RESEARCH ARTICLE

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Implementation of Global System for Mobile Communication-Based Smart Weather Monitoring System for Agricultural Environment

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Abstract

A weather station can be described as an instrument or device, which provides us information about weather in our surrounding environment. For example, it can provide us with details about the surrounding temperature, moisture, humidity, etc. Hence, this device basically senses temperature, moisture, humidity, leaf wetness, etc. There are various types of sensors are used, which measured the above-mentioned parameters. A device for real-time weather monitoring is presented to monitor the real-time temperature, the relative humidity of the atmosphere, leaf wetness of leaf, and moisture of soil via global system for mobile communication (GSM) network, using analog and digital components. The analog outputs of the sensors are connected to a peripheral interface controller (PIC) microcontroller through an analog to digital converter (ADC) for digital signal conversion. A liquid crystal display (LCD) is also connected to the PIC microcontroller to display the measurements. For analysis and archiving purposes, the data can be transferred over GSM and received by a number of mobile users. The weather monitoring system can either be wired or a wireless one. In the case of wireless communication, the connectivity will be more user-friendly and weather monitoring would not require the physical presence of the person at the remote location.

Keywords: Environmental parameters, Global system for mobile communication (GSM), Liquid crystal display (LCD), PIC microcontroller, Sensors.

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Introduction

Modern agriculture is based on knowledge of different parameters and weather forecasting. Weather forecasting is an application to predict the state of the atmosphere for a given location. Using weather monitoring systems, farmers and agricultural experts could collect information about different weather parameters like temperature, humidity, rainfall, etc., and according to real-time and historical data, they could predict accurate timing for different farming activities. Farmers need to have a well-planned system to cover targeted area, in order to collect weather parameters from arable land and their production fields. On one hand, the station needs to be well equipped with different kinds of sensors and must have the ability to send data to the base station. On the other hand, there are limiting factors, such as, power supply and natural obstacles that need to be solved. Proposed solution is based on the use of temperature sensors, moisture sensors, humidity sensors, and leaf wetness sensors, etc. The proposed station will be equipped with all the sensors that can be used in order to improve agricultural production. Along with the solution, the paper gives an overview of the advantages and problems in the realization of the specific station.

This paper presents PIC16f887a based weather station, advantages, and problems in the realization and use of such station, main conclusions and ideas for future research, etc. The weather station is an electronic system which used to measure the weather parameter like temperature, humidity, moisture, and leaf wetness, etc. Weather condition plays a very important role in various fields, such as, agriculture,

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space science, etc. Nowadays, advanced weather stations around the world are used to monitor weather parameters continuously.

Related Work

This paper is aimed at measuring and acquiring weather data parameters like temperature, pressure, humidity, wind direction, wind speed, and solar radiation at a given site for setting up an astronomical observatory. The proposed weather data acquisition system should be working as an autonomous instrument generating its own power from solar panels and location information, time tags from the GPS. Though general data acquisition systems are available in the market, they may be expensive or very general in acquiring the data. The data will be logged onto a thumb drive which is a plug and play device. This paper concludes that to work on the weather data acquisition system using a master slave configuration of PIC 18 and 16 controllers, respectively, connected using RS 485 for astronomical site survey, and log the data on to a thumb drive along with location coordinates of the place obtained using GPS.[1]

Weather monitoring is of great importance in many domains. It offers information about temperature, pressure, humidity, luminosity, wind speed, and direction which are useful in applications from different domains, such as, agriculture, military, entertainment, etc. Another solution is based on wireless sensor networks. Wireless sensors are dropped or placed in the desired area and they collect and send wirelessly the weather information. Data can be sent by each sensor or can be collected locally and sent by a unique device. This paper presents a weather station made of temperature, humidity, pressure, and luminosity sensors embedded in a microcontroller-based board. The station is controlled through the SMS service of mobile phones. The paper has presented a weather station consisting of temperature, humidity, pressure and luminosity sensors, a microcontroller, and a GSM module. The station can be controlled through a mobile phone with SMS service.[2]

Weather station is a facility with instruments and equipment to observe the physical condition of the atmosphere at a location or region at a given moment or in the short-term periods (daily maximum). To that end, the existence of a weather monitoring station is needed in order to obtain data, so that data can be real-time weather data, then the system must be able to work continuously and transmit data from sensors online to the weather monitoring station. The basic components of the system monitoring weather station in Figure 1 are used to build these monitoring stations. This research attempted to develop a remote terminal unit (RTU) of mini weather monitoring station. This is in line with the increasing need for weather station application development in various fields, especially with the phenomenon of climate change. Some of the areas that require weather stations application include agriculture, aviation, and early warning system.[3]

The proposal of this design is based mainly on the measurement of temperature, humidity, wind, ultra violet (UV) radiation, and rain parameters using low-cost commercial sensors compatible with the Arduino platform. These equipment and most commercial stations use batteries and solar panels to have the data transmission fluid with full security and autonomy for the data transmission screen, shown on the LCD, and sensors for more than 12 months. All information and data collected will be available only where GSM network coverage exists and through a text message the data received will be sent to any type of mobile operator. In this article, we propose the design and implementation of a weather station platform based on sensors. Moreover, low power and the calibration of all sensors may be performed in order to be used for longer periods of time with the same batteries and to obtain the error of measurements.[4]

Smart farming is a way to do agriculture by precisely managing the inputs based on variation of field parameters. Low cost and efficient weather stations are always preferred by the farmers. Hence, it is important to study the weather parameters recorded by the stations to understand its limitations and to improve its efficiency. Only the reliable data are helpful for farmers to make a decision, for example, when to start planting, when to harvest, when to water plants and by how much, when each phenology state will occur, etc. In this work, the MySQL database was used as a database management system. The data from every node were stored in tabular form. To prevent the problem due to a large amount of data that affects the speed of data acquiring, the selecting table module was added to Python code to manage the data of each node. After the period of data collection, all information on weather data was exported as a text file and further analyzed with third-party program. The low-cost reliable microclimate weather station called cloud-based station was successfully designed, fabricated, and installed in an Edamame farm.[5]

To monitor the greenhouse parameters, like humidity, temperature, soil moisture, and light properly, a control system is needed. This control system is comprised of greenhouse data acquisition PIC microcontroller along with temperature, humidity, light, and pH sensor. For monitoring and storing the values of these environmental parameters PIC18F452 based circuit is used. Based on the values stored, the above system will compare the stored values with threshold values set for a particular plant and control the actions of cooler, heater, and water pump. Greenhouse monitoring and control software can collect, display, and record the collected data, i.e., values of various parameters, also can control greenhouse environment. In addition to this, the system also consists of solar inverter for backup. For displaying the stored values, we have used liquid crystal display. This system is very useful for proper cultivation and the maximum yield of crops.[6]

Many organizations, scientific institutions, and government agencies are installing monitoring stations to monitor weather data and tides data as raw data for weather forecasts. Weather monitoring system can either be wired

or a wireless one. Just in case of wireless communication, the connectivity will be more user friendly and weather monitoring would not require physical presence of the person at the remote location. Wireless communication is the transfer of information over a distance without the use of wires. The distances involved may be long. GSM module is the cheapest and the most convenient technology now being used for wireless communication. The wireless weather system fundamentally requires few basic modules, such as, GSM module, sensors, and microcontroller module, display module. The Vaisala Weather Transmitter WXT520 measures barometric pressure, humidity, precipitation, temperature, and wind speed and direction. To measure wind speed and direction, the WXT520 has the Vaisala WINDCAP® sensor that uses ultrasound to determine horizontal wind speed and direction. The WXT520 is immune to flooding clogging, wetting, and evaporation losses in the rain measurement. In this project work, we have studied existing system and working on this module using a peripheral interface controller. This work includes the study of sensor (WXT520) and data logger (GEUONICA cm 3000C series).[7]

By creating a global network of weather forecasting infrastructure, rural and developing communities may be able to receive more accurate forecasts, allowing communities to have enough time to adequately prepare for extreme weather events. The purpose of this research was to construct an inexpensive weather forecasting infrastructure that would allow citizens and government officials to be notified and prepare for extreme weather events. After conducting a one-month testing period which consisted of a two-week preliminary period and subsequent two-week forecasting period, it can be concluded through this system was effective in accurately recording data and forecasting in the short term, it was not able to correctly forecast long term weather condition.[8]

Proposed Work

Block Diagram of System

Figure 1 shows the block diagram of weather monitoring system by using PIC microcontroller, sensors, and GSM network. The main controlling operation takes place by using PIC Microcontroller, which is interfaced with different input and output devices which are briefly explained in the following ways,

Input Device

As shown in Figure 1, different types of input devices are connected to PIC Microcontroller, such as, temperature sensor, humidity sensor, moisture sensor, and leaf wetness sensor.

Temperature Sensor

As shown in Figure 1, temperature sensor is used to measure the temperature.

Humidity Sensor

As shown in Figure 1, humidity sensor is used to detect both moisture and air temperature.

Moisture Sensor

As shown in Figure 1, moisture sensor is used to measure the water content of the soil.

Leaf Wetness Sensor

As shown in Figure 1, leaf wetness sensor is used to study the effects of metered vegetative wetting and detect the presence of surface moisture on leaves.

Output Device

As shown in Figure 1, some different type of output devices are connected to PIC Microcontroller, such as, LCD and GSM which is explained in detail below.

Liquid Crystal Display (LCD)

The main principle behind liquid crystal molecules is that when an electric current is applied to them, they tend to untwist. This causes a change in the light angle passing through them. This causes a change in the angle of the top polarizing filter with respect to it. So little light is allowed to pass through that particular area of LCD. Thus, that area becomes darker comparing to others. We always use devices which are made up of LCD, like computer, digital watches, and also DVD and CD players. They have become very popular and have taken giant leaps in the screen industry by replacing the use of cathode ray tubes (CRT). CRT use more power than LCD and are also bigger heavier.

GSM Network

GSM stands for global system for mobile communication. Today, GSM is used by more than 800 million users across 190 countries. In GSM, geographical area is divided into hexagonal cells whose side depends upon power of transmitter and load on transmitter (number of end-user). At the center of the cell, there is a base station consisting of a transceiver (a combination of transmitter and receiver) and an antenna. Base station is placed at the center of cell.

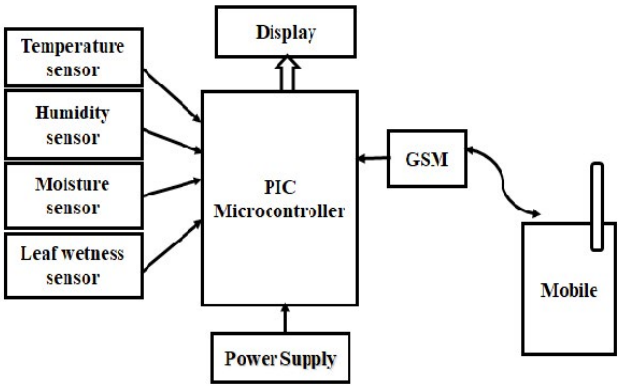

Figure 1: Proposed block diagram

System Description

The weather monitoring system is divided into two sections, i.e., transmitter section and receiver section. Transmitter section consists of the input sensor circuit, the microcontroller unit, display system, and GSM module. The sensor circuit contains four sensors, i.e., temperature sensor, humidity sensor, leaf wetness sensor, and moisture sensor. Some sensors sense the environmental conditions or parameters and provide analog output, which is converted to digital form using ADC channel of the controller and another sensor provides digital output, which is next processed to get temperature and humidity.

Those measured input parameters will be displayed using display system, i.e., LCD. As shown in above block diagram of the overall receiver system is shown in Figure X. Receiver section consists of our mobile. All the parameter's readings coming from weather station to our mobile. In this system, central part, i.e., microcontroller processing unit is the heart of our system. We will be interfacing the different types of sensors, GSM module, and LCD with PIC microcontroller.

In this project, the sensor will sense the weather condition and this sensed data acts as information to mobile users. We will interface temperature sensor, humidity sensor, moisture sensor, and rainfall sensor to sense temperature, humidity, moist in air and rainfall. This reading will be converted to appropriate data and then send to our mobile users through GSM. At a time, we can see this data on the LCD. This data acts as a guide for the farmer and the farmer can easily understand required sprays for the farm.

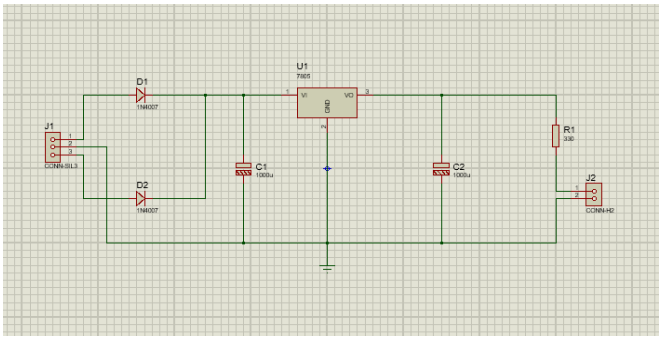

Figure 2: Center tapped full-wave power supply

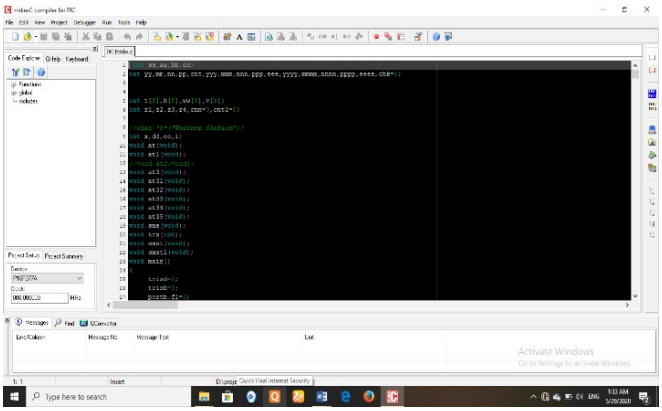

Figure 3: Use of Micro C software

Result of Proposed Work

As shown in Figure 2, design center-tapped full-wave power supply for +5 volts using IC 7805 regulator.

Micro C software has inbuilt commands, so it is easy to write programs as shown in Figure 3. Length of program is less as compare to other programming software, and using this software, we can easily find errors.

Figure 4 represents design of LED blinking. LED D1 connected to PIC microcontroller and LED blink for 1,000 ms delay.

16 × 2 LCD display is connected to PIC microcontroller for the purpose of displaying messages and parameters as shown in Figure 5.

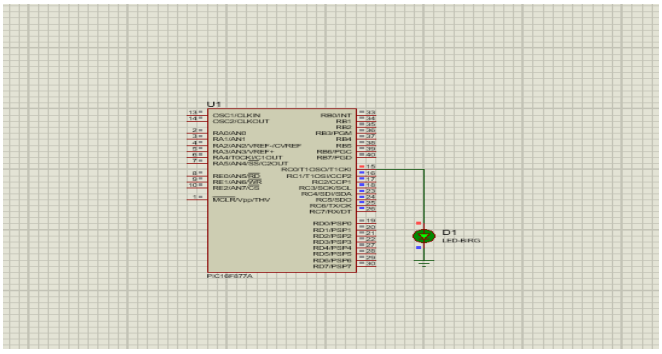

Figure 4: LED programs

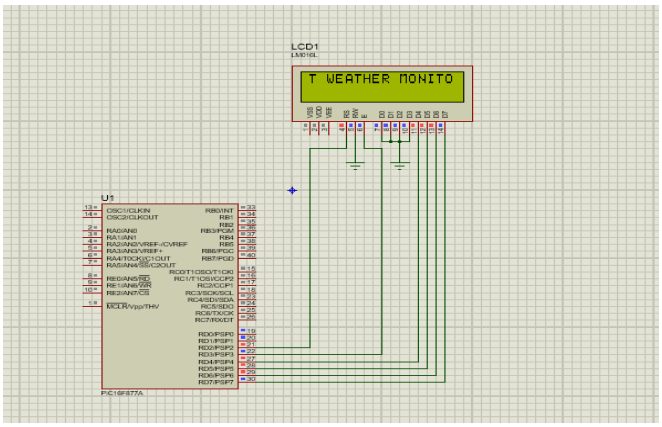

Figure 5: Proteus design of LCD

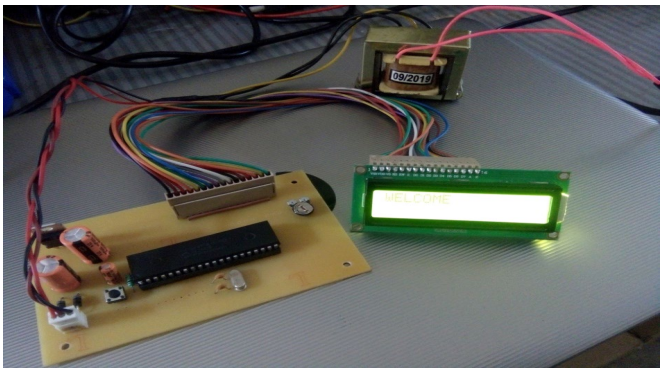

Figure 6: Design and mounting power supply and LCD on PCB board

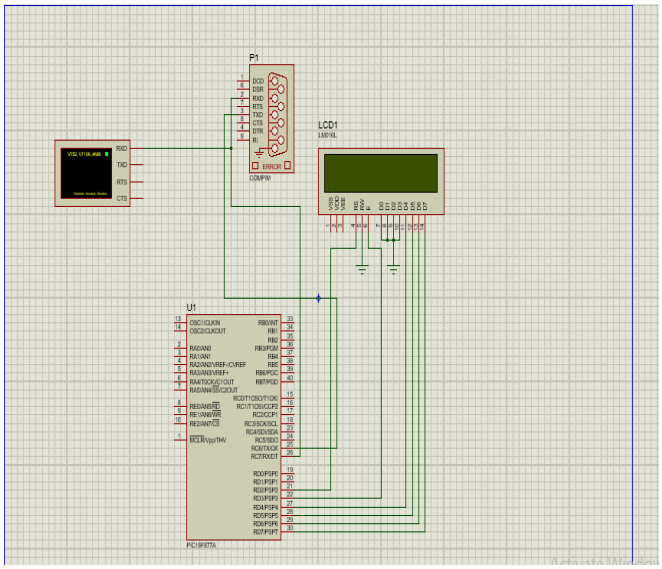

Figure 7: Check connection on hyper terminal

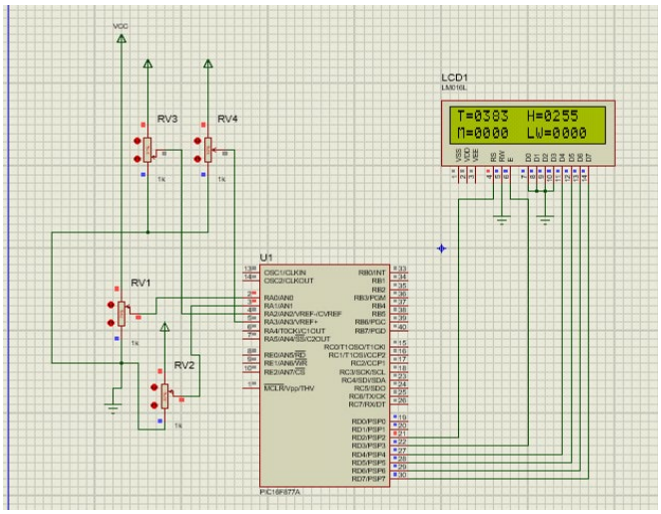

Figure 8: Read data from sensors and ADC

Table 1: AT commands

Command	*Description*	*Response*
AT	Checking communication	Ok
AT+CMGF= <index> index- 0:PDU 1: Text	Command for select message format	Ok
AT+CNMI= 1,2,0,0,0	Command for message indication	Ok
AT+CMGS= "9075xxxxxx"	Send message	>"Type message here" press 'ctrl+z' to send the msg after end msg or 'ESC' to exit without sending Ok

The PIC microcontroller and LCD operate on +5 volt. If we switch on the supply, the program is executed which is burned in integrated circuit (IC), and we got output on LCD as shown in Figure 6.

Study "At Commands"

GSM system use the above AT commands for further communications as shown in Table 1.

As shown in Figure 7, the hyper terminal is an application, in which if we write AT commands and message, then message is sent to mobile user, after pressing Ctrl+Z.

In this design, we send four different parameters from four different sensors and this sensed data send to PIC 16F877A. PIC 16F877A has internal ADC for conversion of analog data to digital data, and this digital data display on LCD as shown in Figure 8.

Flowchart

Below flowchart as shown in Figure 9, is a graphical representation of the working of our system. We can easily

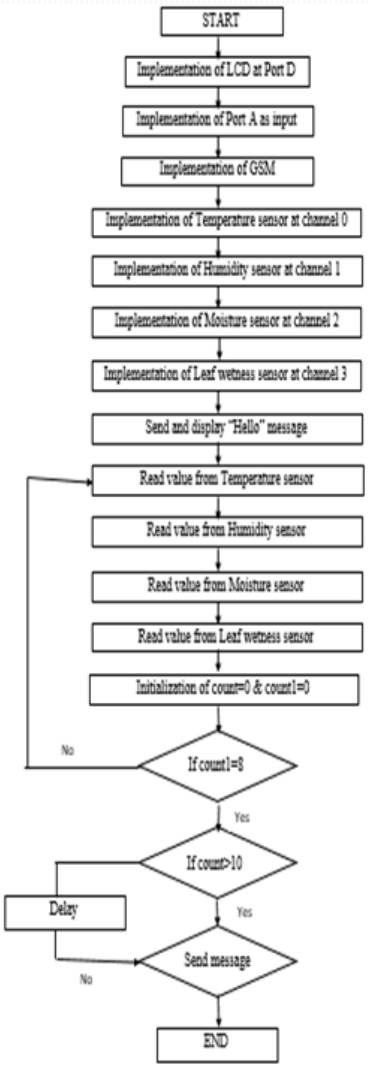

Figure 9: Flowchart

Table 2: Parameters of various crops

Plant	*Temp. (°C)*	*Leaf wetness*	*Soil moisture (%)*	*Humidity (%)*
Cotton	26	2 h d^{-1}	65	80
Rice	29	12 h d^{-1}	80	90
Rose	30	11 h d^{-1}	58	50
Sugarcane	38	4 h d^{-1}	72	63
Tomato	26	12.1 h d^{-1}	65	65
Onion	24	8 h d^{-1}	55	25

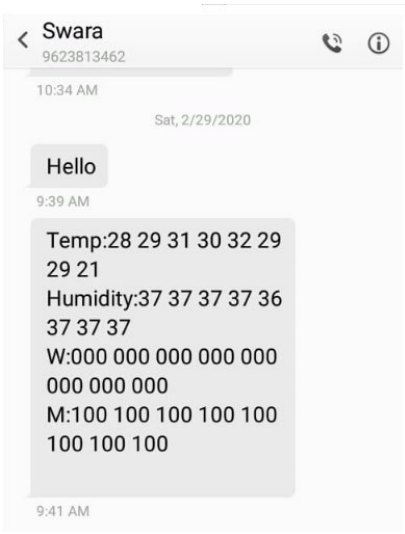

Figure 10: Output reading

analyze system performance. If any error occurs in the system, then we can easily found that error using a flowchart. There are two conditions of the counter. According to true or false, the system performs (Dias B.L., 2020).

Parameters for Various Type of Crops

Measured parameters for various type of crops as shown in Table 2.

Output Readings to Mobile Users

Global system for mobile communication sent measured data to number of mobile users through text message as shown in Figure 10.

Conclusion

From this, we conclude that we can measure different weather parameters using different sensors, and this system acts as an adviser for farmers to perform different activities of the farm. This system sends this measured data to a number of users at a time and also anywhere in the world using GSM network. This system gives alerts of various parameters on mobile on a timely basis. Based on the received data, the prediction of various diseases can be done in advance, to increase productivity, and reduce product cost. But this system cannot be used when powered off. Further improvement of the system can be achieved by adding different sensors that measure the amount of rainfall received, wind direction, and speed. The system can also be improved by making the system web-based so that it can be online from anywhere in the world and we can add batteries and solar panels, so that design allows being powered by batteries rechargeable by solar energy and used in the failure of power.

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