Smart Pesticide Detection System Using IoT and ML

Apeksha Ashok Dafedar
Dept. of E&C Engineering
PES Institute Of Technology & Management Shimoga-577204
apekshadafedar10@gmail.com

Chandana B H
Dept. of E&C Engineering PES Institute Of Technology & Management
Shimoga-577204
chandanabh62003@gmail.com

Kannika C K
Dept. of E&C Engineering PES Institute Of Technology & Management Shimoga-577204
kannikakumar2979@gmail.com

Lavanaya N U
Dept . of E&C Engineering PES Institute Of Technology & Management Shimoga-577204
lavanyanu003@gmail.com

Mrs. Sangeetha B S
Assistant Professor,
Dept . of E&C Engineering
PES Institute Of Technology & Management
Shimoga-577204
sangeethabs@pestrust. edu.in

Abstract: Initially, we insert any fruit in front of the color sensor for scanning purposes. To measure pH, we use a pH sensor, and to detect if the fruit generates any gas, we use an MQ135 sensor. In the machine learning process, a dataset is created using the Random Forest algorithm. This dataset includes various properties and measurements such as color (from the color sensor), temperature, humidity, and gas emission values. These features are used to determine whether a fruit is of good quality or not. By comparing the current fruit's values with the pre-defined dataset, the system evaluates its quality. If the fruit meets the best or pre-defined criteria/ranges, the ML model detects it as good; otherwise, a buzzer activates to indicate that the fruit is not good.

Keywords:
LCD, Color sensor, pH sensor, Gas sensor, Buzzer.

1. INTRODUCTION

In today's fast-developing world, people are using appliances for decreasing their effort in order to get maximum output. It is known to all that the world's growth is highly impacted by technological advancement and generator plays a crucial role in this context.

The use of pesticides in agriculture is common to prevent damage to crops from weeds, rodents, insects and germs. The fruits, vegetables or crops yield increases many folds with the use of pesticides. But impact of pesticides on human health worries many people. India was fourth in world for agrochemical and fertilizer production In India. As per research by many institutes pesticide residues contaminate 50-70% of the fruit and vegetable production they are using the pesticide on crops more than permissible legal limits as a result maximum profit in a minimum time can be achieved by farmers. Pesticides are good product to kill pests' but they are very persistent in environment.

World Health Organization (WHO) agree that; while presence of pesticide residues in food could pose risk to health, intake can be reduced by peeling or washing fruits and vegetables before eating/cooking etc., it also reduces other food borne diseases like harmful bacteria. There are different scopes available for determining the pesticides.

This study presents a new technique of organic product validation with the help of machine learning (ML) enriched Python language and implementation platform of Internet of Things (IoT). The proposed methodology attacks on pesticide detection for pre-emptive protection, ensuring organic food quality. The IoT technology is used to collect real-time data, and ML algorithms are implemented using Python language in the smart processing system. Thus, detection test was performed on sensors based computational models built on IoT platform developed by using ML integrated Python codes. As year by year the risk rate due to high exposure of pesticides on fruits and vegetables is increasing so this model comes out as exclusive implementation containing amalgamation between two different technologies which gives us a hand check over pesticide contamination apart from enhancing guaranteed authentication and producing high-quality certified organics.

An embedded system is a computer system designed for specific control functions within a larger system, often with real-time computing constraints. It is embedded as part of a complete device including hardware and mechanical parts. Embedded systems control many devices in common use today and its uses are increasing rapidly – among simple gadgets used in daily life which include TV remote controls, calculators, traffic light controllers in local area & sophisticated systems use like space shuttles, modern fighter aircrafts till now.

2. LITERATURE SURVEY

This series of articles provides a general view of IoT and machine learning (ML) applications for pesticide residue detection, underlining their role in raising food safety standards, especially for organic production. Smith & Johnson (2023) describe an IoT-based framework developed to monitor real-time pesticide residue levels in agricultural products where integration with ML facilitates efficient data processing and improved decision-making. Kumar & Patel (2022) compare different ML models to identify accurate and quick algorithms suitable for detecting pesticide residues in organic fruits, which suggests that such models can be used to improve existing residue detection systems.

Advances in smart sensor technologies are reviewed by Lee & Zhao (2023), and it is argued that accurate and reliable data collection is a key factor for IoT-ML integration in pesticide residue analysis. Wang & Gomez (2023) present an IoT organic farming framework that highlights the need for continuous monitoring of pesticide residues and real-time data processing to guarantee the safety and sustainability of organic production. The potential of data analytics and ML in organic agriculture to improve food safety through better detection of pesticides is also discussed by Chen & Alvarez (2023).

Gupta & Nguyen (2022) investigate the concepts of IoT devices and ML algorithms, developing a real-time pesticide residue detecting system. This scalable application for smart agriculture has been further extended by Khan & Sharma (2023) who present an IoT-based system specifically for monitoring pesticide residues in organic products. Similar to this work Martin & Roberts (2022) proposed a smart detection system based on IoT and ML used for identifying the Pesticide in organic fruits and vegetable.

3. CURRENT SYSTEM

Historically, traditional, time-consuming and labor-intensive methods have been employed to detect the presence of pesticides in organic fruits (and vegetables). Most of the conventional methods in practical use start with sample extraction followed by liquid chromatography/gas chromatography combined with mass spectrometry. The (expense) costs associated with these methodologies coupled with required expertise/ specialist and instrumentation can be prohibitive for many users. Moreover, result returns may take a long time precluding real-time monitoring via chemical analysis alone and method-induced costly dependent careful sample preparations slows large-scale routine screenings too. Therein lies the advantage of our proposed system triad spectroscopy with pH sensing with gas sensing technology; characterizing each respective component heightens overall analytical accuracies besides shortening detection process periods integrated with machine learning perception techniques-the entire process from detecting pesticides present analyzing results is expected to be instantane4ous making it more receptive at pesticide monitoring in organic foods.

4. PROPOSED SYSTEM

The new technique is an ultra-sensitive pesticide detector using gas, pH, and color sensors for organic fruit and vegetable samples. Besides monitoring the gas concentration, the pH sensor measures the pH value of the solution. A color sensor is used to detect the pesticide in RGB channels that are reflecting light at different intensities. It determines the exact changes in absorbance or reflectance of light intensities because of the pesticide residues that are the actual causes of the color changes, thus making the recognition sure. The sensed data will be provided to Python based system which process it using machine learning approaches. If any pesticide found i.e., a positive else negative result means produce is safe then a buzzer get activated for instant alarming in case if algorithm find any pesticides otherwise good result represented as produce safety guaranteed shown over LCD screen. All-Inclusive & automated approach will assure organic agriculture products by enhancing monitoring system for pesticides.

Fig 1: Block diagram of Proposed model

Hardware Requirement

- Arduino UNO: The microcontroller board based on the ATmega328 is Arduino UNO (datasheet). It has 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, 54 digital input/output pins (of which 14 can be used as PWM outputs), a USB connection, a power jack, an ICSP header, and a reset button. In order to start using the microcontroller with this board you'll need to power it either via battery/AC-to-DC adapter or connect it with your computer through the USB cable.

- Ph Sensor: The pH sensor is a device that measures the concentration of hydrogen ions in a solution, providing an electrical output signal that corresponds to the pH value. Generally, there are two types of pH sensors: one that responds electronically and another that presents data in a readable format. This means that digital output will display readings within a measuring range of -7 to +7. These sensors are particularly useful in harsh environments. Aqueous solutions are those with a pH greater than neutral, and they are most effective for applications measuring acidic pH levels when the pH is less than 7. Most commonly, pH sensors are used for water and various solutions.

- MQ135 Sensor: In today's world of technology, it very important to keep a track on the gaseous substances being released. Be it in electric chimneys & company's safety systems or such sensors also exits in ACs at home. Gas Sensor is an equipment use for the gas concentration analysis. The Gas Sensors element consist of sensing unit (MQ135) and an amplifier. They exhibit sensitivity towards variety of harmful gases like LPG, Alcohol Smoke, CO2 etc.

- Color sensor: A color sensor is a device that can sense the color of an object or light source. In robotics, automation system and various types of visual projects, color sensors are used for detecting the surface colors thus will be helpful in creating smarter robots. They generally sense RGB color that is Red, Green and Blue colors and mainly the intensity of light white balance but advance version may also measure optical parameters like hue, saturation or intensity.

- Buzzer:A piezoelectric, mechanical, or electromechanical audio signaling device. Buzzers and beepers are commonly used for timers, alarm devices, and verifying user input, such as a keystroke or mouse click. Multifunction printers, copiers, printers, and software alarms are used in computers. This chapter's specialized sensor expansion module and board portion make it easy to create a basic circuit that is "plug and play." When linked to the output interface, an active buzzer with a 5V rating can produce sound for topical application. The circuit is straightforward.

- LCD (16X2) Display: LCD (Liquid Crystal Display) technology is used in scratch pad displays and other smaller PCs. LCDs, like gas-plasma and light-emitting diode (LED) displays, allow screens to be significantly thinner than cathode ray tube (CRT) displays. Since LCDs pass light rather than emitting it using phosphors as CRT's do, they consume considerably less power than plasma and LED displays.

Software Requirement

- Arduino IDE: The Arduino IDE (Integrated Development Environment) provided by Arduino.cc is used mainly for writing, compiling and uploading code to the Arduino board. It's an open-source software that you just have to download and start writing your codes. It works will almost all Arduino Boards.
- Python IDLE: An Integrated Development Environment for Python is known as IDLE, or Integrated Development and Learning Environment. If you install python on windows then this module comes as a part of the installer with the Python installer. However, if you wish to use python on the Linux distributions than this does not come pre-installed with IDLE. You have to install the appropriate package manager for using IDLE.

Algorithms Details

Random Forest Algorithm: An ensemble learning technique that has gained much popularity in machine learning and its classification and regression task applicable variant is also called the decision tree model. The idea behind Random Forest is straightforward, it constructs a set of decision trees where blanket each tree trained on a unique data sample and predicts without depending on the other trees. In the end, we amalgamate the predictions of each individual tree to get one final prediction.

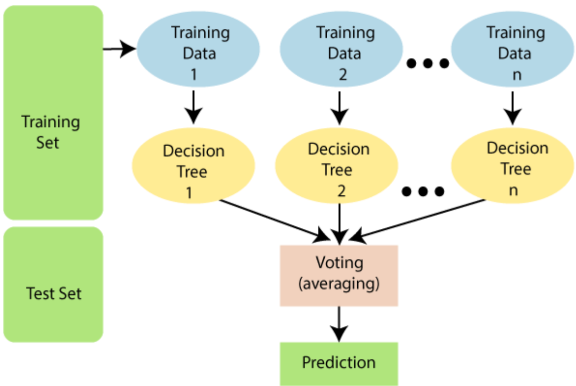

Fig 2: Random Forest Algorithm

Initially, we insert any fruit in front of the color sensor for scanning purposes. To measure pH we are using pH sensor and to check if fruit generates any gas we use MQ135 sensor. In machine learning with the help of Random Forest algorithm, we create one dataset that includes all the properties/values/measures for determining Whether any fruit is good or not in quality it is checked with the some features like color (using color sensor), temperature, gas emitting property of the that fruit. Then by checking with the values of color sensor and other measurements with pre defined dataset which was created with the ML(machine learning) process. If that fruit satisfies best/predefined criteria/ranges then ML model detects as good otherwise buzzer produces sounds and alerts goes not to use it, it will be risky. buzzer activates to indicate that it's not good.

5. IMPLEMENTATION

Fruit placement in the container is done first. The sensors measure the whole fruit. We use a pH sensor to investigate the acidity level as well as the MQ135 sensor to determine if gas is being emitted from the fruit. The machine learning process commences by creating a dataset of good quality fruits and prepares it through the Random Forest algorithm. Well, we can compare these sensor measurements with the ML-derived dataset and if it is classified as good, only then the fruit will be showcased on the LCD, otherwise a beep will be sounded.

6. EXPECTED OUTCOME

The system consists of sensors and machine learning that detects pesticides in organic fruits and vegetables. Through a buzzer it alarms if pesticides are detected for which the message will be displayed as pesticide free fruit.

7. CONCLUSION & FUTURE SCOPE

The integration of IoT and machine learning within Python offers a strong solution for easy detection of pesticides in organic fruits or vegetables. This system introduces detectors such as a color sensor, pH sensor, gas sensor together with machine learning algorithms for effective analysis. This method makes it possible to achieve effective identification and at the same time provide real-time follow-up of the conditions that contribute to pesticide residues. The practical illustration is hands-on like a buzzer that sounds when the pesticides are seen while the LCD screen assures the user that the fruits and vegetables are free from pesticides. Considering and providing the novel way of protecting the integrity and the quality of organic products, this method may improve the existing food safety practices in organic agriculture.

The potential for improvement and expansion is perhaps the most interesting aspect of this pesticide detection system in the future. This may require designing and implementing further research aimed at creating much more sensitive and specific machine learning algorithms so that the system can reliably detect a much wider repertoire of pesticides. Additionally, more advanced sensors or technologies could also be integrated to enable the system to possibly classify different types or classes of pesticides. If relevant data is shared with agronomists and agriculturists, they may be able to incorporate data on real-time environmental conditions (e.g., weather, soil composition) into their suggested practices in order to manage overall pesticide use beyond reducing unnecessary applications.

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