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Implementation of IoT based Smart Warehouse Monitoring System

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***Abstract*—Fruits and vegetables are indispensable part of peoples life. Thus, fruit warehousing in appropriate manner is essential in order to meet the growing demands.The ware- housing time and quality of the fruits are greatly influenced by the warehousing environment factors. Therefore, it has crucial significance for the fruit warehousing environment to carry out multiparameter monitoring and analyze the parameters collected and then make the regulation and control. Currently this paper presents the environmental factors effected on the fruits warehousing quality and traditional means of protection and proposes a multi-parameter monitoring system based on WiFi. In addition, it designs the hardware structure of the system monitoring node, describing in detail the function of various interfaces and sensors and analyzing the fruits warehousing monitoring system structure based on WiFi, working process and software design. This paper provides a more practical solution for fruits warehousing monitoring and control.**

Index Terms:- IOT ,UART,light sensor(LDR),MATLAB.

I. INTRODUCTION

Over several past decades there existed a lot of traditional methods for the purpose of storing fruits and vegetables which required a lot of manual approach every now and then which is time-consuming and inefficient. Another drawback with the traditional warehouse setups is that there was no prominence for multi-parameter monitoring. Its so important to maintain optimal storage conditions for fruit and vegetables so as to protect crops against loss of moisture, aging and decay. Therefore, there is an urgent requirement of a warehouse environment monitoring and control information system in- cluding the characteristics of low price, easy to use, precisely measurement, remote auto monitoring, etc. [2].It has crucial significance for the fruit warehousing environment to carry out multi-parameter monitoring and analyze the parameters collected and then make the regulation and control. However, at present, the method for fruits warehousing environment monitoring mainly depends on watching thermometer and humidity meter manually. Moreover, they use the simple environmental monitoring system to capture local temperature and humidity, or by simple wired environment monitoring system to capture the parameters information, rarely able to do much space, multi-parameter monitoring In order to achieve well-organized planning of warehouses in an easy way, we are presenting the idea of setting up a Warehouse which is based on IoT.

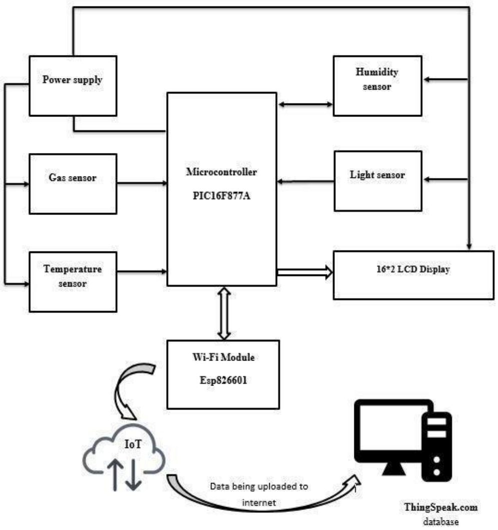

Fig. 1. System architecture of Warehouse monitoring system

II. SYSTEM ARCHITECTURE

The Figure 1. pretty much reveals the complete connection between the functional components of the project setup. Each component is supplied a regulated power supply for them to operate in co-ordination with each other. The microcontroller PIC16F877A has got its built-in ADC to convert the physical parameter values collected in real-time by the sensor network into digital ones which are then transmitted to the internet over AP (access point) provided to the WiFi module. The monitor- ing network consists of a web based database server and all of other warehouse environment monitor system. The client can access through internet to get the state or the real-time parameter of the warehouse and make appropriate changes in accordance with the changing warehouse environment Our model uses low cost device components which make it up to an affordable warehouse setup. The model mainly consists of PIC16F877A microcontroller which is the heart of the system. The IoT functioning of the system is well managed by the low- cost, highly efficient WiFi module ESP826601. There are 4 sensors viz., temperature sensor (LM35), light sensor(LDR), Humidity sensor(DHT11), Gas sensor (MQ6) which are all connected to the PIC microcontroller through which they send the physical parameter values to the ThingSpeak.com server with the help of WiFi module. Later on the data collected at ThingSpeak server can be used to perform various MATLAB analysis,MATLAB visualizations by the analysts to make a difference in the setup in accordance with the changing warehouse environment. According to the applied areas and used sensor types, the more advanced functions for a Data Collection Unit should be developed to satisfy user- friendliness of the system[4].

III. HARDWARE DISCRIPTION

A. Microcontroller PIC16F877A

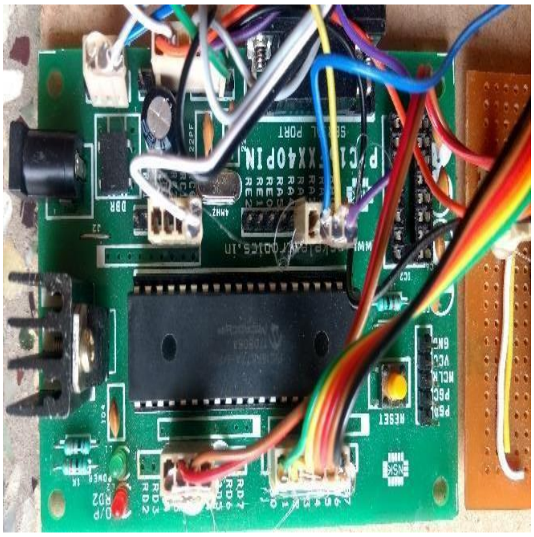

Fig. 2. Top view of PIC16F877A microcontroller

A microcontroller is a small computer on a single integrated circuit which takes control of electrical appliances. Microcon- troller is made up of processing unit, memory unit, interface unit, oscillator unit and interrupt unit. The data from the built-in ADC is given to microcontroller. Then the controller will process this data and send it to the server PC via serial communication using RS-232 protocol. The server PC will then take help of TCP /IP protocol in order to make this data available for the entire client PCs over the internet [3].

B. Wi-Fi module Esp826601

It converts serial information from microcontroller and feeds Wi-Fi router and connects to internet. To communicate with microcontroller it uses 9600 baud rate. It uses TCP/IP protocol to communicate with web server. It has pre-programmed with an AT command set firmware so that we can make the module to perform functions over the internet.

C. Temperature sensor

A temperature sensor is a device, typically a thermocouple or RTD that provides for temperature measurement through an electrical signal. A thermocouple is made from two dissimilar metals that generate electrical voltage in direct proportion to changes in temperature.

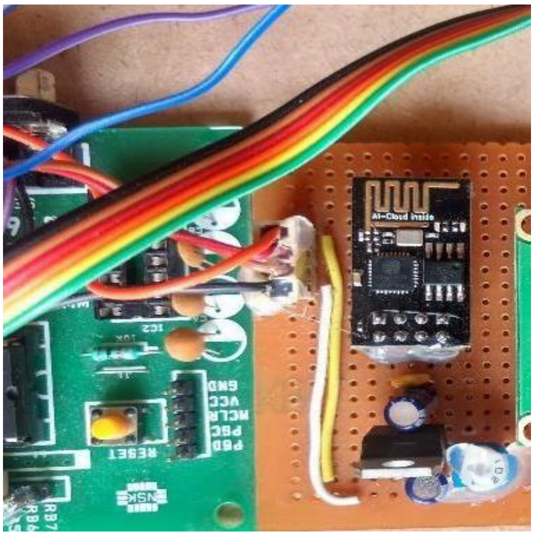

Fig. 3. Top view of ESP826601 WiFi module

D. Humidity sensor

A humidity sensor senses, measures and reports the relative humidity in the air. It therefore measures both moisture and air temperature. Relative humidity is the ratio of actual moisture in the air to the highest amount of moisture that can be held at that air temperature.

E. Gas sensor

Electrochemical sensors or cells are most commonly used in the detection of toxic gases like carbon monoxide, chlorine and nitrogen oxides. They function via electrodes signals when a gas is detected. As detectors measure a specified gas concentration, the sensor response as the referencce Organic respiration consumes oxygen and releases carbon dioxide. High carbon dioxide concentration can make fruit biological damaged. But, the appropriate carbon dioxide concentration can efficiently inhibit the growth of microorganism and benefit for the fruit warehousing [1].

F. Light Dependent Resistor (LDR)

A Light Dependent Resistor (LDR) or a photo resistor is a device whose resistivity is a function of the incident elec- tromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells.

IV. SYTEM FLOW CHART

The model starts its workflow beginning with the boot setup of the code sample overloaded into the PIC microcontroller. The UART connection now establishes a serial communica- tion between the PIC microcontroller and the WiFi module (ESP826601). The device performs a self-test so as to verify whether there is a connection available. Once the device is connected to an available AP (Access Point) soon a display message arrives on LCD screen saying Device Connected. Post the connection of WiFi module to the access point, the

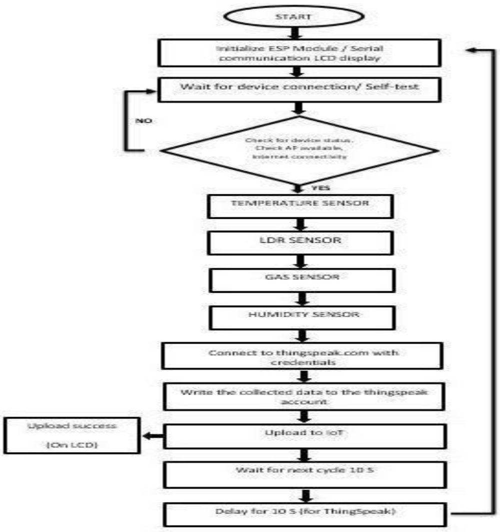

Fig. 4. System flow chart for IOT Warehousing

sensors are all now activated to perform their functions and send the sensed data to the WiFi module with the help of PIC microcontroller. The sensed datas from the sensors are now uploaded to the ThingSpeak.com IoT website which keeps the log of changes in atmospheric parameters of the warehouse. Correspondingly the LCD displays the values sensed by the sensors. And the data uploading process has a delay of 20s. This is because, the controller has a wait time of 10s for the processing of data values and the ThingSpeak.com website requires another 10s to process the incoming data. The processed data can now be used in order to perform either statistical or visual analysis with the help of MATLAB tools over the internet or offline.

V. RESULTS AND IMPLEMENTATION

The physical parameter values sensed from the warehouse environment are now uploaded to ThingSpeak channel. The IoT website has got various features like making available the channel as either private or public, exporting the IoT log file in XML, CSV or JSON formats.

A. Processing and Visualization of data

The incoming data from the IoT to the ThingSpeak channel is now processed in order to perform some statistical analysis or visual graphics in order to give better details of changes atmospherically in any of these 4 parameters viz., temperature, humidity, gas and light intensity.

B. MATLAB Analysis

As mentioned earlier the data collected at the ThingSpeak channel can be used to perform various analysis using MAT- LAB tools. Below is one such visual instance. Here, we make use of this online MATLAB compiler to receive the average humidity value over the past 24 hours from all the collected humidity values.

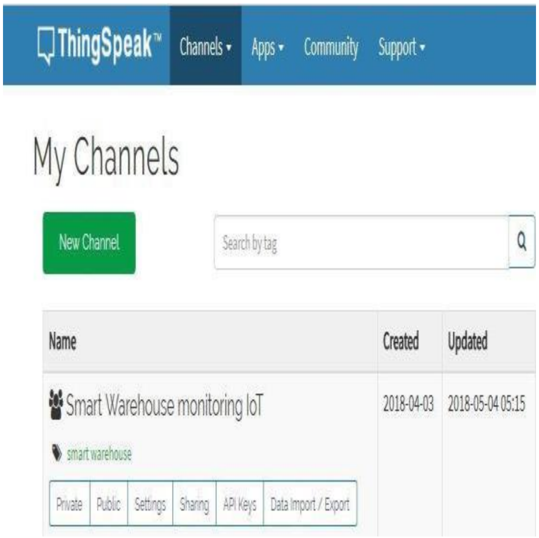

Fig. 5. System flow chart for IOT Warehousing

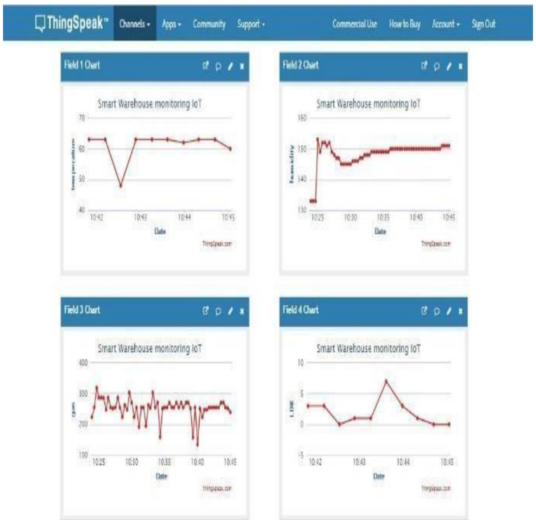

Fig. 6. Visual analytics of the incoming parameter datas

Once, the code is made to Save and Run we get the desirable output.Likewise, there are so many other tools available to analyze the received data values from the sensors.

VI. CONCLUSION

Considering the safe storage of fruits and vegetables which is closely related to our daily life and health, the real time monitoring on fruits warehousing environment promotes the upgrading of warehouse management system, leading to opti- mization of the fruits warehousing environment, guaranteeing the safe storage of fruits and avoiding fruits waste may it be over a short term or a long term thereby avoiding unnecessary economic losses.

VII. FUTURE SCOPE

It is important to highlight that the future scope of this inventory management system is immense in terms of techno-

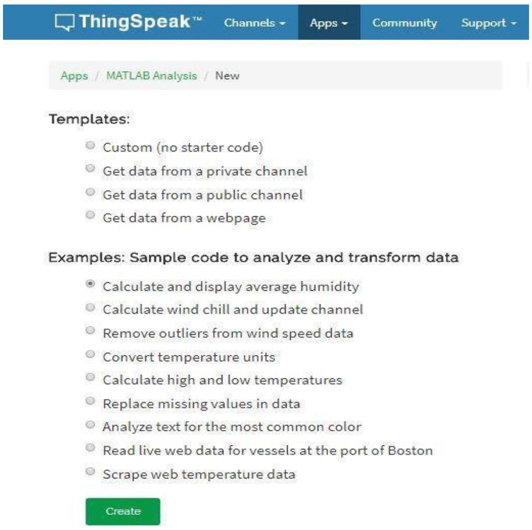

Fig. 7. Making use of Apps online

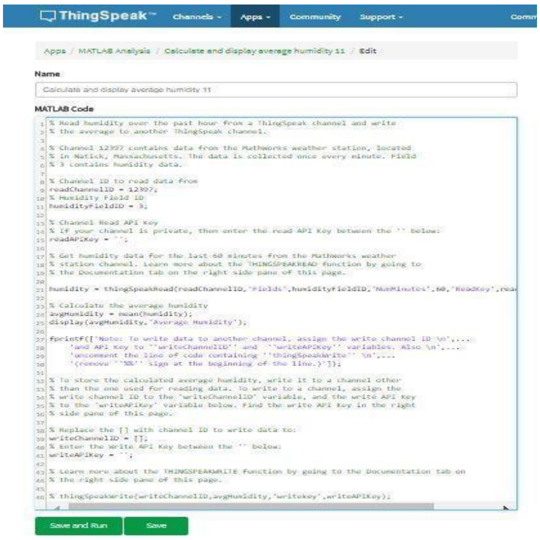

Fig. 8. A sample code for calculating average humidity value over a day time

logical advancement. We are highlighting few of them

- Human Intervention less smart inventory management system, It is observed that human intervention from executives add delay in terms of time spend by goods in the warehouse. This could be largely reduced if goods entry is made robotic. This means goods entered in inventory through a 3-D scanner which should update the customer profile with all the parameters like weight, color and scanned image and attach the GIS. Here goods has to spend very less time.
- Manual monitoring and data entry: The automated Ware- house Monitoring system has reduced the need for people to spend time on manually intervening the warehouse and to complete paper forms or entering data from documents into spreadsheets and other data-management applications.

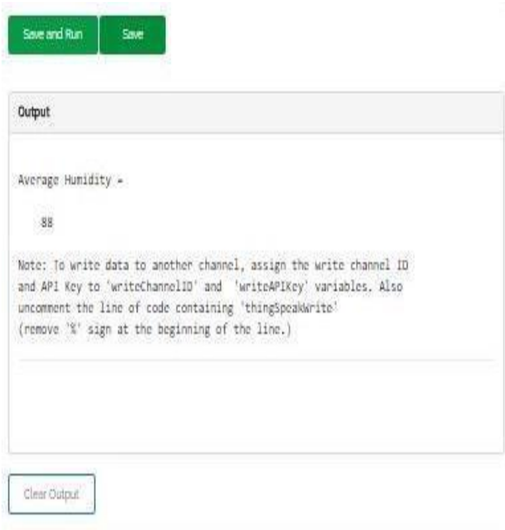

Fig. 9. Desirable output after running the appropriate code

- Minimal risk of processing errors: The processing of the warehouse environmental parameters can be carried out in an error-free and efficient routine.
- Range of different applications: The implementation can suitably be in effect for any other kind of warehouses as well, which is normally based on the sensor network components we choose.

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