemometer or wind meter is a device used for measuring wind speed, and is a common weather station instrument. Vane Anemometers work on the principle that a freely turning turbine will rotate at a speed directly proportional to the wind speed. Wind speed is calculated with a product of 2pi and angular velocity.

Wind Speed = 2Pi X Angular Velocity.

Below figure shows change in frequency due to change in wind speed.

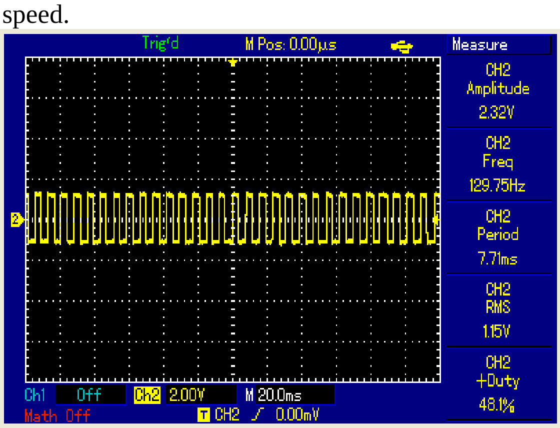

Fig.6: Wind speed testing on DSO

Soil moisture sensor can be used to test the moisture level of soil. It gives a digital output of 5V when moisture level is high and 0V when the moisture level is low in the soil. The sensor also outputs an analog output which can be connected to the ADC of a micro controller to get the exact moisture level in the soil. Operating voltage is 3.3V~5V.

VII. Disease monitoring and Powdery Mildew Risk Index

Powdery mildew appears as white, powdery spots on the leaf surface of many different kinds of plants. Powdery mildews are specific to their hosts and one type will infect only certain plants, usually those in the same or closely related plant families. Disease is favoured by warm temperatures, moderate to high humidity, absence of overhead watering, low light intensity and poor air flow. By considering above conditions pre-detection system is developed for monitoring onset and growth of powdery Mildew pathogen based on risk index model of powdery mildew developed by UC Davis, by monitoring Powdery Mildew pathogen on grapes in California.

VIII. RESULT AND DISCUSSION

Risk Index Monitoring of Powdery Mildew on crops using Wireless Sensor Network system is planted in farm before sowing of seeds to monitor environmental conditions in real time in the month of June. One plot is under the vigilance of precision agriculture system using WSN and another plot with same crop is maintained under manual or traditional vigilance.

Fig.7: Master Node on field during Field test.

Below are the observations of all FIVE sensor for 24 hours in a day. Figure 08 shows relationship between relative humidity and temperature. As temperature increases relative humidity decreases in day light.

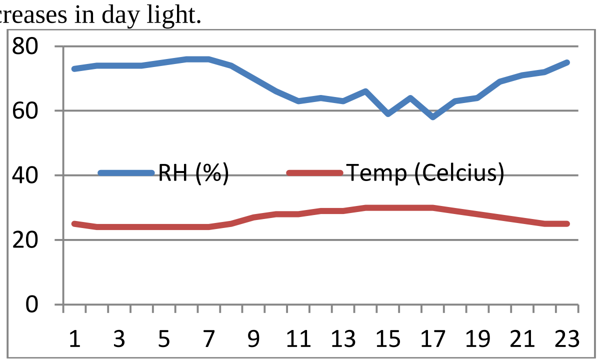

Fig.8: Shows the Temperature and Relative Humidity for 24 Hrs in a Day.

Figure 09 shows wind speed and soil moisture status for the day. Soil moisture increase or decrease solely depends on rain and/or irrigation. Farmer can analyse this to start irrigation. Wind speed helps to check possibility of spreading pathogen after its onset. It also helps to decide direction for sprinkling pesticides, if required.

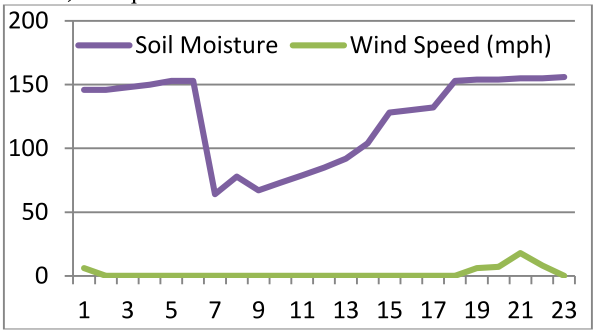

Fig.9: Shows the Soil Moisture and Wind Speed for 24 Hrs in a Day.

Figure 10 shows Light Intensity for the day. Photosynthesis plays important role in development of any crop. Crops under shadow could not deliver good yield only because of absence of photosynthesis.

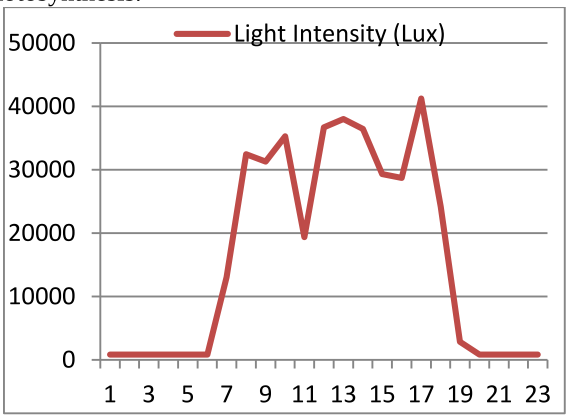

Fig.10: Shows the Light Intensity for 24 Hrs in a Day.

IX. CONCLUSION

In this paper, we proposed deployment of WSN based crop disease monitoring which is designed and implemented to realize modern precision agriculture. Such system can easily be installed and maintained with less efforts and technical knowledge. It has been observed that for the entire season No climatic conditions meets which will satisfy UC Davis Risk Index Model, hence NOT sprinkled pesticides on WSN based monitored plots. This is a sign of excessive use of pesticides on crops when it's not even required to be applied. This helps to reduce cost and labour. Most importantly it avoids hazardous impact of pesticides on crop as well as environment and ultimately on human life. The complete real-time and historical environment information helps the agro-ecology and achieve efficient management and utilization of agro-ecological resources by farmer.

X. ACKNOWLEDGMENT

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