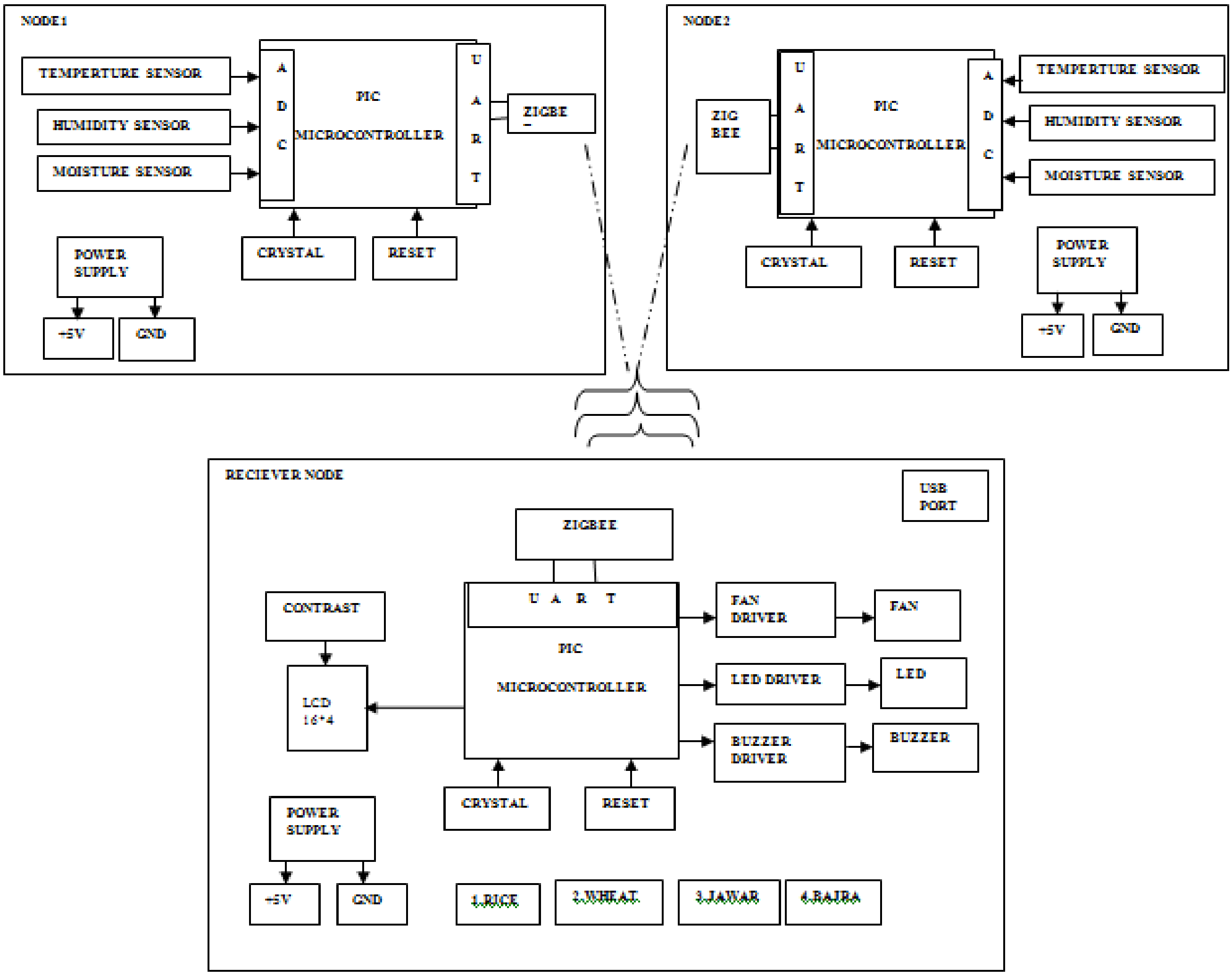

Figure 1: - System Architecture of Proposed Automatic Irrigation System

In this system the receiver node called as the master node. The entire three nodes are controlled using PIC18f458 controller. With inbuilt Analog to digital Converter (ADC) of PIC18f458 temperature, humidity, and soil moisture sensor are interfaced. The outputs of the entire sensor are analog which is then converted into digital. The ZigBee module which is interfaced using UART is serial communication. The ZigBee module transmits data through wireless communication. Node 1 and node 2 both transmit the data to receiver node which is also known as Master node. The node1 and node2 has the same sensor with same working except the destination address of both differs. The destination address of node 1 and node 2 is set as the address of receiver node. The ADC has 8 channels with 10 bit resolution. ADC captures the data and sent data to the UART. UART then fed the data to ZigBee module. All nodes are set constant at the baud rate of communication, i.e. 9600bps.PIC18F458 has one inbuilt UART. The Master node continuously transmits data to PC and monitors the data. The master node consists of a three relay for Pump, Buzzer and Fan. Master node contains a 4 button for selection of crop such as Rice, Wheat, Bajra, Jawar. When any button of the crop is pressed then the values of crop displayed on the LCD of master node as well as PC. Suppose the run time value cross the crop set value, then it will be perform automatic operation.

3.2 Component Description

a) **PIC Microcontroller:** - it is a compact standalone computer, used for control application. The memory, entire processor and I/O interface are located in a single silicon piece. Hence, it takes less time to write and read to other devices. The proposed work is developed using PIC 18F458 microcontroller. The main feature of PIC 18F458 microcontroller is CAN Bus Module and high performance of RISC CPU. It contains inbuilt ADC.

b) **Temperature sensor:** -LM35 sensor is used for sensing the field temperature and interface with the microcontroller. This temperature sensor is a precision integrated-circuit. The range of LM35 sensor is -55o to 150oC. The proposed work is developed using LM35 sensor. The proposed system maintains the range of temperature 27o to 80oC. The temperature range can be changed manually according to season.

c) **Humidity Sensor:** - SY-HS-220 Humidity sensor used. This sensor detects the field humidity. The operating range of humidity sensor is 25-90 RH. A SY-HS-220 sensor is used for sensing the field humidity and interface with the microcontroller. The proposed work is developed using a SY-HS-220 sensor. The proposed system sets the range of humidity 30 to 80RH. We use the set points of Humidity as 30RH to 80RH for the standard irrigation system, but this may change according to the type of soil and climate. We can change the set points manually for proper irrigation.

d) **Soil Moisture Sensor:** it is a resistance type sensor which senses the moisture of a soil. It indicates 0% for dry and 100% for wet. Soil moisture sensor interface with the microcontroller is used for sensing the soil moisture. The proposed work is developed using soil moisture sensors. The proposed system maintains the range of moisture from 25% to 90%.

e) **ZigBee:** ZigBee is a high level of communication protocol. A ZigBee module used the IEEE 802.15.4 standard protocol suite for fast communication from point to multipoint or peer to peer networking. The range of ZigBee maintains up to 100m. The main feature of ZigBee module is low –rate, energy consume, low power application as compared to WI-Fi, Bluetooth. The proposed system work developed using ZigBee. The proposed system maintains range of ZigBee is 50m.

f) **Relay:-** In this system relay is used for connecting the Motor Pump, Fan, Buzzer to microcontroller

3.3 Snapshot of Automatic Irrigation System

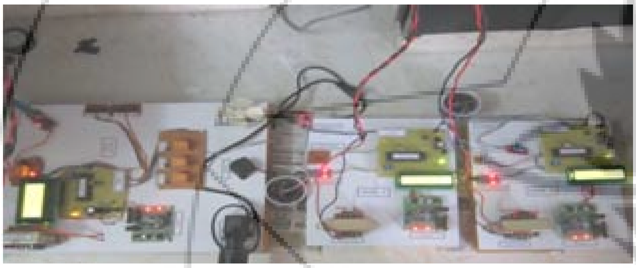

Figure 2: System Hardware Setup

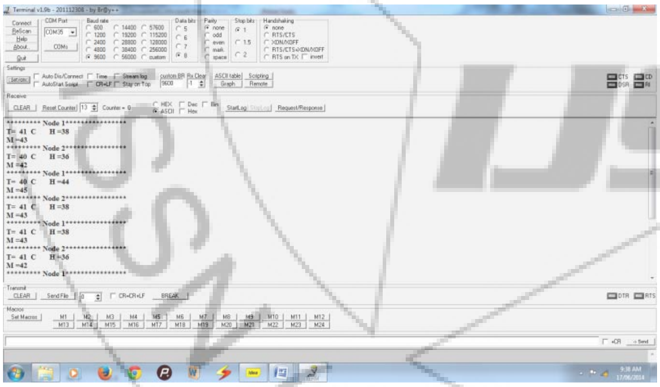

Figure 3: Computer Monitoring system connected with master node

3.4 Mathematical Description

This system is an Open Loop Control System because in this project output is not compared to the desired input. The transfer function is defined as the ratio of the Laplace transform of the output to Laplace transform of input with all initial conditions are zero.

For Node 1

G4 (S) = N1 (s) /R1 (S)

G4 (S) = Transfer function of Node1

N1 (s) = output of Node 1

R1 (S) = input of node 1

N1 (S) = G1 (S) +G2 (S) +G3 (S);

R1 (S) = T1 (S) +H1 (S) +M1 (S)

Calculate transfer function of temperature

G1 (S) =C1 (S) /T1 (S)

C1 (S) =G1 (S) *T1 (S)

C1 (S) = $(c_m s + c_{m-1} S^{m-1} + \text{---------} + c_1 S + c_0)$ -------- -- By using Laplace transform

T1 (S) = $(t_m S^m + t_{m-1} S^{m-1} + \text{---------} + t_1 S + t_0)$ ---------- By using Laplace transform

G1(S)= $(c_m S^m + c_{m-1} S^{m-1} + \text{---------} + c_1 S + c0) / (t_m S^m + t_{m-1} S^{m-1} + \text{---------} + t_1 S + t_0)$

If both the polynomial order is same then the transfer function is PROPER

Calculate transfer function of Humidity G2 (S) = C2 (S) /H2 (S)

C2 (S) = G2 (S) *H2 (S)

C2 (S) = $(b_m S^m + b_{m-1} S^{m-1} + \text{---------} + b_1 S + b_0)$ ---------- By using Laplace transform

H2 (S) = $(h_m m + h_{m-1} S^{m-1} + \text{---------} + h_1 S + h_0)$ ---------- By using Laplace transform

G2(S)=$(b_m S^m + b_{m-1} S^{m-1} + \text{---------} + b_1 S + b^0) / (h_m S^m + h_{m-1} S^{m-1} + \text{---------} + h_1 S + h_0)$

If both the polynomial order is same then the transfer function is PROPER

Calculate transfer function of Soil Moisture G3 (S) =C3 (S) /M3 (S)

C3 (S) =G3 (S) *M3 (S)

C3 (S) = $(a_m S^m + a_{m-1} S^{m-1} + \text{---------} + a_1 S + a_0)$ ---------- By using Laplace transform

M3 (S) = $(s_m S^m + s_{m-1} S^{m-1} + \text{---------} + s1S + s_0)$ ---------- By using Laplace transform

G3 (s) = arms + $a_{m-1} S^{m-1} + \text{---------} + a_1 S + a_0)$ / (smSm + sm-1Sm-1+---------+$s_1 S + s_0)$

Calculate transfer function of Node 1 G4 (S) = N1 (S) /R1 (S)

G4 (S) = G1 (S) +G2 (S) +G3 (S) / T1 (S) +H1 (S) +M1 (S)

For Numerator and Denominator both order is same then transferring function are PROPER

Similarly the Node 2 of Transfer Function G8 (S) can be calculated,

G8 (S) = N2 (S) /R2 (S)

G8 (S) = Transfer function of Node 2

N2 (S) = Output of Node 2

R2 (S) = Input of Node 2

G8 (S) = G5 (S) +G6 (S) +G7 (S) / T2 (S) +H2 (S) +M2 (S)

The order of Numerator and Denominator are same then transfer function is PROPER

Similarly for the Master Node we will calculate the transfer function G9 (S),

G9 (S) = C (S) /R (S)

G9 (S) = [N1 (S) +N2 (S)] / [R1 (S) +R2 (S)]

G9(S)=[G1(S)+G2(S)+G3(S)]+[G5(S)+G6(S)+G7(S)]/[T1(S)+H1(S)+M1(S)+T2(S)+H2(S)+ M2(S)] Thus the above equation represents the Mathematical Model for our Project.

4. Result and Analysis

The farmer has the ability to monitor the Sensor's information at his/her home, the sensor information displays on the master node LCD as well as PC. The farmer can set crop type such as Wheat, Rice, Jawar and Bajara in the master node. Moisture, temperature and humidity value required for a particular crop are set in the microcontroller as a threshold value. Soil moisture, temperature and humidity sensor fixed in the field sense the actual values. These values are compared with the threshold values. If the actual value crosses the threshold values then corresponding pump, fan or Buzzer switched ON. The Farmer pressed his or her choice as "1" in master node, crop type rice is selected, then the actual values of moisture, temperature and humidity for rice will be displayed on master node as well as computer through Terminal v1.9b.

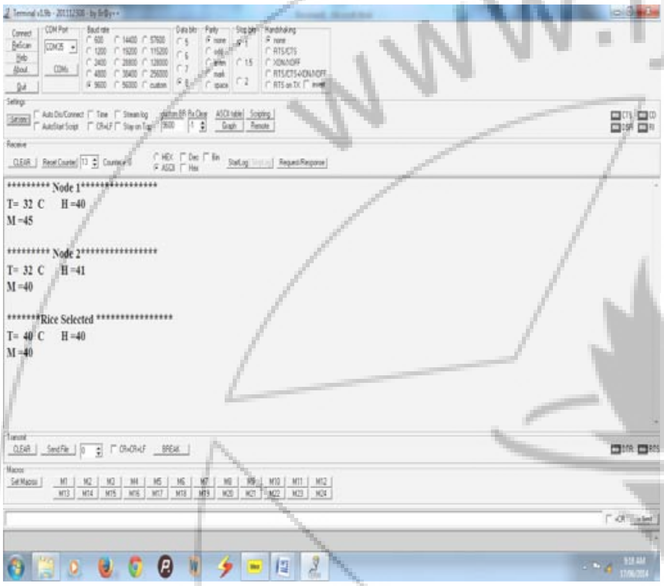

Figure 4: Rice Selected

These actual values obtained from node 1 and node 2 compared with threshold values for Rice. For Rice threshold value for temperature is 40 OC, humidity is 40 RH and soil moisture is 40. If the actual temperature is more than 40 i.e. Threshold values, then the microcontroller sends the signal to Relay 3 to switch ON the Fan. The following output screen displays the current reading of the sensors such as Humidity, temperature and soil moisture on master node for node 1 and node 2

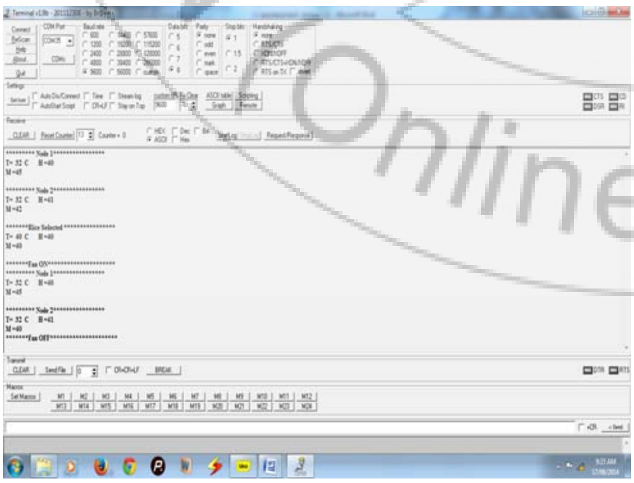

Figure 5: Fan ON when Temperature of Rice increases

If actual value of Humidity is more than 40 RH i.e. Threshold value, then the microcontroller sends the signal to Relay 2 to blow the buzzer. The following output screen displays the current reading of the sensors such as Humidity, temperature and soil moisture on master node for node 1 and node 2

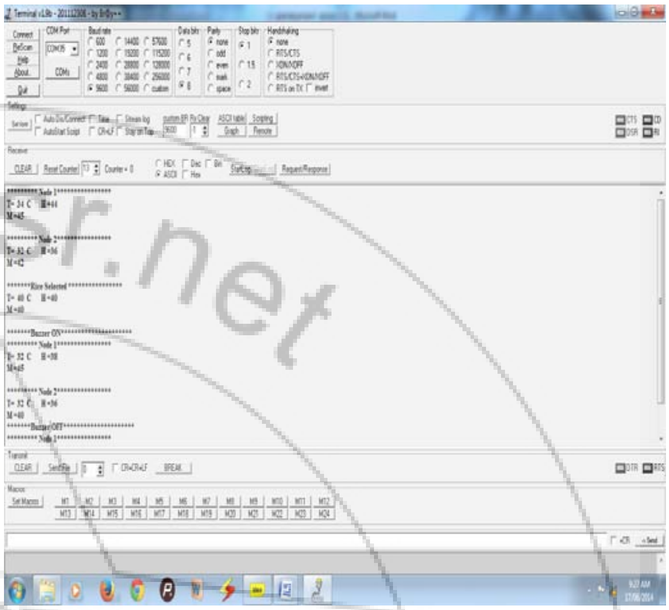

Figure 6: Buzzer ON when humidity of Rice increases

If actual value of soil moisture is more than 40 RH i.e. Threshold value, then the microcontroller sends the signal to Relay 1 to switch on Pump Motor. The following output screen displays the current reading of the sensors such as Humidity, temperature and soil moisture on master node for node 1 and node 2

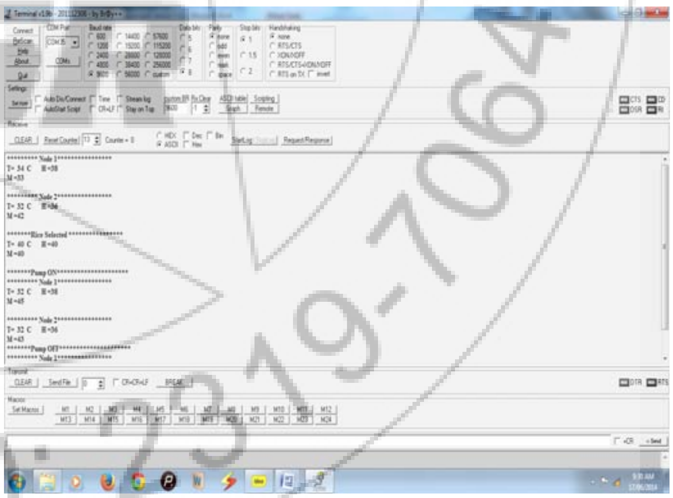

Figure 7: Pump ON when Moisture of Rice decrease

Similarly the Farmer pressed his or her choice as "2" in master node, crop type Wheat will selected, if he/she pressed choice as 3. Crop type Jowar will selected and if he/she pressed choice as"4" crop type Bajra will selected. Then actual values of moisture, temperature and humidity for the corresponding crop will be displayed on master node as well as computer. Same procedure repeated for Wheat, Jowar and Bajra as shown above for Rice. Threshold values are set in microcontroller for different crops as per following table.

Table1: Value of Crop

Type of Crop	Temperature	Humidity	Moisture
RICE	T=40 C	H=40 RH	M=40
WHEAT	T=50 C	H=50 RH	M=50
JOWAR	T=60 C	H=60 RH	M=60
BAJRA	T=70 C	H=70 RH	M=70

5. Conclusions

The WSN in agriculture is new technology for information acquisition and processing in agriculture field. It is more advantageous than the traditional agriculture techniques. The importance of optimized and efficient irrigation management system development has become the need of time, especially the irrigation system that takes decisions over crop soil water contents and environmental parameters. An irrigation management system for container grown crops is presented. If the threshold values are crossed it activates the alarming unit automatically. A WSN based system of environmental monitoring feature is low power and low cost device, hence it can be easily implemented in countries like India and other third world countries. The maintenance cost is almost negligible and hence very much useful for remote applications.

6. Future Enhancement

1. SMS system can be incorporated to send the SMS on the user's mobile phone from the Base Station.
2. Biosensors can be used to check the fertilizers present in the soil, which can reduce the consumption of fertilizers and protect the environment from excessive use of fertilizers.
3. A database for all the crops in a particular region can be prepared and according to this database input to particular crop can be selected and corresponding results can be obtained.

7. Acknowledgement

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