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Automated Irrigation System Based on Wireless Sensor Network ,Crop Field Monitoring and Rice Disease Detection System

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Abstract

Agriculture is vital role in world wide, at the same time remotely monitored embedded system for irrigation purposes have become a new necessity for farmer to save his energy, time and money. The paper describe the optimize water use in agriculture at the same time to identify the rice disease. A software prototype system and distributed wireless network of soil moisture, temperature sensors and wireless camera are placed in crop field. A gateway unit handles the sensor information, trigger the actuators and transmit the data to web applications. Based on soil moisture and temperature threshold values an algorithm was developed and programmed in to microcontroller based gateway to control the water quantity. The system has powered by solar panel, data inspection and irrigation scheduling to be programmed through a web page using cellular-internet interface. Images of the infected rice plants are monitored and captured by wireless camera and processed using image growing and image segmentation to detect the infected parts of the plants is a first step and segmented images are passed to support vector machine for classification purpose in second step. Then information's are send to farmer through remote access so, the farmer identify and control the disease in early stage. In this system combined of manual, automated, and rice disease monitored and controlled. The automated system was tested in one acre crop area for 120 days and water savings up to 85%.because of energy autonomy and low cost.

Keywords: Wireless Sensor networks, PIC micro controller,wireless camera, cellular networks, image processing, rice disease detection (leaf blast, brown spot).

Related Work

In Agriculture research is aimed to optimize water use for agricultural crops and increase the rice productivity and food quality is important consideration but the 85% of fresh water resources will continue to be dominant in water consumption because of population growth and increase of food demand [1] And also despite advances in rice production technology, rice disease are mainly caused by fungi, bacteria, and viruses [2] Urgent need to create strategies for sustainable use water and crop management, accurate diagnoses and timely solution of the field problem. Diagnosis is most difficult task to perform manually as it function of number of parameters such as nutrient, organism and environment etc[3] There are hybrid architectures wired and wireless modules are located at green house management, where greater flexibility is required in wireless modules, and wired modules are actuators [4]

Considering the design of wireless sensor network based on applications [5] Wireless personal area network and wireless sensor networks are combined for device control and energy management [6]

Design and instrumentation of variable rate irrigation system is used efficient water management in cropping system [7] This paper describes the for short range wireless communication the four protocols are used. Bluetooth (IEEE 802.15.1), ultra wide band (IEEE 802.15.3) Zigbee(IEEE802.15.4) and Wi-Fi(IEEE 802.11). This protocols standard evaluating main feature and behaviours [8] This paper describes wireless sensor network monitor the important factors of crop field continuously and update the information's to farmer through web, if any critical variation occur in crop field the farmer inform to agriculture experts through mobile [9]The paper describes the iFarm frame work system was introduced, and it offers the set of service to farmer including the irrigation and water management, the pest and disease control, the crop yield prediction and planning, and the resources optimization[10]This paper addresses the problem of producing an enlarged picture from a given digital image (zooming) [11] The paper describes the infected images are captured by digital camera from rice plants and processed using image growing, image segmentation techniques. Then infected parts of the leaf have been used for the classification purpose using neural network [12]By applying a non-linear K-means clustering algorithm in the affected plant leaf image for segmentation and sobel edge detector is used to extract the exact part of the leaf shape. [13]Image processing technique based images are segmented using k-means algorithm and classification using pre trained neural network [14]The review of edge detection techniques which are based on discontinuity intensity levels. The performance of various edge detection techniques carried out with an image by using MATLAB software[15].

Proposed Automated Irrigation System

The architecture of proposed system (Fig.1) consist of two parts automated irrigation and monitoring, detection. The first part is a wireless sensor, PIC16F887 Microcontroller, Zigbee. The second part is a wireless camera, image processing (Segmentation, classification), GSM modem, internet, and remote access.

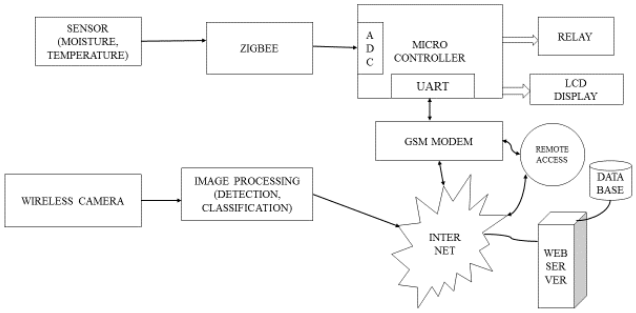

Figure 1: Configuration of automated irrigation,monitoring and detection system.

Sensor Unit

A. Single Chip Pic 16f887

An 8-bit microcontroller with 44-pins and microchip CMOSFLASH Based technology that operates range from 2.0 to 5.5 Vat precision internal oscillator. It has a 14 channels of 10 bit analog to digital convertor (ADC), two inter -integrated circuit (I2c), Enhanced universal asynchronous Receiver and Transmitter (EUART), two serial peripheral interface, 256 bytes EEPROM data memory, two 8 bit timer, and hardware real- time clock calendar (RTCC). This microcontroller is well suited for industrial, automotive and remote application.

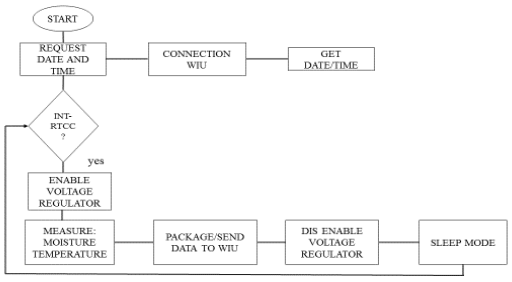

Figure 2: Algorithm For Wireless Sensor Unit

The (Fig. 2) shown the Algorithm for wireless sensor unit. For monitoring the moisture, temperature of the soil the sensors are connected through an analog to digital port implemented in 1 wire communication protocol. Using a voltage divider a battery voltage is monitored is coupled to an analog to digital port. The data are packed with the corresponding identifier, time, and date to be transmitted via Xbee radio modem using RS485 protocol through a two digital ports configured as Transmitter, and Receiver. After sending data, the micro controller is set in sleep

mode for certain period. Whereas the RTCC is running. This operation mode allows energy savings.

B. Zigbee Tranceiver

Zigbee over IEEE 802.15.4 consumes a low power compare than other wireless communication protocols, Bluetooth (over IEEE 802.15.1), ultra-wideband (UWB, over IEEE 802.15.3), Wi-Fi (over IEEE 802.11) and its operating range 10 to 100 meters. The Zigbee devices operate in industrial, scientific and medical 2.4GHZ radio band and allow the operation in a so called mesh networking architecture provides a self-organized, reliable with long battery lifetime. The Zigbee devices are mostly used in home applications, but it is less used in agricultural crop fields. The functionality of both transmitter and receiver combined into a single device known as a transceiver. ZigBee transceivers are used for transmission and reception purpose. In this system the various sensed data from sensors to the central global system for mobile (GSM) node from that sensed data is given to the personal computer, which is used by a farmer.

The (Fig .3) As shown the Communication frames between the wireless sensor unit and wireless information unit. The least significant byte of 64 –bit address is used to label the information of the soil moisture and temperature of wireless sensor unit. This byte is registered in the wireless information unit as identifier associated (ID) to wireless sensor unit. The request date/time and sending date/time formed as a frames.

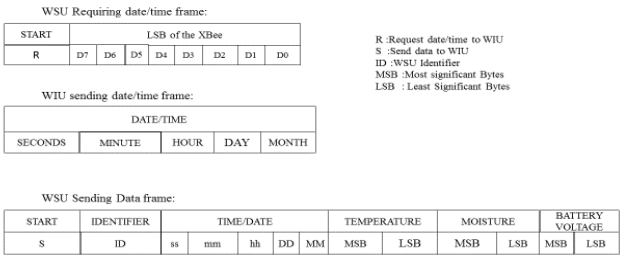

Figure 3: Communication freames between WSU and the WIU

C. Sensors

Wireless sensor network technology for low power wireless measurement and control applications. The wireless system provides the significant cost savings as well as improved reliability for many long term applications. Generally the network consists of a large number of densely deployed small sensor nodes with sensing, computation and wireless communication capabilities. For good irrigation water management increase the crop fields, improve the crop quality, increase the energy and reduce the non-point source pollution. One of the best way we using the soil moisture and Temperature measurement. In this system we using hydro probe sensor. It measurements on the physics and behaviour of a reflected electromagnetic radio wave in soil to determine the dielectric constants. From the dielectric constants the

hydropropbe simultaneously measure the moisture and temperature values. Response time to changing the soil conditions is immediate and calibration is as simple selecting a soil type (sand, loam, silt or clay) .The hydra probe is serial addressable allowing for multiple sensors to be connected of any RS485 via cable. A sensor data can also be sent directly to a radio modem. The temperature rang10° to +65°c and accuracy ±0.1°c, Soil moisture for inorganic and mineral is ±0.3.

D. Solar Energy

Energy independence and food protection are the biggest challenge facing the world. Solar energy for irrigation system is powered system method. The MPT4.8-75solar panel is employed for to maintain the charge of the sensor unit. Each solar panel delivers the current 50mA at 4.8v, which is sufficient energy for voltage maintaining the batteries.

Wireless Information Unit

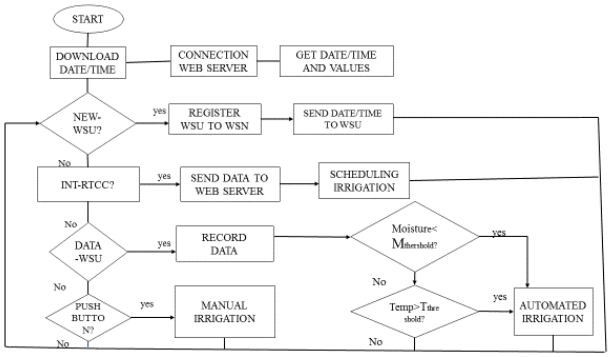

Figure 4: Algorithm for irrigation system automated.

The (Fig.4.) shown the Basis models of irrigation system performed using algorithm.

1) Manual irrigation with push button.
2) Predefined Scheduled date and time irrigations through web page.
3) Automated irrigation system with fixed duration, moisture value is lesser than threshold values.
4) Automated irrigation system with fixed duration, temperature value is greater than threshold values.

E. LCD

The LCD is used in our system displaying the parameters like soil moisture, and temperature values in the crop field. It is a backlit (400×196) LCD Display.

F.Relay

The Relay connection of the irrigation system performed by controller of two pumps through SPDT (Single pole double throw switch) relay. It is an electromagnetic switch connected to the microcontroller.

G.Graphical User Interface

It is the one of software used in PC was developed for real time monitoring an irrigation based on temperature and soil moisture data. The farmer visualizes the, graphically data from each sensors information online using any device with internet. It shows the soil moisture, temperature, water consumption and the kind of an automated irrigation system (Fig.5).

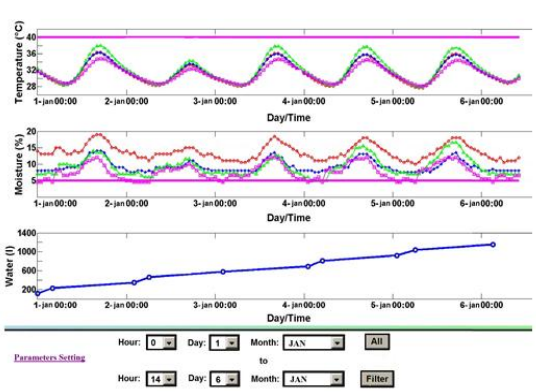

Figure 5: Web application of irrigation system(soil moisture,temperature).

H .IPCAM01(CAMERA)

IPCAM01 is an integrated wireless IP camera and it combines a high quality digital video camera with network connectivity and powerful web server to bring your desktop from over the internet. The basic function of the IPCAM is transmitting remote video on the IP network. High quality images transmitted with 30fps speed by using MPEG hardware compression technology.IPCAMO1 supports a wireless networks, image snap shot, high sensitivity1/4" CMOS sensor powerful high-speed video protocol processor, and support remote system update.

Operation of irrigation system with monitoring and detecting the disease.

The system was tested in one acre rice crop field. The sensor and camera system was placed in middle of the land. Based on the soil moisture, temperature values the automated irrigation system was performed. The threshold values of soil moisture minimum value 5%VWC and temperature values in 40˚C for the automated irrigation modes (IA-3and IA-4).Initially the scheduled irrigation (IA-2) of 40 min/day was used during the first 3 weeks. During the cultivation, automated irrigation periods were carried out by the system because of the soil moisture (IA-3) or (IA-4) levels, regardless of the scheduled irrigation (IA-2).

All data were up load to web server half hour to the web server for remote supervision.at the same time the wireless camera was monitored the crop field each time and captured the infected images analyse and classified which disease affected find out using image processing techniques.

Automated irrigation system triggered by soil moisture for two days are shown (Fig.6) shown ,when the soil moisture value fell below the threshold level of 5.0%VWC,the irrigation system was activated for one hour ,whereas the soil temperature remained below the threshold levels. Similarly, (Fig.7) shown automated irrigation triggered by soil temperature, when the temperature was above 40˚C the irrigation system activated for 15 mints. Whereas the soil moisture remained above the threshold values.(Fig.8) shown the implementation level of the system.

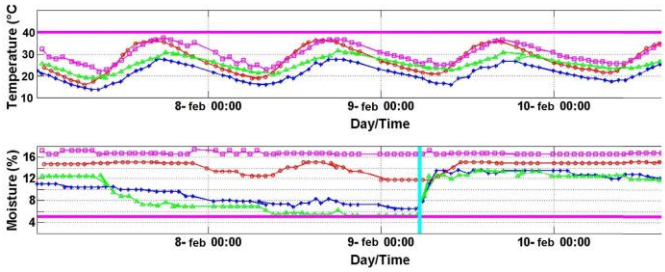

Figure 6: automated irrigation triggered by the soil moisture threshold ≤5% VWC.

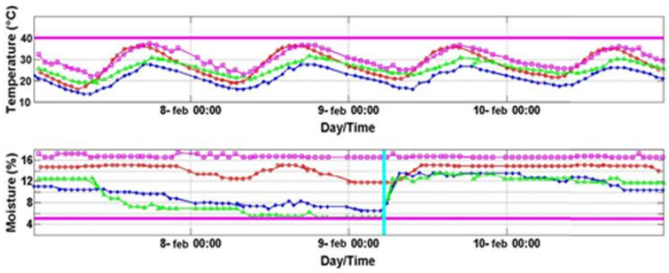

Figure 7: automated irrigation system triggered by the soil temperature threshold ≥ 40˚C.

Figure 8: Implementation level

Automatic detection of rice leaves disease is done by taken from infected samples of images from camera. The leaves affected by brown spot and blast.

Image Processing Techniques

The (Fig.9) Shown the Procedure for rice Disease detection and classification steps. Get the information from the wireless camera, and the images are segmented and classified using the Support Vector Machine.

Figure 9: The Basic Procedure For Disease Detection

Segmentation Process

In the segmentation process acquired images are enhanced by increasing brightness and contrast and then transformed to Hue Intensity Saturation(HIS)model .Entropy based bi-level thersholding method has been invoked for segmenting the images to identifying the infected parts of the leaves.(Fig.10)and(Fig.11) shown the (Rice leaf blast,brown spot).(Fig.12)Shown the output of the segmentation images.

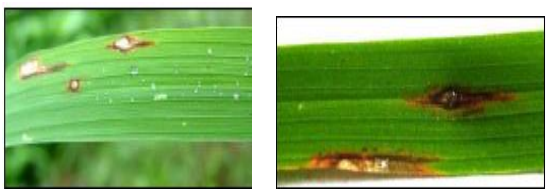

Figure 10: Rice Leaf Blast

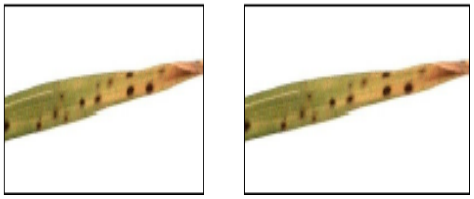

Figure 11: Rice Leaf Brown Spot

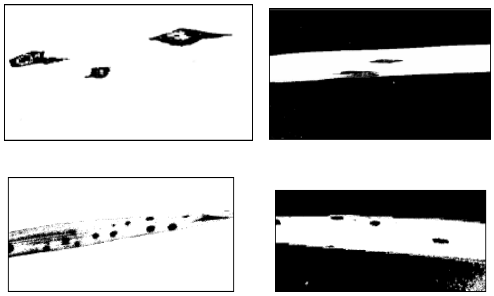

Figure 12: Rice Leaf After Segmented Images

Boundary Detection

Boundary detection algorithm using a 4-connectivity method has been applied on the segmented images.(Fig.13.)shown the output of boundary detection images.

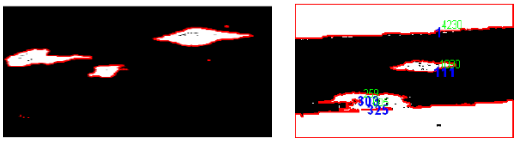

Figure 13: Images After Boundary Detection

Spot Detection

After boundary of the segmented images are obtained, the ratio of the average value of the green intensity and components of the pixel lies in between 1.12 to 1.35 respectively and the measurement is used to identify the infected spots. The selecting green component is based on when the infection occurs in the leaf, the greenness of the leaf is affected most. Instead of we have taken the ratio of green component with the intensity to make the spot detection invariant of the brightness of the image and age of the leave.

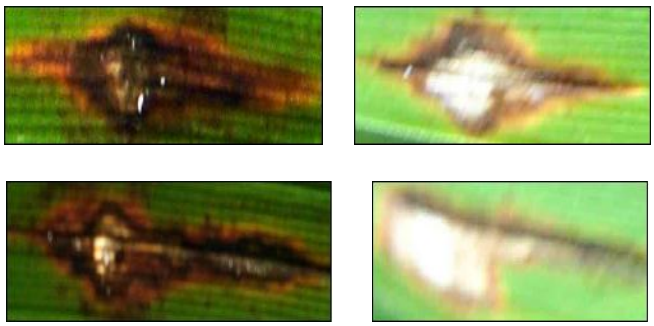

Figure 14: Represents The Spots of Blast

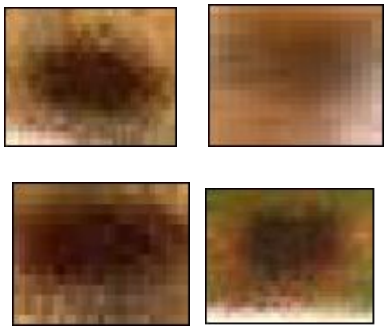

Figure 15: Represents The Brown Spot

Classification (Support Vector Machine)

The extracted feature were used as an input in the classifier support vector machine (SVM).The classification of the data was performed with two samples (rice leaf blast, brown spot) data in the training data set. The SVM classifier works on the concept of decision planes that define decision boundaries. A decision plane is hyper plane that separates between a set of objects that belong to different classes. A support Vector Machine creates a plane in–dimensions to separate-dimensional points lying in different classes. The class is predicted for a new point based on which side of the plane the point lays. Nonlinear mapping function is used to map the data into a higher dimension feature space for nonlinear separable data. The decision function is based on dot product of the input feature with support vectors, and the mapping of data in to higher dimensional feature space is not needed upon use of kernel. Some commonly used kernels are Gaussian radial basis functions and polynomial and hyperbolic tangent .the radial basis function and polynomial kernel were used in this study.

The Texture features such as contrast, uniformity, correlation and homogeneity were extracted from the four-point neighbouring pixels of the segmented image. The features were used in SVM classifier.

Conclusion

In farming activities, agriculture is an important role. During the past years the farm management system is very sophisticated, so emerged to replace complex system and software tools. The latest trend enables the management system to operate through the internet. In proposing system the farmer updates the current information on the crop field through a PC or on his mobile. And also monitored the rice disease attack in crop field area and easily find out the by the farmer and he can take the proper action.

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