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FOOD QUALITY MONITORING SYSTEM BY USING ARDUINO

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Abstract - *Food safety and hygiene is a major concern in order to prevent the food wastage. The Quality of the food needs to be monitored and it must be prevented from rotting and decaying by the atmospheric factors like temperature, humidity and dark. Therefore, it is useful to deploy quality monitoring devices at food stores. These quality monitoring devices keep a watch on the environmental factor that cause or pace up decay of the food. Later, the environmental factors can be controlled like by refrigeration, vacuum storage etc. In this paper, a similar food quality monitoring device will be designed that will keep watch of environmental factors like temperature, humidity, alcohol content and exposure to light. The device is built on Arduino UNO which is a popular prototyping board. The Arduino board is interfaced with various sensors like DHT-11 to monitor temperature and humidity, MQ6 to detect alcohol content and LDR to measure exposure to light. This is an IoT device and sends the measured sensor data to an IoT platform. The ESP8266 Wi-Fi Modem is interfaced with the Arduino to connect it to the internet via Wi-Fi router. The sensor data is also displayed on a character LCD interfaced with the Arduino UNO. The IoT platform used for logging and monitoring of sensor data is embedded spot.*

Key Words: Arduino UNO, ESP8266 Wi-Fi Modem, DHT-11, MQ6, IoT device.

1. INTRODUCTION

The food we consume can affect in any form of contamination that may occur due to storage or chemical changes within the food. There are several viruses and bacteria that causes food contamination and leads to numerous food borne diseases, for example Norovirus a very contagious virus caused by contaminated food or water. About 351,000 people die of food poisoning globally every year. In some countries, majority of people struggles on daily basis for food, due to preservation of foods and use of chemicals to artificially increase the time span of food causes people illness. It is necessary to develop a system that can help people to identify the freshness of food or quality of food items. Our proposed system may give the good quality (freshness) management in food. It is based on electrical, and biosensors [1]. Biosensors play a vital role to detect the bacterial contamination in food sample. Based on the combination of the sensor outputs quality of the food should be detected.

The existing system just does the work of monitoring the food through the temperature, humidity and light sensors. The increase in temperature suddenly may increase the risk of spoiling of the food. The increase in humidity may cause the damage of some type of the foods. Hence threshold values of the foods are set within which the food remains unspoilt. Other than temperature and humidity, the light also plays an important role. Lack of sufficient light to the food may cause it to spoil. Hence, artificial lights are made on, whenever the light is found insufficient through the sensor inputs turned into the analog values[7].

The proposal through this project is to monitor the gas levels coming out of the food, when the food is about to get spoiled. The amount of the gas level released from the food is monitored through the gas sensors and converted into analog values to be displayed on the IoT platform to be monitored wherever required[2]. The MQ gas series plays important role in this aim. However, different types of foods emit different types of gases when at the merge of getting spoilt. Further research is needed to be done in this context and the sensors are needed to be used accordingly.

2. PROPOSED METHOD

The block diagram of the design is as shown in Fig 1. It consists of power supply unit, Arduino microcontroller, Wi-Fi modem, Gas sensor, LDR, DTH11 sensor, LCD. Hardware implementation deals in drawing the schematic on the plane paper according to the application, testing the schematic design over the breadboard using the various IC's to find if the design meets the objective, carrying out the PCB layout of the schematic tested on breadboard, finally preparing the board and testing the designed hardware. The firmware part deals in programming the microcontroller so that it can control the operation of the IC's used in the implementation. In the present work, we have used the Orcad design software for PCB circuit design, the Arduino software development tool to write and compile the source code, which has been written in the C language. The Atmel AVR® core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in a single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers

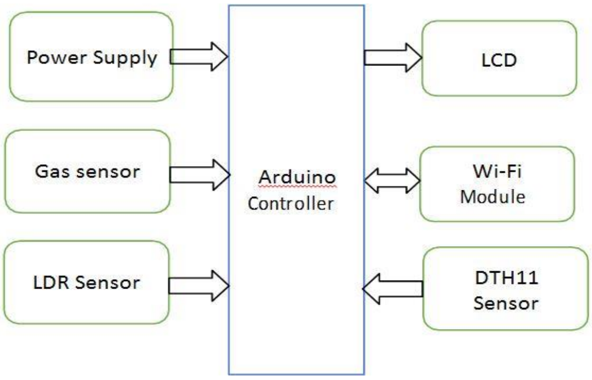

Fig -1: Block Diagram

Hardware components

ARDUINO UNO

The Atmel AVR® core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in a single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega328/P provides the following features: 32Kbytes of In-System Programmable Flash with Read-While-Write capabilities, 1Kbytes EEPROM, 2Kbytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, Real Time Counter (RTC), three flexible Timer/Counters with compare modes and PWM, 1 serial programmable USARTs , 1 byte-oriented 2-wire Serial Interface (I2C), a 6- channel 10- bit ADC (8 channels in TQFP and QFN/MLF packages) , a programmable Watchdog Timer with internal Oscillator, an SPI serial port, and six software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning [3]. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or hardware reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping.

The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator oscillator is running while the rest of the device is sleeping[6]. This allows very fast start-up combined with low power consumption. In Extended Standby mode, both the main oscillator and the asynchronous timer continue to run. Atmel offers the QTouch® library for embedding capacitive touch buttons, sliders and wheels functionality into AVR microcontrollers. The patented charge-transfer signal acquisition offers robust sensing and includes fully denounced reporting of touch keys and includes Adjacent Key Suppression® (AKS™) technology for unambiguous detection of key events. The easy-to-use QTouch Suite toolchain allows you to explore, develop and debug your own touch applications.

Fig: 2: Arduino Uno

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GAS SENSOR

Electrochemical gas sensors are gas detectors that measure the concentration of a target gas by oxidizing or reducing the target gas at an electrode and measuring the resulting current. The sensors contain two or three electrodes, occasionally four, in contact with an electrolyte. The electrodes are typically fabricated by fixing a high surface area precious metal on to the porous hydrophobic membrane. The working electrode contacts both the electrolyte and the ambient air to be monitored usually via a porous membrane. The electrolyte most commonly used is a mineral acid, but organic electrolytes are also used for some sensors. The electrodes and housing are usually in a plastic housing which contains a gas entry hole for the gas and electrical contacts

Fig: 3: Gas Sensor

DTH11 SENSOR

The DHT11 is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers. The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%. So if you are looking to measure in this range then this sensor might be the right choice for you. The DHT11 sensor can either be purchased as a sensor or as a module. Either way, the performance of the sensor is same. The sensor will come as a 4-pin package out of which only three pins will be used whereas the module will come with three pins as shown above. The only difference between the sensor and module is that the module will have a filtering capacitor and pull-up resistor inbuilt, and for the sensor, you have to use them externally if required**.**

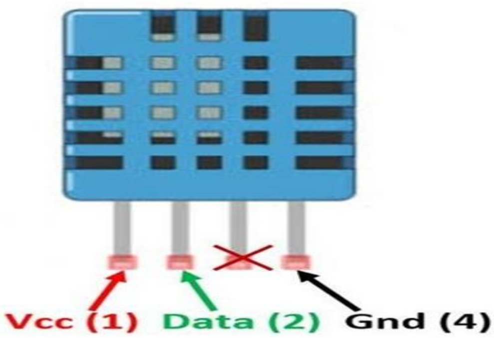

Fig: 4: DTH11 (Humidity and temperature) sensor

ESP8266 WI-FI MODULE

ESP8266 can be used as an external Wi-fi module, using the standard AT Command set Firmware by connecting it to any microcontroller using the serial UART,or directly serve as a Wi-fi-enabled micro controller, by programming a new firmware using the provided SDK. The GPIO pins allow Analog and Digital IO, plus PWM, SPI, I2C, etc.

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre- programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much Wi-Fi ability as a Wi-Fi Shield offers. The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

ESP8266 is an impressive, low cost Wi-Fi module suitable for adding Wi-Fi functionality to an existing microcontroller project via a UART serial connection. The module can even be reprogrammed to act as a standalone Wi-Fi connected device–just add power. In short, the ESP8266 module is a TTL "Serial to Wireless Internet" device. Providing your microcontroller has the ability to talk to a TTL serial device as shown in fig:5

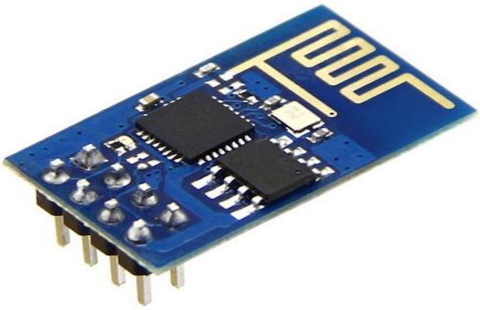

Fig: 5: Wi-Fi Module

LIQUID CRYSTAL DISPLAY

LCD Displays are dominating LED displays, because these displays can display alphabets, numbers and some kind of special symbols, whereas LED's (seven segment display) can display only numbers. These LCD displays are very useful for displaying user information and communication. LCD displays are available in various formats. Most common are 2 x 16, is that two lines with 16 alphanumeric characters. Other formats are 3x16, 2x40, 3x40 etc. In recent years LCD is finding widespread use replacing LED's, because of the ability to display numbers, characters, and graphics. Another advantage is, because of its compactness and ease of programming for characters and graphics, more information in the form of text message or graphics can be displayed. Generally, the LCD modules have an 8-bit interface, besides the 8-bit data bus; the interface has a few other control lines. The 8-bit data bus is connected to port '0' and the control lines are connected to port '2'. The default data transfer between the LCD module and an external device is 8-bits, however it is possible to communicate with the LCD module using only four of the 8-data lines. The R/W line is connected to ground and hence the processor cannot read any status information from the LCD module, but can only write data to the LCD as shown in fig:6

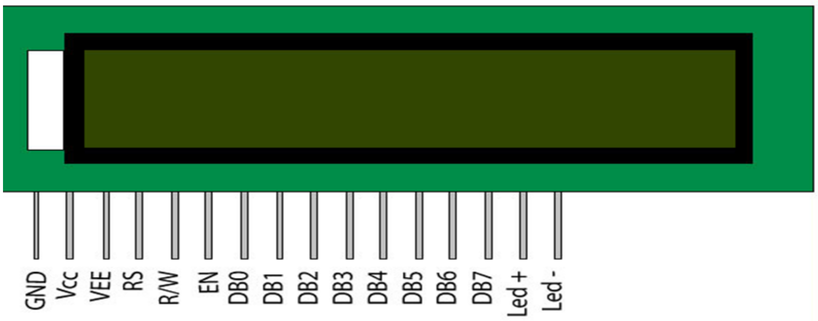

Fig: 6: LCD Display

LIGHT DEPENDENT RESISTOR

LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1,000,000 ohms, but when they are illuminated with light, the resistance drops dramatically. Thus in this paper, LDR plays an important role in switching on the lights based on the intensity of light i.e., if the intensity of light is more (during daytime) the lights will be in off condition. And if the intensity of light is less (during nights), the lights will be switched on. The output of the LDR is given to ADC which converts the analog intensity value into corresponding digital data and presents this data as the input to the microcontroller

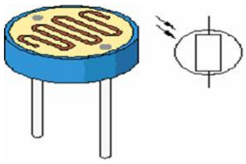

Fig: 7: LDR

3. SCHEMATIC AND DESCRIPTION

In this paper, a similar food quality monitoring device will be designed that will keep watch of environmental factors like temperature, humidity, alcohol content and exposure to light. The device is built on Arduino UNO which is a popular prototyping board. The Arduino board is interfaced with various sensors like DHT-11 to monitor temperature and humidity, MQ6 to detect alcohol content and LDR to measure exposure to light. This is an IoT device and sends the measured sensor data to an IoT platform. The ESP8266 Wi-Fi Modem is interfaced with the Arduino to connect it to the internet via Wi-Fi router[5]. The sensor data is also displayed on a character LCD interfaced with the Arduino UNO. The IoT platform used for logging and monitoring of sensor data i http://embeddedspot.top/iot/. With the power of Internet of Things, the environmental factors affecting the food storage can be monitored from anywhere, anytime and from any device.

This Arduino based IoT device should be installed in a food store. Once it is properly installed and powered on, it connects with the internet via Wi-Fi modem and start reading data from the interfaced sensors – DHT-11 temperature and humidity sensor, MQ6 Sensor and the LDR sensor. DHT11 Temperature and Humidity Sensor is a digital sensor with inbuilt capacitive humidity sensor and Thermistor. It relays a real-time temperature and humidity reading every 2 seconds. The sensor operates on 3.5 to 5.5 V supply and can read temperature between 0° C and 50° C and relative humidity between 20% and 95%.The sensor cannot be directly interfaced to a digital pin of the board as it operates on 1-wire protocol which must be implemented only on the firmware. First the data pin is configured to input and a start signal is sent to it. The start signal comprises of a LOW for 18 milliseconds followed by a HIGH for 20 to 40 microseconds followed by a LOW again for 80 microseconds and a HIGH for 80 microseconds. After sending the start signal, the pin is configured to digital output and 40-bit data comprising of the temperature and humidity reading is latched out. Of the 5-byte data, the first two bytes are integer and decimal part of reading for relative humidity respectively, third and fourth bytes are integer and decimal part of reading for temperature and last one is checksum byte.

The LDR sensor is connected in a potential divider circuit and inputs a voltage at the analog input pin of the controller. The voltage is read and digitized using in-built ADC channel. The MQ6 sensor detects the emission of ethanol type of gases. If the food/fruits get spoiled, they emit the ethanol type of gases. The MQ6 sensor detects the concentration of such gases and output an analog voltage proportional to the concentration of the gas. The analog output is passed to the analog pin of the Arduino which has inbuilt ADC that coverts the analog to digital value.
The Arduino collects data from all the sensors and convert the values to the strings. The sensor data wrapped as proper strings are passed to the character LCD for display. The ESP8266 Wi-Fi module connected to the Arduino uploads the data to embedded spot Server.

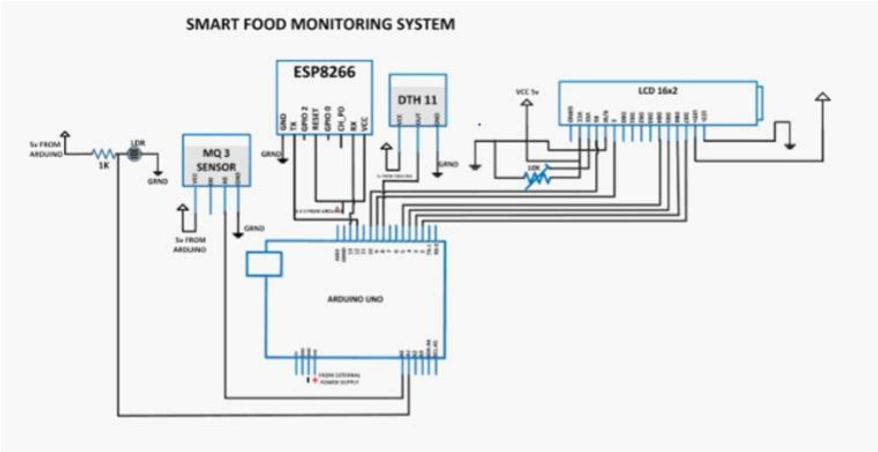

Fig-8: Schematic Diagram

4. RESULTS

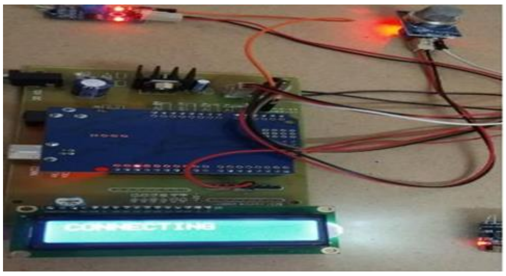

Fig-9: Test case 1

The sensor values only get displayed on LCD only when it is connected to Wi-Fi module ESP8266. So after it is get connected the values will be displayed on LCD

Fig-10: Test case 2

Decrease in temperature and LDR sensor values in darkness. Gas value is normal.

Fig-11: Test case 3

Increase in temperature values in warm surroundings. Increase in LDR sensor value when there is enough light. The spoiled food emits gas which in turn has increased the gas sensor value

Fig-12: Test case 4

ESP8266 Wi-Fi module gets connected to Wi-Fi and uploads the data to IoT web server

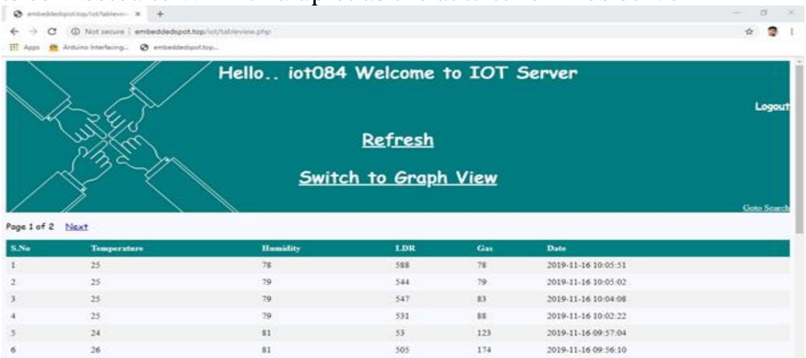

Fig-13: Arduino output

5. Conclusion

Food poisoning has been the source of innumerable diseases, to reduce and avoid illness we use biosensors and electrical sensors to determine the freshness of household food items like diary, fruits, and meat, to expend the device for more items by adding new sensors and by using existing sensors. User can also get output in the form of voice by attaching the speaker.

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