# Monitoring Maize Plant Irrigation System using ARM Microcontroller LPC2148 with Wireless Sensor Network

**T.Gayathri[1], K.Boomidevi[2], S.Ragul[3]**

[1]*PG Scholar [Embedded System Technologies], Dept. of EEE, Kongunadu college of Engineering and Technology, Trichy, Tamilnadu, India*

[2]*PG Scholar [Embedded System Technologies], Dept. of EEE, Kongunadu college of Engineering and Technology, Trichy, Tamilnadu, India*

[3]*Assistant professor, Dept. of EEE, Kongunadu college of Engineering and Technology, Trichy, Tamilnadu, India*

[1]*gayu.nov15@gmail.com,* [2]*kboomidevi@gmail.com,* [3]*raguleee78@gmail.com*

*Abstract* - **In this project, the implementation of proposed system for monitoring the growing status of the corn plant continuously and intimate the status to the agriculturist using Wireless Sensor Network (WSN). The upsurge increase in the technological and scientific innovation makes advancement in agricultural field. But in practice, cultivator faces too much effort in the farmland. This project makes eases the work of the farmer in cultivated land through the usage of different kind of sensors. The temperature sensor will find the intensity of heat present in the air. The humidity sensor will find the humidity level of the air. The soil moisture sensor will compute the moisture level in the soil, if the level decreases, then it automatically switches ON the DC motor. PH sensor will find the PH level in the soil. All the particulars of farmland are sending to the farmer through Global System for Mobile communication (GSM) and revel in the Liquid Crystal Display (LCD) screen. The temperature sensor will find the intensity of heat present in the soil. With this less cost and energy utilization, WSN is a hopeful method for harvesting the corn crop and also improves the quality of the corn crop and reduces the usage of pesticides, thereby increasing the overall profits for the farmers.**

*Keywords* - **Leaf Area Index (LAI), GSM, Wireless Sensor Network (WSN), Proteus8.**

## I. INTRODUCTION

Today, Agriculture plays very important role in country development. To make feasible for the farmer, the automatic monitoring system for corn farmland using different sensors, PIC Microcontroller etc., and transmit the farm information through SMS to the farmer using Global Positioning System (GPS). Wireless Sensor Network plays important task in monitoring physical, environmental conditions used in the agricultural field, military surveillance, industrial, consumer application, etc., In the agriculture field, wireless sensor network is used to monitor Temperature, Humidity, Soil moisture, Wind, Pressure, PH and Redox.

By monitoring the corn growth continuously will achieve better yield with less manpower. If the canopy growth reaches its threshold value, then the information was displayed in the Liquid Crystal Display (LCD) and also send to the cultivator through mobile phone SMS for monitoring the canopy growth using LDR sensor with GSM [1].Using wireless sensor network (WSN), the Leaf Area Index (LAI) was monitored continuously for measuring plant growth in forest by LAInet method and the information are shared using cloud computing [2]. The automatic irrigation system wills save-all the unique stages of plant growth and the message about plant growth are transferred through Zigbee module to the agriculturist [3]. Using Digital Image Processing, the unique stages of plant growth are taken as input image. Based on the captured image with its weather condition, the nutrition material is given to the plant for its better yield [4].

The INTELLIGENT HUMIDITY sensor will automatically monitor the soil moisture level in the farmland with reduced power consumption by collecting only less data which in turn cause more data to be lost in the system and there is no need to monitor and save the bulky data required in agricultural fields [5]. The different types of crops such as Paddy, banana, turmeric fields the canopy growth was monitored by a temperature sensor, humidity sensor, soil moisture sensor and the information about the farm are transmitted using a Zigbee module to the farmer and consume less power by using solar cells [6]. Using the Image Processing, the population of the corn plant count is measured automatically using a digital video camera on the vehicle moving in the distance of 1 to 2m/s. Based on this count, the fertilizers are given to the plant more approximately with avoiding insect attack [7].

## II. SYSTEM ARCHITECTURE

In the proposed system, the Corn plant is continuously monitored by Temperature sensor, Humidity sensor, Water level sensor and finally the Soil Moisture sensor automatically and updates the information about corn plant growth to the agriculturist periodically through mobile phone SMS using Global Positioning System for improving the quality of the corn plant with better yield by avoiding spraying of chemical substance in the farmland which in turn reduces the insect attack in the corn.

Fig 1 shows the stages of corn plant growth. The power consumption is reduced by using Solar cell panel for running stepper motor automatically when the water level becomes low in the farmland and switch off the motor after watering the field with glowing LED. By using ARM LPC2148, the sensor will sense the temperature of the soil, soil moisture level, water level in the field, the amount of light which falls on the corn leaf for photosynthesis, the amount of acidity in the soil and display the messages on the LCD screen and also update the details to the farmer by connecting GSM using max232 in UART module. The system will make feasible for agriculturist in the modern environment. Fig 2 shows the block diagram for monitoring corn growth.

 

**Fig 1 Stages of Corn Plant Growth**

The Architectural model is developed to monitor the corn growth in the farm. The ARM LPC2148 Microcontroller is a low cost RISC processor with multiple features. When the 5v power supply is given to the ARM LPC2148 Microcontroller, the sensors which are attached to the controller start sensing the corn farmland. The Temperature sensor will perceives the soil temperature in the corn field. If the temperature is high, then intimate to the cultivator through mobile phone SMS via GSM. The humidity sensor will sense the soil moisture level and automatically turn ON the DC motor when the water level in the farm is low.

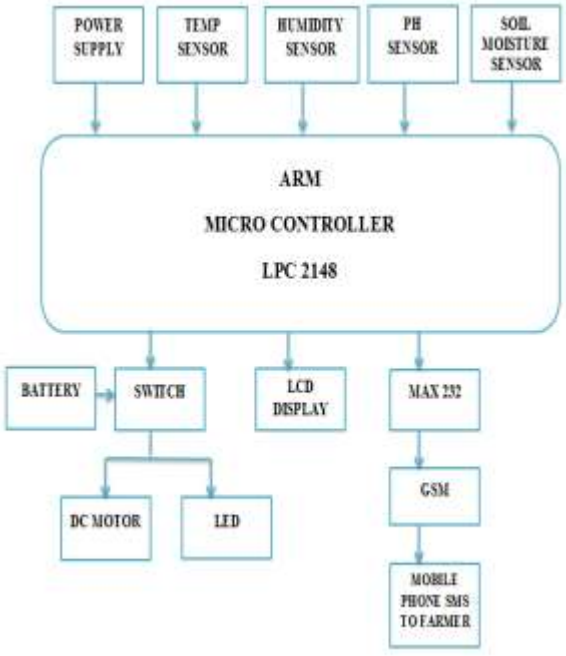


**Fig 2 Block Diagram for Monitoring Corn Growth**

The DC motor will run on battery supply from the solar cell panel and LED will also glow when the DC motor runs. The water level sensor will sense the water level in the farm aloft or not, if it exceeds then automatically switch OFF the DC motor. The solar cell arrangement is designed based on the amount of power required to run the DC motor. The Soil Moisture sensor will detect the humidity level of the soil. The LCD display will shows the messages about corn grown in cultivated land. The max232 is used to connect the GSM to the ARM LPC2148 Microcontroller in UART module. The mobile phone SIM should be registered for sending messages to the cultivator. By using the messages displayed on the cultivator's phone, the corn field situation will periodically know. If any upsurge changes occur, it will inform the cultivator through GSM.

## III. Simulation Overview Of Maize Monitoring

### A. *Introduction to MATLAB*

MATLAB is abbreviated as matrix laboratory is a multi-paradigm numerical computing environment and fourth-generation programming language. A proprietary programming language is developed by the Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with the programs written in other languages such as C, C++, Java, Fortran and Python. Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing abilities.

### B. *PROTEUS*

PROTEUS is Processor for Text Easy to Use simulation tool for embedded microcontroller. The main features are being fully functional and procedural programming function. It has clear and comprehensible syntax. PROTEUS is easy to use, efficient, complete, and readable. C/C++ language is mostly used in the PROTEUS software. The advantages of PROTEUS is powerful string manipulation, comprehensibility of Proteus scripts, availability of arrays, AVL trees etc. In this paper PROTEOUS 8 version is used.

### C. *MPLAB IDE*

MPLAB IDE is the integrated development environment. The MPLAB IDE software runs the program on the windows operating system. It is used for developing the application for microchip microcontrollers and digital signal controllers. MPLAB provides a single integrated 'environment' is used to develop the code for embedded microcontroller. So it is called as an The features of MPLAB are comprehensive editor, project manager and design desktop. It is used for application development of embedded designs using Microchip PIC MCUs and ds PIC DSCs. The HI-TECH C compiler is used to build the embedded c coding in the MPLAB software.

### D. *Simulation Output*

The Simulation output for corn plant farmland monitoring system is shown below. Fig 3 schematic shows the MATLAB simulation output screen1for proposed method and also will display monitoring status in the LCD screen. The water level in the farmland is detected by water level sensor and humidity sensor. If the water level is low, the DC motor is starts running with the help of solar power supply. The Fig 4 shows MATLAB simulation output screen2 for proposed method and also shows the schematic output for running DC motor during fewer water levels in the farmland.

 

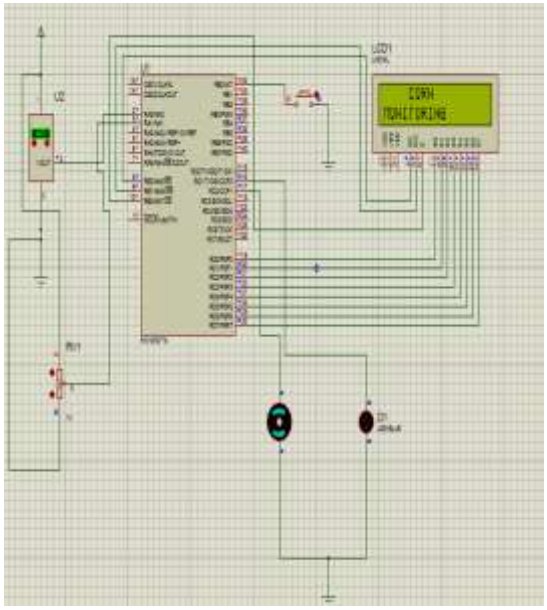

**Fig 3 MATLAB Simulation Output Screen1for Proposed Method**

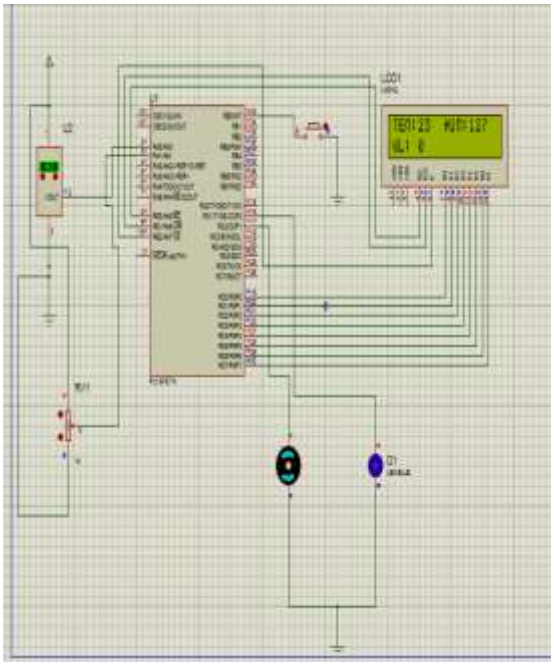

**Fig 4 MATLAB Simulation Output Screen2 for Proposed Method**

## IV. HARDWARE IMPLEMENTATION OF MAIZE MONITORING

### A. *ARM Microcontroller LPC2418*

The LPC2148 micro-controllers are based on a 32/16 bit ARM7TDMI-S CPU core. They have real-time emulation and embedded trace support, which combines the micro-controller with embedded high speed flash memory of 512 KB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode 16bit instruction set reduces code by more than 30 % with minimal performance penalty.

Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement, such as access control systems and point-of-sale systems. It has serial communications interfaces ranging from a USB 2.0 Full Speed device, multiple UARTS, SPI, and SSP to I2Cs. It has on-chip SRAM of 8 KB up to 40 KB. This makes these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power.

ARMv6 processors represented a step up in performance from standard ARMv5 cores, and are used in some cases, but Cortex processors now provide faster and more power-efficient options than all those previous generations. ARM provides a summary of the numerous vendors who implement ARM cores in their design. KEIL also provides a somewhat newer summary of vendors of ARM based processors. ARM further provides a chart displaying an overview of the ARM processor line up with performance and functionality versus capabilities for the more recent ARM7, ARM9, ARM11, Cortex-M, Cortex-R and Cortex-A device families. Fig 5 shows ARM LPC 2148 pin diagram.

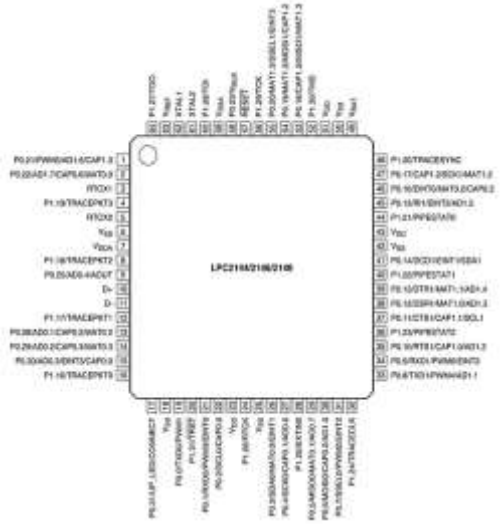

**Fig 5 ARM LPC 2148 Pin Diagram**

The Features of ARM LPC 2148 are as follows,

- 16/32-bit ARM7TDMI-S microcontroller.
- In-System/In-Application Programming (ISP/IAP) via on-chip boot-loader software.
- Single 10-bit D/A converter provide variable analog output.
- Two 32-bit timers/external events counters with four capture and four compare channels each, PWM unit six outputs and watchdog.
- Low power real-time clock with independent power and dedicated 32 kHz clock input
- Vectored interrupt controller with configurable priorities and vector addresses.
- Up to nine edge or level sensitive external interrupt pins available.

 

**B. *Temperature Sensor***

The LM35 series are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. Thus, the LM35 has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. TheLM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°cover a full −55°C to +150°C temperature range. Table 1 shows LM35 sensor details.

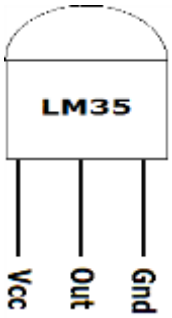


**Fig 6 Pin Diagram of LM35**

| Parameter | LM35 |
|---|---|
| Local Sensor Accuracy | 0.5 |
| Minimum Supply Voltage | 4 |
| Maximum Supply Voltage | 30 |
| Maximum Supply Current | 114 |
| Sensor Gain | 10 |
| Output Impedance | 0.4 |
| Interface | Analog Output |

**Table 1 LM35 Sensor Details**

The LM35D is also available in an 8-lead surface-mount small outline package and a plastic TO-220 package. Figure 6 shows the pin diagram of the LM35.

**1) *Features:***

- Linear + 10 mV/°C Scale Factor
- 0.5°C Ensured Accuracy (at +25°C)
- Rated for Full −55 +150°C Range
- Suitable for Remote Applications.
- Low Cost Due to Wafer-Level Trimming
- Operates from 4 to 30 V
- Less than 60-µA Current Drain
- Low Self-Heating, 0.08°C in Still Air.

C. *Humidity Sensor*

The humidity sensor will find the water content in the soil responsible for the soil moisture. Fig 7 shows the humidity sensor. In the corn farmland, the humidity of the soil should be maintained by using humidity sensor. Based on the humidity of the soil, it will turn ON or OFF the DC motor. It will help the cultivator for producing the good quality corn.

**Fig 7 Humidity Sensor**

**1) *Features:***

- Full interchange ability with no calibration required in standard conditions
- Instantaneous desaturation after long periods in saturation phase
- Compatible with automatized assembly processes, including wave soldering, reflow and water immersion
- High reliability and long term stability
- Patented solid polymer structure
- Suitable for linear voltage or frequency output circuitry
- Fast response time
- Individual marking for compliance to stringent traceability requirements

**D. *Soil Moisture Sensor***

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

**Fig 8 Soil Moisture Sensor**

The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners. Soil moisture sensors typically refer to sensors that

 

estimate volumetric water content. Another class of sensors measure another property of moisture in soils called water potential these sensors are usually referred to as soil water potential sensors and include densitometers and gypsum blocks. Fig 8 shows the soil moisture sensor.

**E.** ***Soil PH Sensor***

The Soil pH is an expression for the acidity of water or other solution. The pH value of the matrix of the cannabis plant is important in breeding. The cannabis plant grows best at a pH value of 5.8 to 6. With this meter it can check the pH value and if necessary, adjust the pH value by adding nutrients. When using the pH meter is important that the metal pin is in wet soil for 3/4. The needle will display the pH value after 60 seconds. This pH meter works without batteries and is very easy to use however the pH meter is not very accurate but rather gives an indication.

Acids and alkalis are simply chemicals that dissolve in water to form ions atoms with too many or too few electrons. An acid dissolves in water to form positively charged hydrogen ions $H^+$, with a strong acid forming more hydrogen ions than a weak one. An alkali or base dissolves in water to form negatively charged hydroxide ions $OH^-$. Again, stronger alkalis which can burn you as much as strong acids form more of those ions than weaker ones.

**F.** ***LCD***

LCD screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. Figure 9 shows the LCD 16x2 display. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

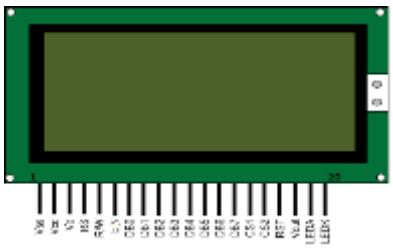

**Fig 9 LCD Display**

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.

1) Features:

- 5 x 8 dots with cursor.
- Built-in controller.
- + 5V power supply.
- 1/16 duty cycle.
- B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K.
- + 3V power supply.

**G.** ***GSM Modem***

A GSM Modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone. When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. Fig 10 shows the GSM modem model.

**Fig 10 GSM Modem**

GSM modem could also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port or USB port on your computer. Note that not all mobile phones support this modem interface. A One of the key features of GSM is the Subscriber Identity Module, commonly known as a SIM card. The SIM is a detachable smart card containing the user's subscription information and phone book. This allows the user to retain his or her information after switching handsets. Alternatively, the user can also change operators while retaining the handset simply by changing the SIM. Some operators will block this by allowing the phone to use only a single SIM, or only a SIM issued by them; this practice is known as SIM locking.

**H.** ***RS232***

Serial communication is a way enables different equipment's to communicate with their outside world. It is called serial because the data bits will be sent in a serial way over a single line. RS-232 is a standard communication protocol for linking computer and its peripheral devices to allow serial data exchange. In simple terms RS232 defines the voltage for the path used for data exchange between the devices. It specifies common voltage and signal level, common pin wire configuration and minimum, amount of control signals

As mentioned above this standard was designed with specification for electromechanically teletypewriter and modem system and did not define elements such as character encoding, framing of characters, error detection protocols etc. That is essential features when data transfer takes place between a computer and a printer. Without which it could not be adopted to transfer data between a computer and a printer.

 

**I. *DC Motor***

The DC motor is used to watering the corn farm. The DC motor converts electrical energy into the mechanical energy. Here, the DC motor operates based on the commands from the humidity sensor and water level sensor in the corn farmland. The speed of the DC motor is maintained by voltage applied to it. Fig 11 shows the DC Motor model.

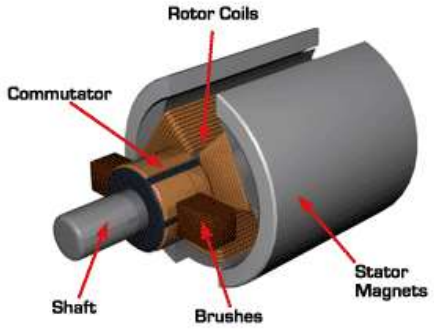


**Fig 11 DC Motor**

Fig 5.14 shows the DC motor model. The Relay will act as a switch for operating DC motor in ON or OFF condition for supplying the water to the corn field. The Relay has the coil, when the current is flowing in the coil and it creates the magnetic field and attracts the lever, which in turn causes the switch ON or OFF state.

**J. *Hardware Setup***

The following Fig 12 shows the hardware setup of maize farmland monitoring with ARM Microcontroller with WSN.

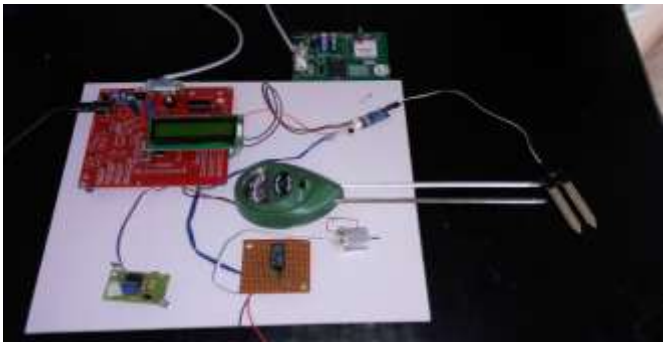

**Fig 12 Hardware Setup of Maize Monitoring**

Whenever the hardware is connected to the power supply the LCD shows the following Fig 13. It is initial screen shot of Maize farmland monitoring with ARM Microcontroller with WSN.

**Fig 13 Maize Monitoring System**

When the temperature sensor will find the intensity of the air exceeds the 2.5v, it will automatically send the information to the farmer using GSM Message.

**Fig 14 LCD display of High Temperature**

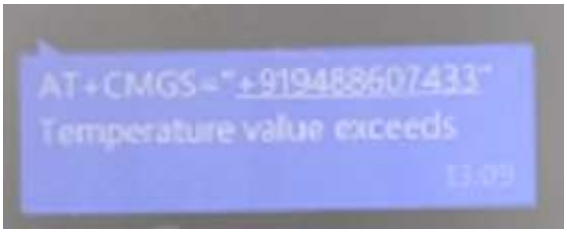


**Fig 15 SMS Intimation of High Temperature**

Fig 14 shows the LCD display of high temperature indication and Fig 15 shows the SMS intimation of high temperature message to the farmer.

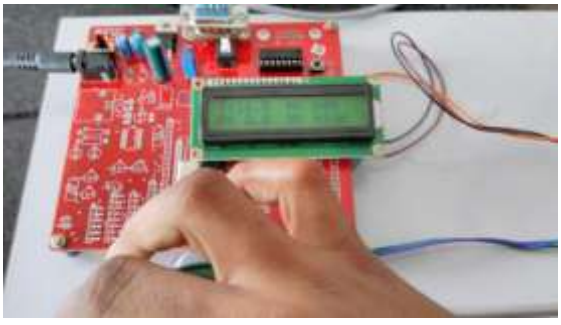

**Fig 16 LCD display of High Humidity**

The humidity sensor will find the humidity level of the air. If it decreased or exceeds the 2.5V, it will automatically send the information to the farmer using GSM Message. Fig 16 shows

 

the LCD display of high humidity indication and Fig 17 shows the SMS intimation of humidity level to the farmer.

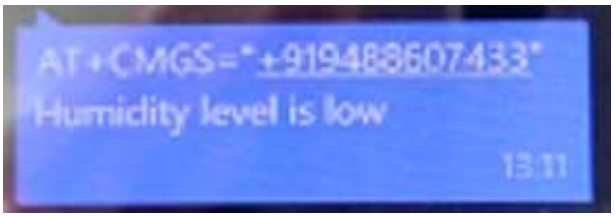


**Fig 17 SMS Intimation of Humidity Level**

The soil moisture sensor will sense the moisture level of the soil. The moisture level is always high shown in Fig 18.

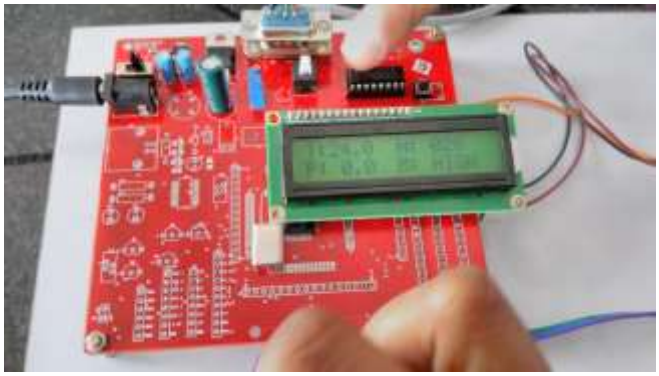

**Fig 18 LCD display of High Moisture**

**Fig 19 DC Motor Rotation**

If the moisture level becomes low it will automatically switch ON the DC motor shown in Fig 19

## V. Conclusion

The hardware work of proposed system has been completed. In the existing system, the corn was continuously monitored using manual work. In the proposed system, the maize was continuously monitored by ARM Microcontroller LPC2148 using different types of sensor with the help of Wireless Sensor Network. The temperature sensor will measure the intensity level of the air. If the level of the temperature exceeds the 2.5V, it will intimate the information to the farmer using GSM module. The PH sensor will measure the PH level of the soil. If the level of the PH exceeds the 2.5V, it will intimate the information to the farmer using GSM module. The Humidity sensor will measure the humidity level of the air. If the level of the Humidity exceeds the 2.5V, it will intimate the information to the farmer using GSM module. The soil moisture sensor will compute the moisture level in the soil, if the level decrease below 2.5V, then it automatically switches ON the DC motor. If the level of the Soil moisture exceeds the 2.5V, it will intimate the information to the farmer using GSM module. Thus the system will monitor the maize plant more efficiently with the help of WSN. The hardware and simulation outputs can be already shown in the hardware setup part. Thus the simulation part and hardware part of the maize monitoring works more efficiently than the existing system.

## VI. Scope Of The Future Work

The upsurge increase in the technological and scientific innovation makes advancement in agricultural field. But in practice, cultivator has to put too much effort in the farmland. In order to overcome these difficulties, the following improvement can be added in future.
The improvements are,

- Advanced Microprocessor can be used to improve the efficient monitoring system.
- By adding different sensors for improving the productivity of the corn plant.
- The system can be implemented for different types of plants such as wheat, rice, banana etc.,

## References

[1] P.S.Sathish, B.Chellaprabha "*Monitoring the Plant Growth Using Sensor Network*" ARPN Journal of Engineering and Applied Science VOL 10, NO 7, APRIL 2015 ISSN 1819-6608

[2] A. Ahamed Meeran, Mydeen, A. Balasubramanian, V. Mahalakshmi, P. K. Dhal, "*Observation and Cloud Storage of Crop Leaf Area Index Using Wireless Sensor Network*" International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 5, Issue 4, April 2015)

[3] Patil Kalika Milind, P.C.Bhaskar, "*Microcontroller Based Adaptive Irrigation System Using WSN for Variety Crops and Development of Insect Avoidance System for Better Yield*" IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308 Volume: 03 Issue: 07 | Jul-2014

[4] Anil Kakran Rita Mahajan, "*Monitoring Growth of Wheat Crop Using Digital Image Processing*" International Journal of Computer Applications (0975 –8887) Volume 50 –No.10, July 2012

[5] Kshitij Shinghal, Dr. Arti Noor,Dr. Neelam Srivastava, Dr. Raghuvir Singh, "*Intelligent Humidity Sensor For - Wireless Sensor Network Agricultural Application*" International Journal of Wireless & Mobile Networks (IJWMN) Vol. 3, No. 1, February 2011

[6] Dr. K.Srinivasa Ravi, K.Tapaswi, B.Lokesh, G.Sai Krishna, "*Smart Sensor System for Agricultural Chronology*" K. Srinivasa Ravi et al / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 2 (6) , 2011, 2650-2658.

[7] D. S. Shrestha, B. L. Steward, "*Automatic Corn Plant Population Measurement Using Machine Vision*" Vol. 46(2): 559–565 Transactions of the ASAE E 2003 American Society of Agricultural Engineers ISSN 0001–2351 ASAE in December 2002

 

## BIOGRAPHIES

T.Gayathri was born in Trichy, Tamilnadu, India on 15-11-1992. She received the bachelor degree in electronics and communication engineering from the Agni College of Technology, Chennai, Tamilnadu, India, in 2014. She is now doing M.E., degree in Embedded System Technologies from Kongunadu College of Engineering and Technology, Trichy, Tamilnadu, India.

K.Boomidevi was born in Chennai, Tamilnadu, India. She received the bachelor degree in electronics and communication engineering from the Vel Tech, Chennai, Tamilnadu, India, in 2014. She is now doing M.E., degree in Embedded System Technologies from Kongunadu College of Engineering and Technology, Trichy, Tamilnadu, India.

S. Ragul was born in Namakkal, Tamilnadu, India on 14-04-1988. He received the M.E., degree in power electronics and drives from Anna University, Chennai, Tamilnadu, India, in 2012, respectively. He is now working as an Assistant Professor in the department of Electrical and Electronics Engineering at Kongunadu College of Engineering and Technology, Trichy. He is published his research work in various National/ International journals and Conference. His teaching and research areas include Electrical Machines, Fault Diagnosis, Intelligent Techniques, Power Electronics and Drives and Machine Design. Mr. Ragul is a member of IEEE.

 