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Identification of Chemicals in Fruits and Vegetables using IOT

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ABSTRACT

Due to their great nutritional value, fruits and vegetables constitute an important part in human food diets. They have a short shelf life, making them very perishable. Fruits and vegetables are the important source of carbohydrates, proteins, and minerals. According to various reports, nowadays many food products are contaminated with harmful and dangerous chemical ingredients. To detect that, gas sensor has placed and estimate the chemical levels present in fruits and vegetables. If any chemicals detected immediate alert is sent through GSM to the owner. In most of the hostel mess and government schools' kitchen everybody is getting affected by the food they consume. Milk, fruits like banana and other foods used in daily life, as all of them do not offer quality since their moisture harmful gases vary from time to time. To ensure food safety it should be monitored at every stage of the chain.

Keywords : GSM, Commodities, Consumption, and Perishable.

I. INTRODUCTION

Human health is at danger from hazardous chemical residues found in fruits and vegetables [1]. Hazardous compounds cannot be detected in fruit and vegetables using standard LIBS (i.e., Laser-Induced Breakdown Spectroscopy) procedures [2]. We added metal nanoparticles to fruit and vegetable samples to help LIBS in identifying the traces of heavy metal and pesticide residues in a better manner. The detection limits for pesticide residue in fruit and vegetables were achieved as two orders of magnitude lower in the conventional LIBS while the detection limits for heavy metals were noticeably higher in the proposed nanoparticle-enhanced LIBS approach when compared to the conventional LIBS. The distribution of chemical contaminants in vegetable leaves is being studied using the LIBS method. We discovered that heavy metal concentrations are irregularly distributed across edible plant leaves, being greater in the veins when compared to the mesophyll. By using chemicals, we can increase the quantity of the food production we can decrease the quality of the production.

Chemicals known as pesticides are sprayed to crops at different times during their production as well as when they are being stored after harvest. By reducing agricultural pests and weeds and enhancing plant quality, pesticides are used to avoid the destruction of food crops. The use of pesticides in commercial agriculture has increased agricultural output [3]. [4] Since the majority of nations established maximum residue levels (MRLs) for pesticides in food items, the detection of pesticides in fruit and vegetable samples has grown in recent years. Despite the many advantages of applying pesticides in agriculture, a number of erroneous applications can lead to excessive and unacceptable levels of the chemicals in the product that is consumed. Among them are picking the wrong pesticides to use on food, using too much pesticides, and harvesting crops before the residues from the pesticide applications have been removed.

Due to their high biological activity and toxicity, pesticides occupy a special place among environmental contaminants. [5] Several pesticides do not differentiate between pests and other accidental lifeforms that are similar to pests. If used improperly, they might be detrimental to human beings, animals, other living things, and the environment. Pesticides are thought to be responsible for between 5000 and 20,000 fatalities and between 500,000 and 1 million poisonings annually [6, 7]. Agricultural workers make up at least 50% of the intoxicated and 75% of the pesticide-related fatalities.

Problem Statement

The Internet of Things (IoT) plays a crucial part in the field of chemical Detection. The term used for that is chemical detection in vegetables and fruits. IoT applications monitor a wide variety of pesticide monitoring function by detecting vegetables fruits. The scope of the project is to find the chemical level in fruits and vegetables, and we have to eat nutritious food which has doing in a organic farming manner.

Pesticides are detected by Chromatographic methods like Gas Chromatography, Liquid Chromatography and Mass Spectrometry. They are time consuming processes since samples can only be treated in laboratory and requires lot of manual work.

The disadvantages present in most of the existing works are listed below as:

1. Lack of integrity
2. Lack of availability
3. Continuity of service
4. Lack of accuracy

Objectives of the work

The objective of the project is to tell and how to identify and calculate the chemical percentage in fruits and vegetables. By using gas sensor and dht11 sensor to identify the chemical level. If anyone has spread the chemicals on the object by using GSM we can alert from the message.

The other objectives which the proposed work aims to achieve are:

1. To lessen the ailments that they bring about in the human body.
2. To lessen the presence of pesticides in vegetables and fruits.

Paper Organization

The organization of this research paper is given as follows: Section I gives the basic introduction about the pesticides and its impacts. Then previous works related to the pesticides and various detecting techniques are listed in section II. Then section III discusses about the proposed system and its specifications. The general architecture and the design phase are mentioned in section IV. Section

V concentrates on the implementation and testing. Then the simulation results and discussions are explained in section VI. Finally, section VII gives the conclusion along with the future scope for the current research.

II. Literature Review

[8] According to calculations made and taken into consideration at the joint FAO/WHO workshop on pesticide residues, general food processing factors (PF) predict the following effects of processing techniques on pesticide residue levels and the disposition of the residues in processed products. PF is equal to mg Kg-1 of residues in processed goods. PF values more than 1 signify a concentration effect, whereas those less than 1 imply a decrease in the residue level. Fruits and vegetables undergo culinary and food preparation, much as other foods, before being ingested.

Due to the unavoidable amount of pesticides in certain fruits or vegetables, greater levels of pesticides have a significant rise in the negative effects in people. In order to detect illnesses and pesticides that humans should consume, [9] the research work creates an appropriate solution. The three stages of the processing-based considered approach required for image segmentation—the first of which is the conversion of RGB to grey—have been experimentally tested for the detection and classification of diseases. These stages are median filtering, edge detection, and morphological operations. In the case of a second-degree output feature, both domains are compared for feature extraction, and an image separation process is performed in a third phase using a different kernel on a vector support machine. The SVM method was chosen for fruit image classification and the fruit's image was obtained from the SVM classifier.

In India, 234 pesticides have been registered. Each of these pesticides has an acceptable limit for human ingestion and going over this limit would make humans to develop numerous carcinogenic effects. This can only be rectified by choosing fruit of a high quality, and the only way to accomplish this is through Quality Detection employing cutting-edge technology. This entails identifying the fruits that have been artificially ripened and the presence of pesticide residue in the fruit. In order to give more efficiency, [10] the research study incorporates three already-used methodologies, as stated in the article. This is likely to guarantee the organic fruits and vegetables to be consumed and significantly aids the horticulture and agro-industries in boosting the trade of fruits of high quality.

Similar to this, a prototype of the system was created in [11] using four different sensors like gas, moisture, temperature and ph sensors, along with a Wi-Fi module and an Arduino microcontroller to gather data regarding the existence of pesticides. Another study [12] then seeks to introduce the idea of "green analytical chemistry" and to evaluate the current advancements in pesticide detection methods in the context of sustainability and green chemistry. The research study [13] proposes a novel smart pen tool for detecting and measuring pesticide residue. The IOT is highly linked and uses the smart pen. A Bluetooth or digital meter is used to assess the amount of pesticides once the fluorescent cyclodextrin has been injected into the pen. The foundation of this new paradigm is made up of several technologies, including machine to machine (M2M), cloud services, and QR barcodes.

Researchers employ a number of strategies and technologies to extract, quantify, and identify bioactive chemicals from a wide range of fruits and vegetables. [14] A short overview of a wide variety of various tests was provided in this review. The benefits of phenolic natural compounds from fruits and vegetables such as antioxidants, antimicrobials, and anticancer agents are also covered. The cost-effective IoT dependent gadget described in this study can determine whether climacteric fruit has been artificially ripened or not [15]. Fruit that has been artificially or organically ripened can be distinguished using machine learning algorithms. The system comprises of an Arduino board, Raspberry Pi, an LCD display shield, a camera, and a solenoid valve. With accuracy and recall values of 0.93 and 0.92, respectively, this gadget can recognize the behaviour of fruit that has been artificially ripened.

III. Proposed System

Chemical contents are detected IR Emitter and biosensor. It is portable and consumes less time to predict.

The main advantages possessed by the proposed system are:

1. Is independent of temperature.
2. Everyone can be able to utilize it.
3. Ease of use
4. Highly efficient use.
5. Decrease in disease-causing agents.

1. System Specification

The specifications of the proposed system are listed here in terms of software specification and hardware specification.

Software Specification

1. Software: Arduino IDE (Integrated Development Environment)

Hardware Specification

The below table 1 gives the specification about the hardware utilized in the proposed system.

Table 1 Hardware Specification

Hardware	**Specifications**
Type of Arduino	Arduino Nano
Board	ESP8266 NodeMcu WiFi Development Board
Air Quality Gas Sensor Module	MQ-135
Temperature and Humidity Sensor	DHT11

IV. Methodology

In this project, we are proceeding with the identification of chemicals in fruits and vegetables using IOT by making use of Arduino Nano, DHT11 sensory device, gas sensory device, GSM, LCD, and NodeMCU as applicable in the sender and receiver ends as shown in the below figure 1. Our implemented system in this project has the ability to easily spot the chemicals being added with the support from the GSM module that triggers the message in order to alert the intended user.

1. Block Diagram

As shown in the below figure 1, we use two major sensor devices namely, DHT11 sensory device and gas sensory device with Arduino being the major processing element processing the data supplied by the sensory devices. This Arduino is being powered by using the applicable power supply depending upon the specification of used standard of it.

The sensory devices have the purpose of detecting the percentage of prevailing pesticides or in other words, we can say any other unnecessary chemicals that ruins the quality of vegetables and fruits get detected by the sensory devices. These inputs read by the sensory devices are fed into the Arduino for processing which then displays/ intimates the results as necessary to the administrator with the help of GSM, LCD, and NodeMCU. The chemicals if any present in the vegetables and fruit can be usually be displayed in the connected display device.

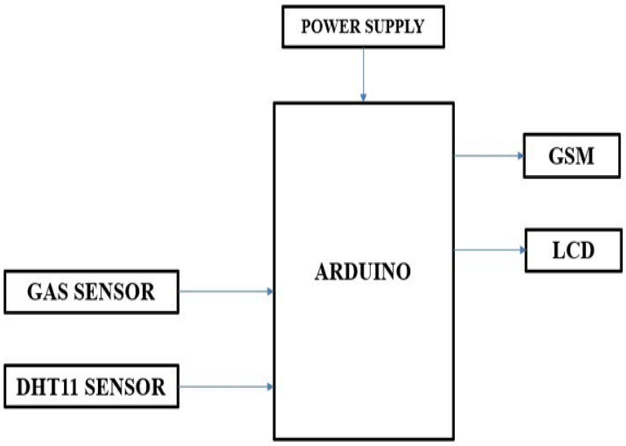

Figure 1 Block Diagram of our system doing the identification of chemicals in fruits and vegetables using IOT

Design Phase

As far as the design of our system is concerned, we depict the Data flow, use case, class, and collaboration diagrams in the following sub-sections:

1. Data Flow Diagram

As shown in the below figure 2, the flow of data has been shown clearly shown with the help of Data flow diagram. The diagram could be briefed as follows:

1. First, the vegetables and fruits are needed as the input to the system.
2. Then, the two sensory devices namely, DHT11 sensory device and gas sensory device are placed in closer proximity to the vegetables and fruits.
3. Afterwards, the signals get amplified so that the subsequent processing by Arduino is smoother.
4. Arduino then complies the program and then data gets processed to fed to the devices in the receiver end.
5. Then, the values get received by the devices in the receiver end.
6. Finally, the output of chemical related info gets displayed and intimated to the intended user so that the action by him/ her is not delayed.

Use Case Diagram

Furthermore, we now plot the use case diagram in the below figure 3 based on the desired working methodology of our system. Based on the nature of values of being either greater than or lesser than the certain pre-defined safe values, the chemical contents gets easily identified.

Class Diagram

Now, we depict the class diagram in the below on the desired working methodology of our system.

Collaboration diagram

Finally, we depict the collaboration diagram in the based on the desired working methodology of our system.

Required Components

All the required components used in our system doing the identification of chemicals in fruits and vegetables using IOT have been briefed in the following sub-sections:

1. Arduino Nano

Arduino Nano is nothing but a tiny, complete, and breadboard supporting board which is found to be primarily based out of either ATmega168 or ATmega328. It is just a touch above the functionalities served by the Arduino Duemilanove, however in a unique package. The one which we have used is of standard is ISO/IEC 32346.

2. DHT11 Sensory device

This DHT11 Sensory device is a single sensory device that is powered to measure two parameters namely, temperature and humidity [16]. This DHT11 Sensory device is found to be in stable condition for longer duration and also imparts greater reliability [16]. It is more like a micro controlling device that fancies NTC kind temperature sensory equipment.

MQ135 typed Gas sensor

The MQ135 type Gas Sensory device is a single sensory device that is capable of measuring the levels of kinds of gases including but not limited to alcohol, smoke, CO2, benzene, and many more [17]. The MQ135 type Gas Sensory device is a easily accessible several purpose serving gas sensory device available for the grab [17]. It is attached to the Arduino Nano and the output given by it is usually expressed in AQI.

NODEMCU

A well-known Lua scripting language-based IoT tool is NodeMCU. It is deploying that language to encourage the sharing of variables measurement done between the sensor and the respective vegetables and fruits being screened for chemical contents in it easily in a wireless mode. This could be further connected to other communication modules like GSM module in order to trigger the alerts as necessary.

GSM Module

GSM module is a type of communication module that aids to initiate the communication in any forms. In our case, the messages are triggered to intimate and alert the intended users of the chemical contents found in the vegetables and fruits.

Module Description

In this part, we will discuss about the three modules that our system contained in it.

1. Module 1

As shown in the below figure 6, the first module is concerned with the collection of required components, which are as follows:

1. Arduino Nano
2. DHT11 Humidity and Temperature sensory module
3. MQ135 Air quality Gas sensory module
4. NODEMCU – ESP8266 Wi-fi Development board
5. GSM Module

(a) Arduino Nano

(b) DHT11 Sensory device

(c) MQ135 Sensor

(d) NODEMCU - ESP8266 Wi-Fi Development Module

(e) GSM Module

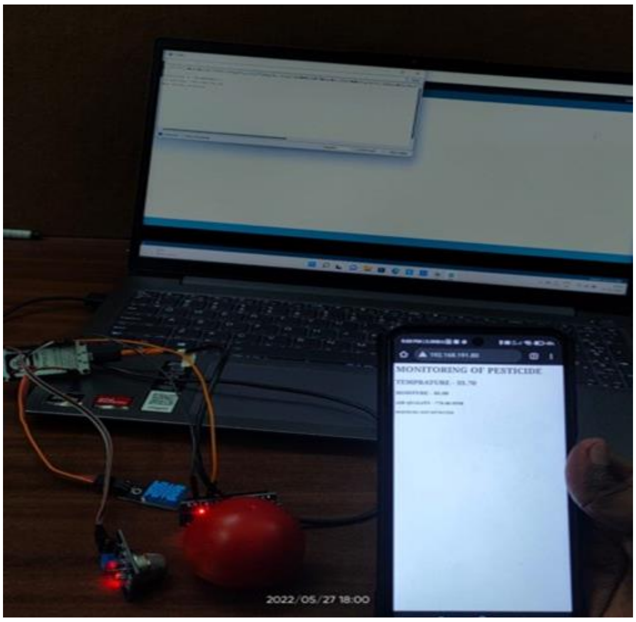

Figure 2 Validation and Testing

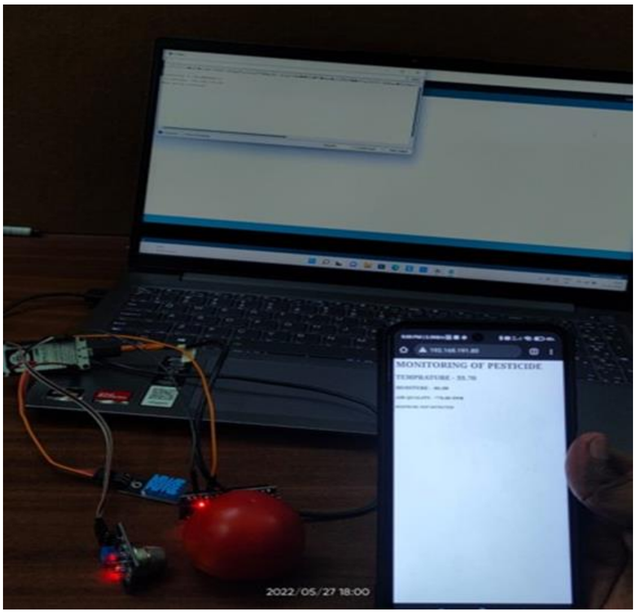

Figure 3 Validation and Testing

Steps to execute/ run /implement the project

The Following are the steps to execute/ run /implement the project:

1. Connecting the sensor components as per required manner and then place the desired vegetables and fruits to be tested for chemical traces.

2. Running the Arduino IDE compiler.
3. After testing the model, we will come to know about the pest detection along with the Temperature and display moisture percentage.

Implementation and Testing

In this project, we are proceeding with the identification of chemicals in fruits and vegetables using IOT by implementation and testing of various components like Arduino Nano, DHT11 sensory device, gas sensory device, GSM, LCD, and NodeMCU. Our system is being implemented with the input and output designs found in the following sub-sections:

1. Input and output in the implementation

In this sub-section, we will see both the designs of input as well as the output of our system doing the identification of chemicals in fruits and vegetables using IOT, which have been shown in the following sub-sections:

2. Design of the Input

The design of the input in our chemical traces identification system has already been shown in the above figure 5.

3. Design of the Output

The design of the output in our chemical traces identification system

Steps to execute/ run /implement the project

The Following are the steps to execute/ run /implement the project:

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2. Design of the Output

The design of the output in our chemical traces identification system

Testing and its types

In this sub-section, we will see about the inputs as well as the outputs of various kinds of implementation level testing namely, unit, integration, and system testing. Furthermore, this sub-section

1. Unit testing

Unit level testing is always done to assess the tinier segments of several functionalities instead of assessing the overall system. The following figure 10 shows the input and test result of this unit level testing:

Testing and its types

2. Integration testing

Integration level testing is a test that is always being done to integrate the modules of the software in a logical manner for the sake of assessing it as a set. The following figure 11 shows the input and test result of this integration level testing:

3. System testing

The major concentration of this system level testing on the verification of every functional necessity. The following figure 12 shows the input and test result of the system level testing:

Depiction of Test Result

Once the implementation has been assessed in every possible way and the perfection has been ensured, a test is conducted and the performance of our chemical traces identification system is ensured as shown in the following figure 13:

Simulation Results & Discussion

1. Efficiency of the Proposed System

The devised method is found promising as our chemical IOT technology is able to successfully monitor the agricultural food products in an easier, automatic, and effective way. The deployment and utilization of system ensuring safety and quality of the agriculture-based products is found to be well-performance, which fulfils the needs of the public people as it used the state-of-the-art tech of IoT. In the last few years, the tech of IoT has been found deployed in several unique arenas because of its raised efficiency yielded. Thus, the tech of IoT deployed in the safety and quality aspects of the agriculture-based products not only ensures the context of supply chains and production, but also ensures the sales of the entire chain of supply. Finally, because of detecting the pesticides or any unnecessary chemicals using our chemical traces identification system based on practical samples, various adverse health related issues could be avoided totally by starting to consume vegetables and fruits that have become chemical-free.

2. Comparison of Existing and Proposed System

As far as the existing system (system in which lab testing is majorly done) is concerned, the Pesticides are detected by Chromatographic methods like Gas Chromatography, Liquid Chromatography and Mass Spectrometry. They are time consuming processes since samples can only be treated in laboratory and requires lot of manual work.

Whereas, our proposed system based on IoT is concerned with the detection of chemical contents by using the IR Emitter and bio-sensor. It is portable and consumes less time to predict than the lab-based existing systems. Furthermore, the accuracy aspect of our chemical traces identification system using the IoT is considerably more when compared to the existing system.

Sample Code

The sample code of our chemical traces identification system has been shown in the following

Obtained Outputs

Two typical outputs of our chemical traces identification system have been shown in the following figures 15 and 16:

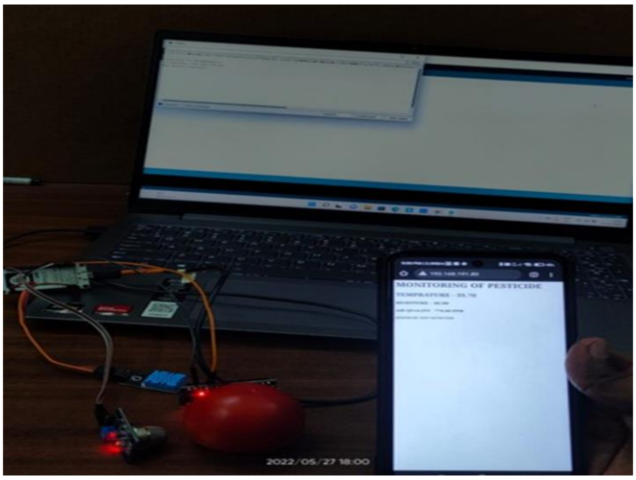

Figure 4 Depiction of Output 1 of our chemical traces identification system

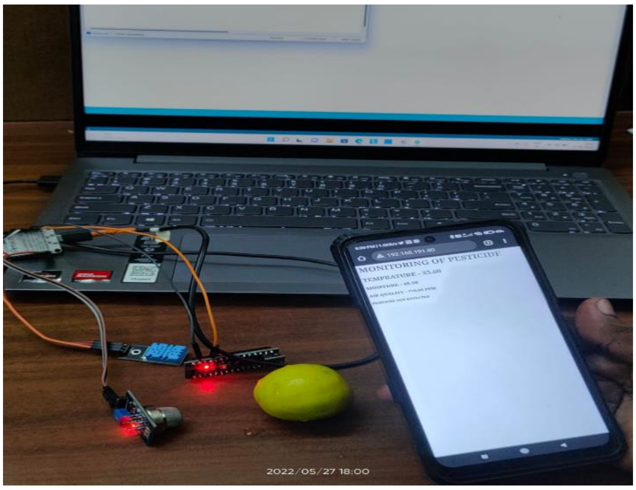

Figure 5 Depiction of Output 2 of our chemical traces identification system

V. Conclusion and Future Work

As the existences of pesticides or any unnecessary chemicals changes based on the portion as well as the type of plants and molecule nature and mostly the quality aspect of the vegetables and fruits reduces much higher, the need for system like our chemical traces identification system becomes much necessary and is found to be much beneficial. Furthermore, in general, the vegetables and fruits containing pesticides or chemicals might not survive for more days than an organically prepared vegetables and fruits could survive.

As the utilization of our chemical traces identification system was done in the practical condition samples, the capability for identifying the residues of pesticides or any traces of chemicals was found to be much larger as we have utilized state-of-the-art tech of IoT using the sensory devices and good communication medium like GSM module. As even the residues could be easily identified with our system, the rate of washing required for those vegetables and fruits could appropriately be predicted so as to ensure a much negligible chemical traces of closer to 0.01.

As we were able to only identify a few chemical compositions like Nitrate, Sulphur, Phosphorous, etc. in fruits and vegetables, we desire to identify a greater number of chemical contents found in various fruits and vegetables in the future.

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