IoT based solution for monitoring of pollution through pesticide in fresh fruits and vegetable available in market.

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ABSTRACT

Internet of Things (IoT) technology has been identified as one of the emerging technologies which is widely used in all walks of life in the world. The IoT comprises such as Radio Frequency Identification(RFID),Wireless sensor networks(WSN),Global Positioning System(GPS), which is used for sensing, tracking ,etc in environment management. With the help of Arduino and pest detection sensor is used for sensing the pests present in the fruits and vegetables in the market. With addition of that ,the LCD is used for indicating the pests present in fruits and vegetables . The problem shows through LCD and make aware that How much Percentage is present in fruits and vegetables.

Keywords;IoT,Arduino,LCD,GPS,RFID,Wireless sensors.

INTRODUCTION

Pesticides are chemical substances applied to crops at various stages of cultivation and during the post-harvest storage of crops. The use of pesticides is intended to prevent the destruction of food crops by controlling agricultural pests or unwanted plants and to improve plant quality . Pesticide use in commercial agriculture has led to an increase in farm productivity. Despite the wide ranging benefits of using pesticides in agriculture, several incorrect applications can result in high and undesirable levels of the compounds in the produce that reaches consumers. These include inappropriate selection of pesticides used on foodstuffs, over use of pesticides and harvesting the crops before the residues have washed off after application .

Monitoring of pesticides in fruit and vegetable samples has increased in the last years since most countries have established maximum residue level (MRL) for pesticides in food products . With the gradual advance of urbanization construction, the procurements of vegetables and fruits are most in markets and supermarkets. However, these procurement locations almost have no pesticide residues detection devices. Gas chromatography (GC), liquid chromatography (LC) or combinations (GC-MS or LC-MS/MS) are traditional analytical techniques for identification and quantity determination of pesticides residues . Although these methods offer quantitative analysis with sensitivity and selectivity, they are slow, expensive, laborious and not convenient to popularize and promote. Moreover, they don't have the ability of information sharing and remote control.

Therefore, they are not suitable for rapid detection and agricultural products traceability. Biosensors account for an easy method to determine pesticides in environmental and food matrices. The use of biosensors as screening devices is cost effective and decreases the number of samples to be analyzed by traditional analytical techniques mentioned above. With the explosive growth of smart phones, wireless technologies and sensor technologies have become a fundamental tool for everyday life around the world. The coming wave of interconnected devices, appliances, sensors, meters and countless other "things" represents the next generation of a hyper-connected world, the IoT. Interconnected entities can open a communication channel with each other based on the IoT. Many technologies serve as the building blocks of this new paradigm, such as QR barcode, cloud services, machine-to-machine interfaces (M2M), and so on. Also, this application domains . The IoT we used in this pesticide residues detection system based on the pesticides detection . Due to the above, the purpose of this investigation is to design a system for pesticide residues detection and agricultural products traceability. We intend to allow anyone to interconnect this system with programming knowledge. This system can be used in supermarkets, markets and plantations. Moreover, this system also can be used in the areas of purchasing, storage and transportation , and in house.

NECESSITY OF PESTICIDES

Increase in the population of India, results in higher demand for food as well as decrease in land for farming. Hence to fulfil the increased demand, food is adulterated to get more quantity in short period of time. Moreover, pesticides in crops are using above the legal maximum residue limit by farmers to gain more profit in lesser time. Although pesticides are highly effective on pests but they can reside in an environment. Among the class of organophosphate pesticides, chlorpyrifos is widely used in vegetables. Chlorpyrifos has toxic effects on the human body particularly on brain and nervous system. In this paper, design and development of sensors for pesticide residue detection using parameters like electrical conductivity, pHs etc. are proposed. It was found that the relative percentage deviation between the value of conductivity in pesticide free samples and the pesticide containing samples of bitter gourd, bottle gourd and tomatoes are 31.4%, 10.7% and 19.09% and also between pesticide free samples and market samples are 33.5%, 8.7% and 16.56% respectively. This large variation among different samples shows the presence of pesticide residue. Hence, the method can be successfully used for the detection of pesticide residues in vegetable samples. The proposed sensor system is easy, rapid and time undemanding method. So, this electronic device can also be used to check impurities in any other liquid like water, milk etc.

PESTICIDES IMPACT ON HUMANS

Pesticides are substance or mixture of substance which differ in their physical, chemical and identical properties from one to other. Hence, they are classified based on these properties. Some pesticides are also categorized into various classes depending on the needs. Presently, three most popular classifications of pesticides which are widely used is classification based on the mode of entry, pesticide function and the pest organism they kill, the chemical composition of the pesticide. Based on toxicity of pesticides, WHO classified them into four classes: extremely dangerous, highly dangerous, moderately dangerous and slightly dangerous. Improper application of pesticides can cause severe harmful effect to living system and the environment. Most pesticides do not distinguish between pests and other similar incidental lifeform and kill them all. The toxicity of insecticides to an organism is usually expressed in terms of the LD50 (lethal dose 50 percent) and LC50 (50 percent lethal concentration).

TYPES OF PESTICIDES

There are many different types of pesticides, each is meant to be effective against specific pests. The term "**-cide**" comes from the Latin word "**to kill**."

Algaecides are used for killing and/or slowing the growth of algae.

Antimicrobials control germs and microbes such as bacteria and viruses.

Biopesticides are made of living things, come from living things, or they are found in nature.

Desiccants are used to dry up living plant tissues.

Defoliants cause plants to drop their leaves.

Disinfectants control germs and microbes such as bacteria and viruses.

Fungicides are used to control fungal problems like molds, mildew, and rust.

Herbicides kill or inhibit the growth of unwanted plants, aka weeds.

Illegal and Counterfeit Pesticides are imported or sold illegally.

Insecticides are used to control insects.

Insect Growth Regulators disrupt the growth and reproduction of insects.

Minimum Risk Pesticides are exempt from EPA registration, but many states require them to be registere.

Miticides control mites that feed on plants and animals. Mites are not insects, exactly.

OBJECTIVE

The main objective is to reduce the diseases that causes in our human system.However, we have solution to reduce the pesticides in fruits and egetables such as by using Vinegar,Baking Soda,Turmeric Powder,etc. But still the residues are present still in fruits and vegetables which causes severe damage to our human system. The farmers use the pesticides to crop their fields and to get profit . Due to development in our technology the chemicals percentage is increase.The death rate increases than the birth rate.This pesticides infects the unborn child growth.

SYSTEM DESCRIPTION

The system's architecture can be divided in three parts, as it can be seen in Fig. 1: Sensor which detects the pesticides percentage and indicates the pesticides present in fresh fruits and vegetables available in markets. Secondly, of Arduino which is microcontroller connected to computer ,the program in the Arduino gives for the output display .Finally, the third part is LCD display which gives an information about the pesticides , it indicates the percentage that is present in the fruits and vegetables. We could get the pesticide residues concentration . The detection information will be displayed in the LCD(Liquid Crystal Display).

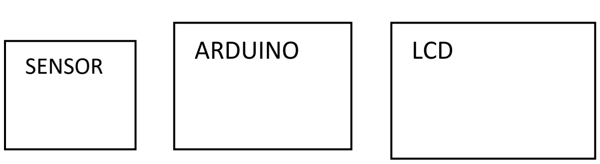


Fig.,Block Diagram

HARDWARE COMPONENTS

- SENSOR
- ARDUINO KIT
- LCD DISPLAY
- BREADBOARD

SOFTWARE COMPONENTS

- ARDUINO SOFTWARE

Challenges	**Total Percentage**	**Perception**
Insect pest	72	Pesticides are harmful only under certain conditions
Plant Disease	68	Pesticides harm mostly some People like old and with weak immune system
High Cost Of Pesticides	62	Pesticides are harmless to Humans.
Limited Storage Life Of Fruits And Vegatables	58	
Fluctuating Under Weather Conditions	61	Pesticides are harm but their preventive methods can cause more harm than good.
Lack Of Pest Resistant	68	

Table.,Chart of causing infection

Sample program performed in Arduino IDE

A *sketch* is a program written with the Arduino IDE.Sketches are saved on the development computer as text files with the file extension **.ino**. Arduino Software (IDE) pre-1.0 saved sketches with the extension **.pde**. A minimal Arduino C/C++ program consist of only two functions:

setup() : This function is called once when a sketch starts after power-up or reset. It is used to initialize variables, input and output pin modes, and other libraries needed in the sketch.

loop() : After setup() function exits (ends), the loop() function is executed repeatedly in the main program. It controls the board until the board is powered off or is reset.

PROGRAM

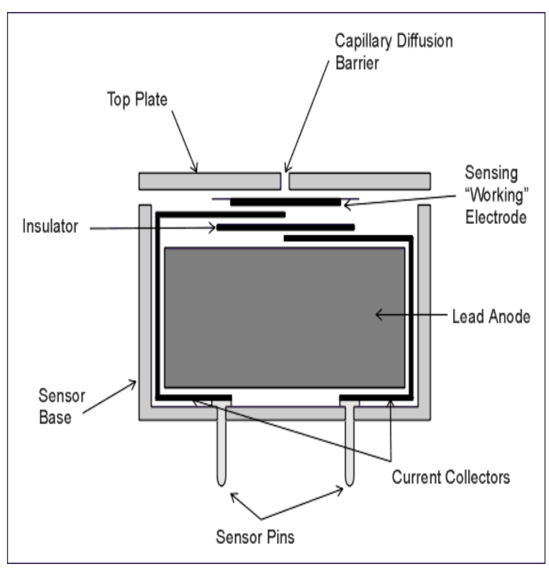
```
int count=80;

void setup(){

Serial.begin(9600);

}

void loop() {

int s=digitalRead(2);

if(s==0)

{

count=count-15;

Serial.print("Percentage of pesticides");

Serial.println(count);

delay(1000);

}

}
```

SENSOR

All electrochemical oxygen sensors are of the self powered, diffusion limited, metal-air battery type, comprising an anode, a semi-solid electrolyte paste and an air cathode. The cell comprises an enclosure containing two electrodes, a flat PTFE tape with an active catalyst, the cathode and a block of lead (anode). The enclosure is sealed apart from a small capillary that controls the rate at which oxygen can enter the cell.

Oxygen enters the sensor through the capillary where it comes in contact with the cathode, and is immediately reduced to hydroxl ions:

$O_2 + 2\ H_2O + 4\ e^{--} \rightarrow 4\ OH^{--}$ (1)



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These hydroxyl ions then migrate through the electrolyte to the lead anode. The hydroxyl ions react with the lead anode which is then oxidised to lead oxide.

2 Pb + 4 OH -- → 2 PbO + 4 e-- + 2 H_2O (2)

As these two processes take place a current is generated which can be measured by the instrument. This current is proportional to the oxygen concentration and leads to an accurate determination of oxygen for gas analysis purposes.

As the electrochemical reaction results in the oxidation of the lead anode, the electrical/chemical properties of the cell change, requiring periodic calibration. The oxidation of the lead anode also means the oxygen analyzer sensors have a limited life. Once all the available lead has been oxidised the cell will no longer produce an output, and must be replaced. Consequently the lower the oxygen level the sensor is exposed to, the longer it will operate. Systech Illinois ppm cells measuring low levels of oxygen should have lifetimes in excess of 3 years. Percent cells, measuring air, should have lifetimes around 5 years.Some components of the gas stream increase the rate of oxidation, or form other lead compounds, thus shortening the life of the sensor. These include CO2 and Cl2. Gas streams containing these gases should be avoided where possible.

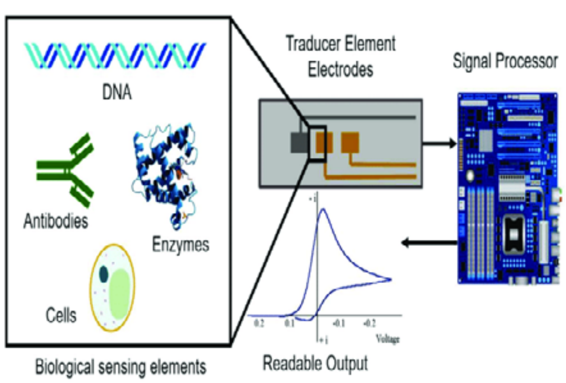

Fig.,Electrochemical Oxygen Sensor

ENZYME SENSOR FOR PESTICIDES DETECTION:

Modern biosensors can be miniaturized, mass produced and easily transported. Biosensors can also measure analytes in real-time, which is extremely useful for monitoring rapid changes in biological fluids.

A biosensor is universally defined as “a self-contained analytical device that combines a biological component with a physicochemical device for the detection of an analyte of biological importance”. It consists of a biological recognition element which is able to specifically interact with a target molecule and a transducer able to convert this interaction into a measurable signal.

Chemical biosensors are based on the presence of a biological element, which is specific for the analyte, and stable under normal conditions of use and storage . Numerous recognition elements have been used in biosensors, such as receptors, nucleic acids, whole cells, antibodies and different class of enzymes.

Biosensors are normally classified according to the transduction method they use. In biosensors, the transducer converts a wide array of chemical, physical or biological reactions into an electrical signal . On this basis, optical, calorimetric or acoustic biosensors have been built and characterized, but the most widely used biosensors rely on the electrochemical proprieties of transducers and analytes. Electrochemical biosensors have been studied since the early 1960s when the first glucose oxidase biosensor was developed . Electrochemical biosensors can be impedimetric, potentiometric or amperometric biosensors, where the biochemical signal is transduced into a quantifiable amperometric signal . Enzyme-based amperometric biosensors, in which the production of a current is monitored when a fixed potential is applied between two electrodes, have been widely studied over the last few decades as they are easy to miniaturize, robust and can operate with small sample volumes of rather complex matrices .

Designing biosensors requires consideration of both the target analyte and the complexity of the matrix in which the analyte will be measured. Electrochemical measurements depend strongly on the working electrode material . Since the end of 1980s, research has focused on the development of amperometric biosensors based on carbon paste electrodes . Carbon still represents one of the most widely-used material for biosensing in electrocatalysis and electroanalysis, exploiting the favourable chemical-physical proprieties of carbon nanotubes or graphene, as well as desirable catalytic proprieties (high surface area, good biocompatibility, chemical stability and signal reproducibility) . In addition, metals, such as gold, platinum or palladium, have been used as transducers in electrochemical biosensors as electron transfer is easy and hydrogen peroxide generated by first generation oxidase based biosensors is efficiently electro-oxidized to generate a signal .

The characteristics noted above make biosensors useful for biomedical application, research and, even in some cases, for diagnosis. Biomedical biosensors are cost-effective, easy to use, fast and can use wireless detection . Castillo *et al.* reported in 2004, that enzyme-based amperometric biosensors could be used in the following ways

i. As “off line” devices — biological samples are collected and target analytes are measured using biosensor-based analytical equipment. For example, commercial devices are available for measuring blood glucose.
ii. As “*in vivo*” sensors — biosensors are implanted and continuously detect extracellular changes in the concentrations of the analyte of interest. The invasiveness of such implantable devices limits their use mainly to preclinical research in animal models.
iii. As “on-line” device — biosensors are integrated with a sampling device implanted in the body or biological material. For instance, microdialysis probes can be implanted and connected to a flow through detector incorporating a biosensor element.

Amperometric enzyme-based biosensors are subject to interference from chemicals present in the sample matrix. Interference is especially problematic in biological samples in particular, as there are often electrochemical interferences in the sample matrix , as well as small molecule metabolites, proteins, macromolecules and cells. Complex biochemical reactions occur naturally in these fluids (for example, blood clotting) . Some pathological conditions, such as inflammation or tumors, could modify some fluid parameters chemical composition or pH, influencing the activities of the enzyme and, consequently, the biosensor performances. Matrix interference can often be overcome by pretreatments, such as extraction, pre-concentration, filtration and derivatization .

ARDUINO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino .The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable .It can be powered by a USB cable or by an external 9volt battery , though it accepts voltages between 7 and 20 volts.

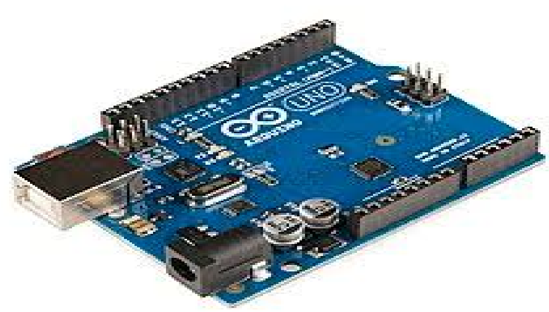

fig.,Arduino UNO

It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative

Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0.The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform .The ATmega328 on the Arduino Uno comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

TECHNICAL SPECIFICATION

- Microcontroller: Microchip ATmega328P
- Operating Voltage: 5 Volt
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25 g

LCD DISPLAY

LCD (liquid crystal display) is the technology used for displays in notebook and other smaller computers. Like light-emitting diode (LED) and gas-plasma technologies, LCDs allow displays to be much thinner than cathode ray tube (CRT) technology. LCDs consume much less power than LED and gas-display displays because they work on the principle of blocking light rather than emitting it.

An LCD is made with either a passive matrix or an active matrix display grid. The active matrix LCD is also known as a thin film transistor (TFT) display. The passive matrix LCD has a grid of conductors with pixels located at each intersection in the grid. A current is sent across two conductors on the grid to control the light for any pixel. An active matrix has a transistor located at each pixel intersection, requiring less current to control the luminance of a pixel. For this reason, the current in an active matrix display can be switched on and off more frequently, improving the screen refresh time (your mouse will appear to move more smoothly across the screen, for example).

Fig.,LCD Display

CODING

```
#include<LiquidCrystal.h>

int count=80;

LiquidCrystal  lcd(12,7,5,4,2);

void setup(){

Serial.begin(9600);

}

void loop() {
```

```
int s=digitalRead(7);
if(s==0)
{
count=count-15;
lcd.print("Percentage of pesticides");
lcd.println(count);
delay(1000);
}
}
```

CONCLUSION

Finally, we conclude that by using IoT based monitoring the pesticides in fruits and vegetables .Detecting the pests present in fruits and vegetables or any residues present through the pest detection sensor it senses and passes the information to the Arduino and then displays in an LCD display .By detecting through the process it informs that how much residues of pests present so that the fruits and vegetables are washed more than twice still it reaches to 0.01%. The application of this pesticides residues detection instrument has been performed on real samples. The system showed to be successful in pesticide residues detection and agricultural products traceability. For cholorpyrifos extracts, the detection system based on biosensor permitted to determine concentrations of 2μg/L, thus indicating the performance of this system can satisfy the pesticide residues detection and information sharing requirement of real vegetables and fruits samples. The detection system based on amperometric biosensor and IoT for pesticide residues detection can be used in every link in the agricultural products traceability.

ADVANTAGES

- Does not depend on Temperature.
- Can be used by anyone.
- Simple to use.
- Very effective usage.
- Reducement of causing diseases.

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