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Detection of Food Adulteration Using Embedded System

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***Abstract*: Food plays an important role in our day to day life. With the advent of globalization the need to create consumer products for efficient usage has become a necessity. As a part of globalization the food we are consuming is also contaminated by various factors some which malignant. So in order to find out the contaminated food we have come up with some ideas and are given in this paper. We have used sensors and IoT platform to overcome this problem.**

***Keywords*: ADC (MCP 3008), Gas Sensor, LM 35, Node MCU, pH Sensor, ThingSpeak.**

1. Introduction

In order to produce high-quality food products, everyone involved with food products needs to understand their role in the process. In the last few years many scientists, technologists and managers, contributed largely to the thinking about food quality. The described quality concepts range from simple illustrations to complex models reflecting factors that might influence quality expectation by consumers. There are many definitions for product quality, such as conformance to specifications and requirements, and fitness of a product for any use. There is an open research problem in the field of health and nutrition on accurate measurement of dietary intake. The increased focusing on obesity among the youth is great concern. Not only nutrient content of food, the quality of food is much more important, it should be free from bacterial contamination and other foreign bodies. The intake of contaminated food causes various health issues like food poisoning, etc. Food poisoning has been the source of innumerable diseases and illnesses over the years. In a country like India, where majority of the population struggles for their daily bread, efficient preservation of existing food resources is critical. This paper is concern to find out the contaminated food using latest technology.

2. Components Required

Node Microcontroller Unit(ESP8266), LM 35, pH Sensor, mcp 3008, Gas Sensor, Cloud Platform, ADC.

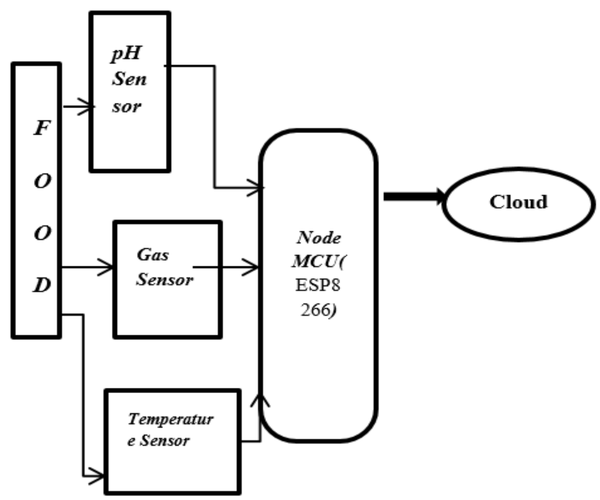

Fig. 1. Block diagram

A. ESP8266

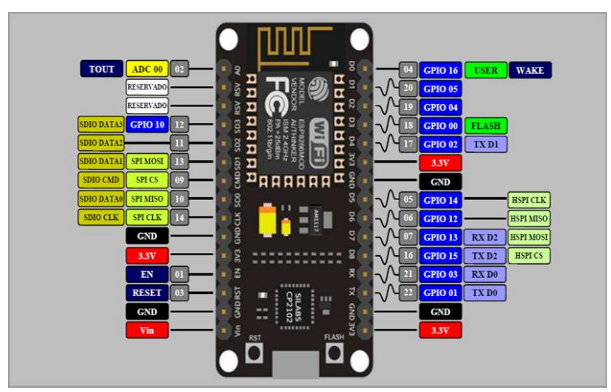

Fig. 2. Node MCU

The ESP8266 is a very user friendly and low cost device to provide internet connectivity to your projects. The module can work both as an Access point (can create hotspot) and as a station (can connect to Wi-Fi), hence it can easily fetch data and upload it to the internet making Internet of Things as easy as possible. It can also fetch data from internet using API's hence your project could access any information that is available in

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the internet, thus making it smarter. Another exciting feature of this module is that it can be programmed using the Arduino IDE which makes it a lot more user friendly. However this version of the module has only 2 GPIO pins (you can hack it to use upto 4) so you have to use it along with another microcontroller like Arduino, else you can look onto the more standalone ESP-12 or ESP-32 versions. So if you are looking for a module to get started with IOT or to provide internet connectivity to your project then this module is the right choice for you. There's also 128 KB RAM and 4MB of Flash memory (for program and data storage) just enough to cope with the large strings that make up web pages, JSON/XML data, and everything we throw at IoT devices nowadays.

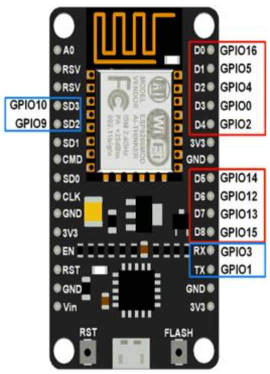

Fig. 3. NodeMCU GPIOs

B. pH Sensor

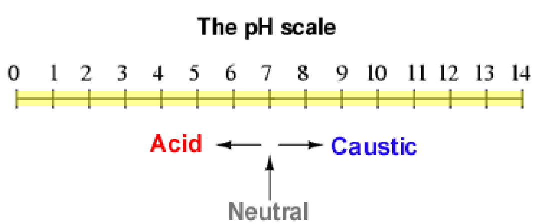

Fig. 4. pH Scale

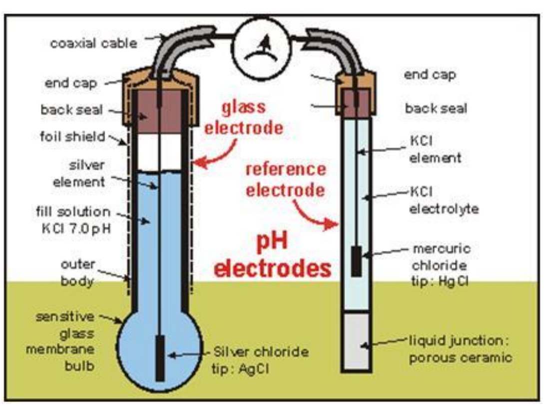

Fig. 5. Working of pH Sensor

A very important measurement in many liquid chemical processes (industrial, pharmaceutical, manufacturing, food production, etc.) is that of pH: the measurement of hydrogen ion concentration in a liquid solution. A solution with a low pH value is called an "acid," while one with a high pH is called a "caustic." The common pH scale extends from 0 (strong acid) to 14 (strong caustic), with 7 in the middle representing pure water (neutral):

C. LM 35

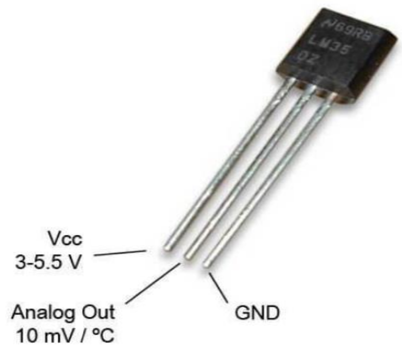

Fig. 6. LM 35

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C, over a full -55 to +150°C temperature range. Low cost is assured by trimming and calibration at the water level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a -55° to +150°C temperature range, while the LM35C is rated for a -40° to +110°C range (-10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package.

D. Gas Sensor

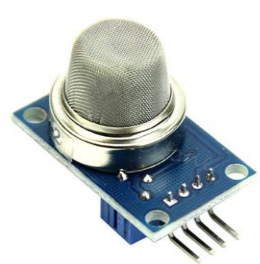
Fig. 7. Gas Sensor

A gas sensor is a device which detects the presence or concentration of gases in the atmosphere. Based on the concentration of the gas the sensor produces a corresponding potential difference by changing the resistance of the material inside the sensor, which can be measured as output voltage. Based on this voltage value the type and concentration of the gas can be estimated.

E. MCP 3008

The MCP3008 is a 10bit 8-channel Analogue-to-digital converter (ADC). It is cheap, easy to connect and doesn't require any additional components. It uses the SPI bus protocol which is supported by the Pi's GPIO header.

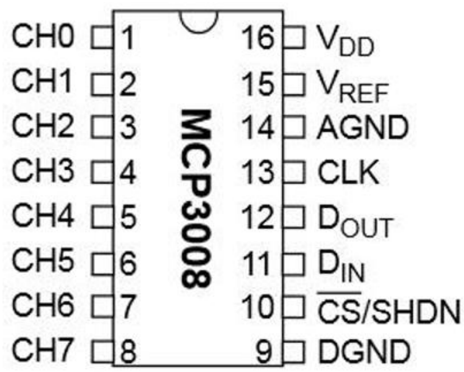

Fig. 8. MCP 3008 Pin Details

The explanation of how to use an MCP3008 device to provide 8 analogue inputs which you can use with a range of sensors is described. The circuit below shows the MCP3008 to read a temperature and light sensor. The first step is enabling the SPI interface on the Pi which is usually disabled by default. Please follow SITE article to setup SPI and install the SPI Python wrapper. The following list shows how the MCP3008 can be connected. It requires 4 GPIO pins on the Pi P1 Header.

F. Cloud Platform (ThingSpeak)

ThingSpeak is an Open-Source IoT application and API to store and retrieve data from Hardware devices and Sensors. It uses HTTP Protocol over the Internet or LAN for its communication.

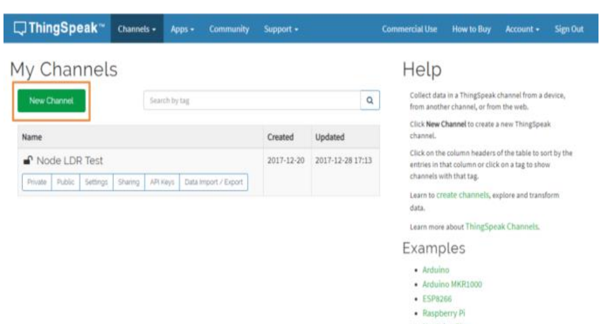

Fig. 9. ThingSpeak

The MATLAB analytics is included to analyze and visualize the data received from your Hardware or Sensor Devices. We can create channels for each and every sensor data. These channels can be set as private channels or you can share the data publically through Public channels. The commercial features include additional features. But we will be using the free version as we doing it for educational purpose. ThingSpeak is an IoT platform, that allows you to connect and save sensor data in the cloud and develop IoT applications. Also, the platform provides apps that let you analyze and visualize data. MATLAB support helps you act on data. Sensor data can be easily integrated and sent from Arduino or Raspberry Pi or any other IoT gateway.

G. ADC

Analog to Digital Converter samples the analog signal on each falling or rising edge of sample clock. In each cycle, the ADC gets of the analog signal, measures and converts it into a digital value. The ADC converts the output data into a series of digital values by approximates the signal with fixed precision.

In ADCs, two factors determine the accuracy of the digital value that captures the original analog signal. These are quantization level or bit rate and sampling rate. Below figure depicts how analog to digital conversion takes place. Bit rate decides the resolution of digitized output and you can observe in below figure where 3-bit ADC is used for converting analog signal.

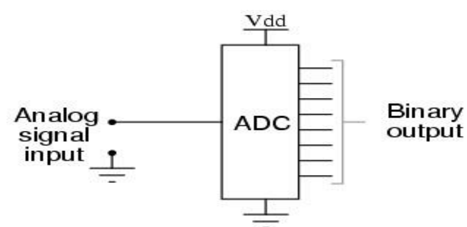

Fig. 10. ADC

3. Working

In the proposed model we are using gas sensor, pH sensor, temperature sensor to analyse the quality of the food. These sensors are interfaced with the Wi-Fi module called Node MCU and from these data are uploaded to the IoT cloud platform called Thingspeak. From the Thingspeak the data are retrieved and the percentage of adulterants in the food is examined with the reference values. The recorded data of these sensors in the Thingspeak platform is added below.

Fig. 11. Gas Sensor

Table 1
Comparison between existing and proposed model

Food sample	Existing system procedure	Proposed system procedure
MILK	To find the presence of urea Mix half tablespoon of milk and soyabean (or arhar) powder together and shake well. After 5 minutes, dip litmus paper for 30 seconds and if there is a color change from red to blue it means the milk has urea in it. To find the presence of starch. The test tube is then kept for incubation in boiling water bath for 5 minutes. After incubation, the test tube is then cooled and few drops of 1% iodine solution and mix the contents well. Appearance of blue black color indicates presence starch in milk.	In this pH value of the milk is checked. The pH value of the milk is between 6.5 and 7 due to the presence of lactic acid in it. If the pH value of the milk is varied from its standard value, it is not edible. And according to the change in the pH value what contaminant is added in it is detected.
OIL	To find the presence of Argemone oil The oil is blended with water and mixed well. If the oil turns out red argemone oil is added in it. To find the presence of urea Take a teaspoon of milk in a test tube. Add ½ teaspoon of soybean or arhar powder. Mix up the contents thoroughly by shaking the test tube. After 5 minutes, dip a red litmus paper in it. Remove the paper after ½ a minute. A change in colour from red to blue indicates the presence of urea in the milk.	Different oil has different congealing temperature. And by using the temperature sensor, the temperature of the congelation of oil is detected. And by this the adulterants in the edible oil is detected.
FISH	To find the presence of Formalin A reagent is used which turns the rubbed paper with fish into blue. Else the paper is turned out into yellow. To find the presence of Heavy metals DPSAV (differential pulse stripping anodic voltammetry) which is most expensive method.	Using the gas sensor the addition of formaldehyde is detected and the heavy metals is detected using the pH sensor.
APPLE	To find the presence of Wax in outer layer To remove the wax from the outer layer using knife. But we are unable to detect whether the wax is natural or artificial.	Using the pH sensor the petroleum wax and natural wax are detected in a simple manner.

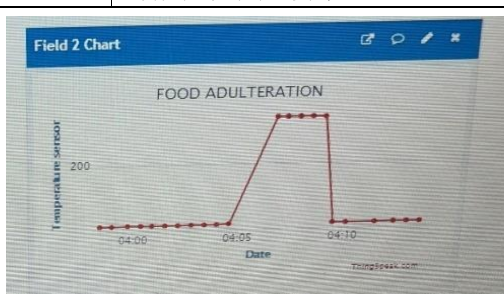

Fig. 12. Temperature Sensor

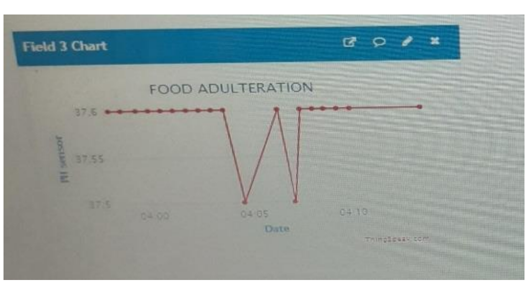

Fig. 13. pH Sensor

4. Conclusion

This embedded system aids to find the adulterated food in a simple way. This enables to distinguish between unadulterated and adulterated food. With the employment of pH sensor, gas sensor, temperature sensor interfaced to NodeMCU microcontroller the values are displayed in the Thingspeak IoT cloud platform. This use to check whether the food is edible or not. Food poisoning and other malicious diseases are prevented. Further improvement in the project can be sending the details of the adulterated food directly to the specific mobile as a message instead of verifying the cloud platform.

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