

IoT-Based Solution for Food Adulteration

Karan Gupta and Nitin Rakesh

Abstract Food acts as an energy source for the organisms that help them to grow and sustain life. In order to maintain the proper hygiene and the safe supply of food products, the food quality should be checked and monitored regularly. To quench the thirst of greed, people add adulterants in the food products to get the monetary benefits by selling the low-quality food at the higher price. So, to avoid any compromise to the human health, food adulteration monitoring system can be used to detect the presence of adulterants in the food product. This system is governed by the Raspberry pi which controls the use of sensors in the system. The recorded data is transferred using the ZigBee module and results are displayed. The IoT technology has been introduced in the system for the purpose of making the system as smart device. With the use of this system, consumption of poor-quality food can be avoided. Moreover, the simplicity of the system can help everyone (commoner, food inspectors, and shop owners) to use food adulteration monitoring system.

Keywords Food adulteration monitoring system · IoT · ZigBee · Raspberry pi

1 Introduction

Food is one of the basic necessities of the human life and without it there will be no scope of human origin. Moreover, if the energy providing food is adulterated, then it will lead trauma to human existence. Furthermore, the present equipment used for monitoring the food adulterations is beyond the scope of a commoner as he is

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unable to understand the basic principle of them. Moreover, methods used for monitoring are of orthodox level which cannot be used every time. For the present generation, food hygiene problem is the major issue of the concern. With the increase in the health problems, due to the presence of adulterants in food products, there has been huge loss to the immunity and to the health of a personage. Plus, food inspectors are not equipped with proper resources to check the food quality and to inform the public about it. As a result, there is complete negligence toward the health of the people and as a result, human race is unable to grow.

Food adulteration starts from the initial step of the food chain that is from the fields. In the fields, the fertilizers and pesticides are overused. There are some fertilizers and pesticides whose residue still remain and lead to entering in the food chain. The pesticides bioaccumulates in the human body which can lead to rise in toxic levels, thus leading to several diseases in the human body [1]. Diseases such as stomach ache, food poisoning, nausea, and appendix problems are some of the negative aspects due to the food adulteration. Moreover, people adulterate the food products for their monetary needs which reduce the food quality but increase the seller profit. It becomes tough for the buyer to hand-pick a food product due to misleading ads, inappropriate media prominence, and food adulteration. As a result of these malpractices, the ultimate victim is a consumer, who innocently takes adulterated foods and suffers. Although the seller is able to earn huge profit by selling the low-quality food at high cost, the health of humanity is compromised. This paper provides the solution which can be used to resolve the problems related to the adulterants present in the food product. In order to protect from the adulterated food, the food adulteration monitoring system will act as savior. This monitoring system will be able to check whether the given food product is adulterated or not. If the food product is adulterated, then it will prompt the warning to avoid consumption of the food product. The monitoring system will be within the approach of everyone (commoner, food inspectors, and shop owners) and they can use the system to check the food product. In this modern world, none is having enough time to keep regular check on the food products. So keeping that in mind IoT has been used in the system. The food product will be brought near the sensors and after sensing is done the notification is sent to the user. This will allow the user to formulate the notification to others accordingly.

The paper is structured into five sections as follows. Section 1 is the Introduction which introduces various food adulteration approaches and problems prevailing due to the food adulteration. The Sect. 2 is Problem Statement and Motivation which explains why there is a need of food adulteration monitoring system. In the Sect. 3, a complete model of the system is explained, i.e., food adulteration monitoring system is used for describing. The Sect. 4 talks about the classification of working that is the elements used in the system. And the Sect. 5 discusses about the future work and conclusion of the paper which includes the preventive measures for the food safety and the implementation of food adulterant monitoring system.

2 Problem Statement and Motivation

In a report issued by Public Health Foundation of India, more than 80% of the premature deaths are the result of poor food quality [2]. Kids and the mature individuals are the utmost susceptible to the problems caused by the adulterated food. However, the food monitoring system in the nation is neither uniform nor wise enough to keep a regular check of the adulterated food. With the rise in unemployment, individuals are curious to purchase inexpensive food products; as a result, they mostly end up by purchasing the adulterated food.

Moreover, during the festive seasons, there is a huge increase in the amount of adulterant used. In order to make maximum profit, shopkeepers add adulterants in the food products thus leading to several diseases in the human race [3]. Some of the well-known food adulteration shames that shocked our nation and prompted distress in everyone's hearts are: (i) Poisonous Alcohol in West Bengal (Sang Rampur), India—In this incident more than 156 people lost their life after consuming the poisonous alcohol which was distributed at the cheap rates that have been adulterated with methanol (2011). (ii) Midday Meal School Poisoning, Bihar (2013)—This scandal shocked the nation as the government initiated program didnot go well. In the official report more than 48 students were affected and 23 were died. Later on, it was found that the oil that has been used for the cooking purposes was adulterated with the pesticide content. (iii) Unaccepted levels of Lead in the Maggi, India (2015)—It was the most recent and popular scandal that shocked the entire youth. It was found that there was an excess amount of lead present which could damage the human health seriously. In these scandals, not only life of people was lost but also they harmed the coming generations. The most common vulnerable food products are as follows: "Saffron, milk, olive oil, apple juice, coffee, honey, and orange juice are the most vulnerable food products that can be targeted for economically or intentional driven adulteration of diet."

The FSSAI defines food adulteration as the addition or subtraction of any substance to or from food, so that the natural composition and quality of food substance is affected [4, 5]. *In nation like India generally, the adulteration in food products is prepared either for monetary advantage or due to negligence in appropriate sterile situation of processing, keeping, transportation in addition selling.* Food adulteration has quenched away the pleasure of food life. So, food adulteration monitoring system will not only protect the pleasure of life but also help in the buildup human health.

3 Proposed Model and Methodology

The food adulteration monitoring system helps us to determine the adulterants present in the system. First, the sample food product is selected and placed near the sensors so that signals are easy to transmit. This paper represents the list of some of the adulterants that can be found in the food products [6]. These adulterants sustain in the

Table 1 Food products and adulterants present

Food article	Adulterant	Harmful effects
Tea	Used tea leaves processed and colored	Liver disorder
Milk	Starch, vanaspati, urea	Stomach disorder
Khoa	Starch and less fat content	Less-nutritive value
Chilies powder	Brick powder, salt powder	Stomach disorder
Edible oils	Argemone oil	Loss of eyesight, heart diseases
Turmeric powder	Yellow aniline dyes	Carcinogenic
Sweets, juices, jam	Non-permitted coal tar dye	Metanil yellow is toxic
Honey	Molasses sugar	Stomach disorder

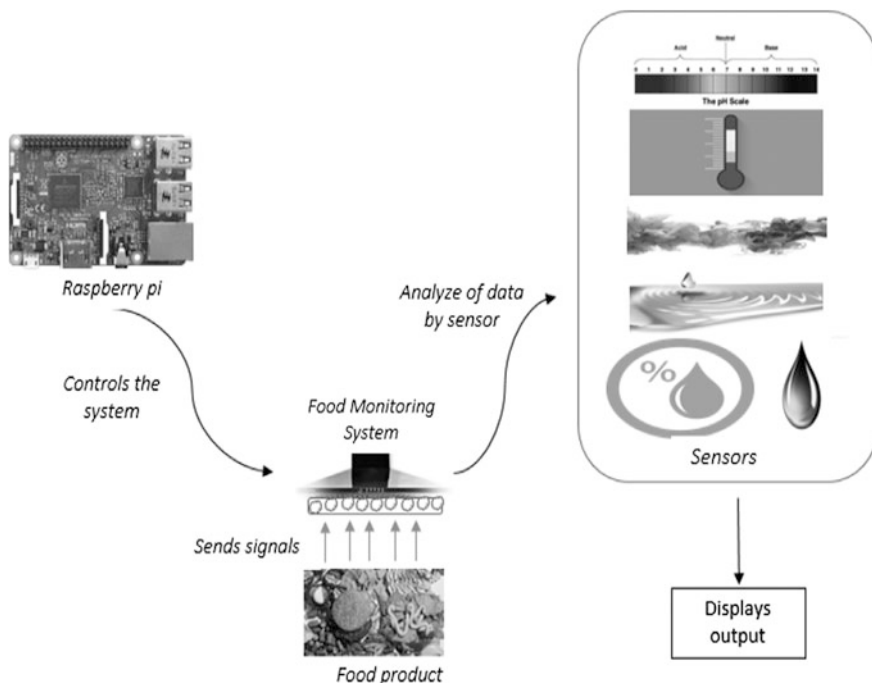


Fig. 1 Methodology

human body and can have several harmful effects on the body which are discussed in Table 1. Furthermore, the core methodology has been discussed in Fig. 1.

This system is administered by the Raspberry Pi. The Raspberry pi acts as the brain of the monitoring system. Raspberry pi handles all the operations taking place from sending command to the sensors to the displaying output. When the system is provided with power supply, the Raspberry pi gets switched on and then asks for the entire details related to the food product. Later on, Raspberry pi sends signal to the sensors to analyze the food product. Raspberry pi is low power consuming device, so it can be operated easily and more efficiently. After receiving the command from the raspberry pi, the sensors get activated and gets ready to perform the task. Moreover,

the sensors sense the signals from the food product in various forms, for instance, temperature and oil sensor receive the signal in the form of radiation from the food product, whereas the metal detector receives the signals by electromagnetic property from the food product. Thereafter, the sensed data is transmitted as analog signals by the sensors which have to be converted into digital signals using the interface. After converting to digital signals, the signals are passed to the microcontroller where they are made linear and amplified. The motive of passing the signals through the microcontroller is to have linear and clear signals that make easy to transmit the signals by removing the other noises from the signals. Following it, the signals get transmitted to Raspberry pi and this task is achieved by using ZigBee module.

The ZigBee module is used to transmit the signals to the receiver end. ZigBee helps to transfer the signals more efficiently and easily with low power consumption. Then the Raspberry pi displays the output. In addition to this, IoT has been introduced in the system. After completing all the processes and recording the results, notification will send to the user using IoT. In this way, user will get to know about the food product. Figure 2 shows the explanation of complete working of the food adulteration monitoring system. The diagram includes all details about the process that has been taking place in the monitoring system. The IoT technology has been introduced in the system because after starting the monitoring system keeping the food product near the sensor, the user can indulge in other tasks. Furthermore, the notification received by the user can be formulated among the people related to the food product or the seller company. The notification can be used as evidence against the food processing company. Moreover, the user can upload the notification as Google Review which will help the entire world to know about the company whose product has been used. By the introduction of the IoT, this food adulteration monitoring system can be used both as personal and commercial devices. By keeping the result information to oneself system can be personal and formulating the results to others it can be used as commercial device. The displayed output can either show that food product is adulterated or food product is good for consumption. With the optimal use of this system, everyone will have affair chance to keep their sides and decide accordingly the best quality of food. This system will not only help in getting the good quality of food but also help in eradicating the negative aspects of the society.

In a nutshell, it will be right to say that by the introduction of this system many negative aspects of the food industry can be avoided and food adulteration can be

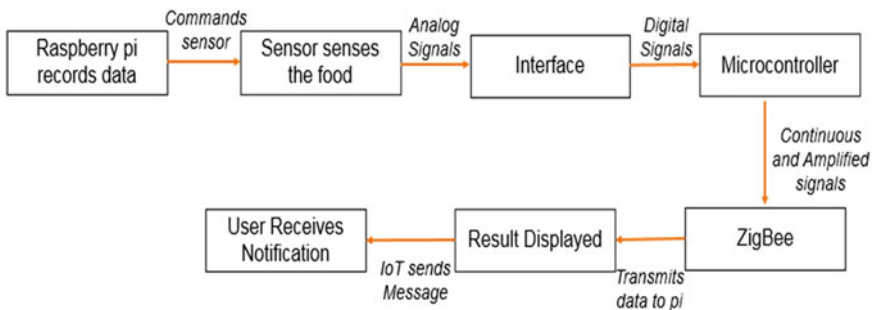


Fig. 2 Working

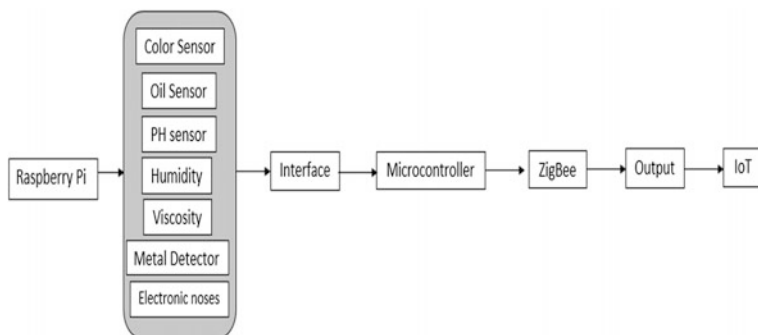


Fig. 3 Integration of the proposed model

controlled to a higher limit. Furthermore, using the IoT in an efficient manner, everyone will have the idea of the company products and this will bring uniformity in the quality monitoring system. This food adulteration monitoring system can be frequently used and easily managed by everyone (the food inspectors, commoner, other shop owners). Figure 3 shows all the equipment that has been used at a particular position during the process of monitoring the food product.

4 Classification of Working

This section of the paper explains the use of several instruments in the food adulterant monitoring system. This will provide all the necessary details of the particular technology that has been used in the model.

Raspberry pi: [7, 8] The Raspberry pi performs similar to a computer when plugs hooked on a computer display or TV, and applies a usual keyboard besides mouse. The raspberry pi board is a portable as well as low cost. In this system, the raspberry pi acts as a brain of computer which commands the sensor to work accordingly. Later on, raspberry pi displays the output of the certain food product accordingly. Every step in the system is monitored by the raspberry pi. The other equipments in the project revolve around the raspberry pi itself.

IoT: [9, 10] Internet of Things signifies a notion in which network equipments have capability to accumulate as well as sense information from the entire world; moreover, it shares that information throughout the web where that information can be operated and administered for several resolutions. In the food adulterant monitoring system, the IoT has a key role to play. The resulted information will be sent to the user using IoT technology. During the monitoring time, the user can engage in different works and when the monitoring is complete, then using IoT notification will be sent to the user providing the result. Furthermore, the user can use the notification as both personal and commercial.

ZigBee: [11–13] ZigBee is a less priced, small power, wireless network standard. The low price permits the tools to be broadly arranged in wireless controller

plus observing applications. In the food adulterant monitoring system, the ZigBee protocol enabled us to transfer the data from the sensors to the raspberry pi using wireless technology efficiently and at low cost. The ZigBee protocol has enabled us to achieve great results after the proper quality of signals sent over the network.

Sensors: These will detect the adulterant in the food product, i.e., all the results will be based on the conditions information provided by the sensors. Table 2 shows

Table 2 Sensors

Sensor	Detection	Name of sensors	Attributes	Applications
Temperature	Thermal radiation and measuring electrical output relation with temperature	PT 1000, LM35, NTC sensor	<ul style="list-style-type: none"> • High accuracy • Robust and impact resistant 	<ul style="list-style-type: none"> • Catering • Butchers • Restaurant • Cold stores
Oil	Thermal radiation, capacitance due to TPCs	Instruments like FOM310 and TESTO 270	<ul style="list-style-type: none"> • Exact determination frying oil quality • Adjustable to several oil types 	<ul style="list-style-type: none"> • Catering • Sweet shops • Restaurant • Kitchens
Humidity	Electrical resistance proportional to humidity	DHT11 and DHT22	<ul style="list-style-type: none"> • Reliable and precise • Impact resistant 	<ul style="list-style-type: none"> • Cold stores • Butchers
Salt meter	Salinity ions, electrical resistance	Instruments like SSX 210	<ul style="list-style-type: none"> • Easy operation • Handy and robust 	<ul style="list-style-type: none"> • Meat, ham sausages, cheese, salads
Metal detector	Electromagnetic radiation	Using transmitter coil and reference coil	<ul style="list-style-type: none"> • Exact determination metals in food 	<ul style="list-style-type: none"> • Cold stores • Shops
Color	Infrared, Silicon photodiodes	TCS3210 and TCS3200	<ul style="list-style-type: none"> • Handy and robust • Impact resistant 	<ul style="list-style-type: none"> • Catering • Sweet shops • Restaurant • Kitchens
pH	Electronic ions, Hydrogen ion concentration	SEN0161 and pH810	<ul style="list-style-type: none"> • Factory calibration certificate • Handy and robust 	<ul style="list-style-type: none"> • Meat • Fluids • Butchers • Dairy
Viscosity	Fluidity using electromagnetic theory	Viscosity sensor 440–443 by the PAC industry	<ul style="list-style-type: none"> • Reliable and precise 	<ul style="list-style-type: none"> • Fluids • Catering • Sweet shops
Electronic noses	Olfactometry using MOSFET, conducting polymers, piezoelectric sensors	Devices like Cyranose 320, SensorFreshQ and JPL electronic nose	<ul style="list-style-type: none"> • Factory calibration certificate • Easy operation 	<ul style="list-style-type: none"> • Catering • Butchers • Restaurant • Sweet shops

all the sensors that have been used in the food adulteration monitoring system with the knowledge of how they sense the food product. Moreover, the table lists the range of the sensors used and the attributes of the sensors. The applications of the sensors have all been in the table below [14–18]. The different sensors used in the system are given in Table 2.

5 Conclusion and Future Work

With the increasing amount of adulterants in the food products, there is a need to maintain a proper quality of food product without affecting the health of the humans. Improvement in the food adulterant monitoring system can provide a simple solution to maintain proper food quality. As the system will be affordable and easily available, anyone can make full use of it. This system can be installed at every food shop so that they get their customer satisfied. This will help in building stronger relationship between the consumer and the company. In addition to this, quality of the food products available in the market will increase, thus benefitting the personage. Moreover, food adulterants scandals can be avoided in the world.

So in a nutshell, it will be right to say that besides the use of food adulteration monitoring system, there should be proper implementation of the food laws, optimal use of advanced technology in the monitoring of food products, and reduce in the amount of pesticide used and proper public awareness. With the help of implementation of food adulterant monitoring system, everyone could avail the nutritious food and check the quality of their food product. And every commoner has the proper knowledge of the adulterants that can be used in the particular food products. There should be perfect execution of Public Food Safety Policy, Food safety laws, and Food adulterant laws. The future work is enhancing and improving the technology prevailing in the food industry so that everyone can make full use of the available food resources and maintain their proper health and stay fit [19]. Table 3 shows the rate of adulteration within the subsequent years and Fig. 4 shows

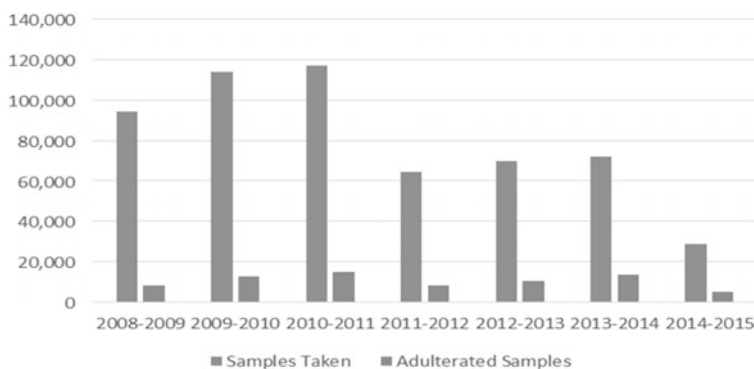


Fig. 4 Adulteration rate

Table 3 Adulteration rate

Year	Samples taken	Adulterated samples
2008–2009	94,470	8,304
2009–2010	113,969	12,692
2010–2011	117,061	14,806
2011–2012	64,593	8,247
2012–2013	69,949	10,380
2013–2014	72,200	13,557
2014–2015	28,731	4,861

the consequent details of Table 3. The table also includes the total samples taken and the adulterated samples found in total samples.

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