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AI-BASED DIFFERENTIATION OF FERTILIZED AND ORGANIC FRUITS

[1]Mrs Ramya KR, [2]Sarika S, [3]Shree Harshitha S,[4]Surya RV,[5]Tirumala Ganesh Bharadwaj Sharma

[1]Assistant Professor, [2]Student, [3]Student, [4]Student, [5]Student
[1]Electronics And Communication,
[1]KS Institute Of Technology, Bangalore, India

Abstract: The project "AI-Based Differentiation of Fertilized and Organic Fruits" aims to identify whether a fruit is organic or chemically fertilized using AI and image processing techniques. A camera module captures fruit images, which are analyzed through machine learning algorithms for color, texture, and shape features. When image-based detection is uncertain, a pH sensor measures the fruit's acidity level for accurate classification. The system is implemented on a Raspberry Pi for real-time analysis. This project promotes healthy consumption and sustainable farming practices through smart automation.

***IndexTerms* - This project involves the use of Artificial Intelligence (AI) for accurate fruit classification. It applies Image Processing techniques to analyze visual features of fruits. A pH Sensor is integrated to determine chemical characteristics and support differentiation. The system classifies fruits as organic or fertilized based on combined visual and chemical data. Implementation is done using a Raspberry Pi for real-time detection and analysis.**

II. INTRODUCTION

Music serves as a profound tool for expressing oneself, communicating ideas, and fostering emotional well-being. Unfortunately, many conventional musical instruments demand precise motor control and coordinated physical actions, which can be challenging for individuals with physical disabilities. To address this issue, assistive technology is continually advancing to make musical expression more inclusive. This project presents a gesture-based virtual instrument system that allows individuals with limited physical mobility to create and enjoy music using simple hand gestures..

The system is built using a Raspberry Pi 4 and a Pi Camera, which together capture and process real-time hand movements. Through computer vision techniques and gesture recognition frameworks such as MediaPipe, the system maps specific gestures to musical notes and instrument actions. By integrating FluidSynth and soundfonts, the project supports multiple instrument sounds including piano, guitar, drums, and violin, without requiring any physical contact or traditional input methods. This project is developed to be cost-effective, easy to use, and inclusive, providing motor-impaired individuals with new ways to interact with music. It also highlights the power of human-computer interaction in improving accessibility and expanding creative possibilities.

III. LITERATURE SURVEY

In recent years, the demand for organic food products has grown rapidly due to increasing awareness of health, nutrition, and environmental sustainability. However, distinguishing organic fruits from chemically fertilized ones has become a major challenge for consumers and even for vendors, as both often look similar in appearance. The excessive use of chemical fertilizers and pesticides in fruit farming not only affects the nutritional quality of the produce but also poses serious health risks when consumed over time. Hence, there is a strong need for an efficient and reliable system that can accurately identify the nature of fruits before they reach consumers.
The project "AI-Based Differentiation of Fertilized and Organic Fruits" aims to solve this problem by combining Artificial Intelligence (AI), Image Processing, and Sensor Technology. The system captures fruit images using a camera module and analyzes them based on features such as color, texture, and surface pattern to detect signs of chemical treatment. When the visual differentiation is unclear, an analog pH sensor measures the acidity level of the fruit to enhance accuracy. This entire process is powered by a Raspberry Pi 4B, which serves as the central processing unit for real-time data analysis and classification. The project also integrates a mobile application or display interface for showing the results conveniently. By using a combination of digital imaging and chemical sensing, the system

provides a low-cost, eco-friendly, and automated solution for fruit quality detection. This innovation not only benefits consumers but also supports organic farmers and contributes to a healthier lifestyle and sustainable agricultural practices.

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III. PROBLEM IDENTIFICATION

Consumers, farmers, and vendors face a significant challenge in reliably distinguishing organic fruits from those treated with chemical fertilizers using conventional methods. Visual inspection alone often falls short as the external appearance of fruits may not clearly indicate chemical treatment. Laboratory testing for chemical residues, while accurate, is costly, time-consuming, and impractical for everyday use. This project addresses this gap by developing an intelligent, automated system that combines artificial intelligence, image processing, and sensor technology to differentiate organic and fertilized fruits. By capturing images and analyzing visual features alongside measuring the fruit's chemical properties such as pH, the system can classify fruits non-destructively and in real time. Implemented on a Raspberry Pi platform and accompanied by a user-friendly interface, this solution aims to enhance food safety, boost consumer confidence, and promote sustainable agricultural practices by making organic verification accessible and affordable.

IV. OBJECTIVES

- To build an AI-based system that classifies fruits as organic or fertilized.
- To use image processing to study color, texture, and surface features.
- To use a pH sensor to detect chemical differences in fruits.
- To implement the system on a Raspberry Pi for real-time results.

V. METHODOLOGY

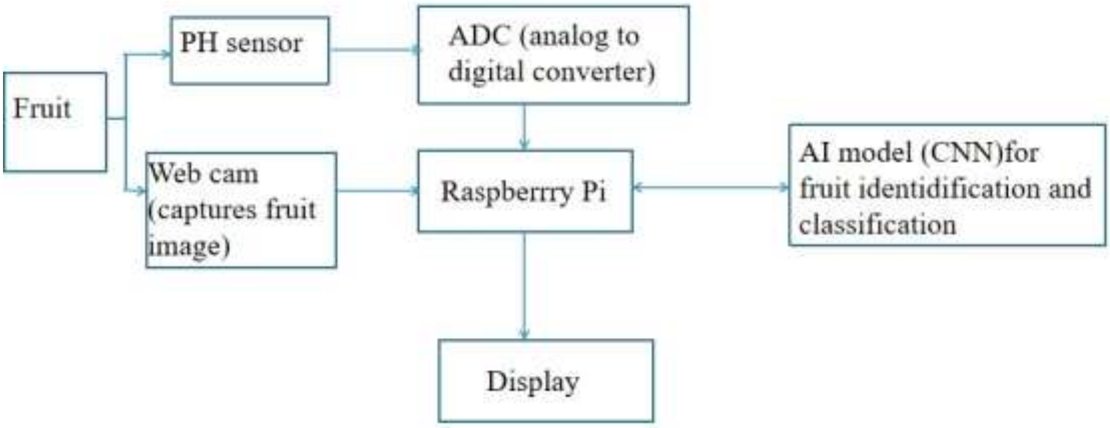

figure 1: block diagram ai-based differentiation of fertilized and organic fruits.

The system uses a pH sensor and a webcam to collect both chemical and visual data from the fruit, which are processed by the Raspberry Pi through an ADC and image capture module. The Raspberry Pi then sends the image to an AI CNN model for fruit identification and classification while displaying outputs on a 3.5-inch LED screen. A web interface is included for storing, managing, and monitoring fruit data in real time.

- **Fruit Sample Collection**

Different fruit samples, both organic and inorganic, are collected for testing. This ensures a diverse dataset for accurate evaluation. Proper sampling helps the system analyze real variations in fruit quality.

- **Image Capture**

A webcam captures clear images of the fruit's outer surface. These images are used to identify visual differences that may indicate chemical treatment. Good image quality directly improves the accuracy of the AI model.

- **PH Measurement**

A pH sensor measures the surface or juice pH of the fruit. This value helps detect chemical ripening or fertilizer residue. The pH reading supports the visual data to improve overall classification.

• Signal Conversion

The pH sensor produces analog signals that cannot be directly processed by the Raspberry Pi. An ADC converts these analog readings into digital form. This ensures the data is accurate and ready for further processing.

• Data Processing

The Raspberry Pi receives both the captured image and the pH sensor data. It preprocesses and organizes this information for the AI model. The device acts as the central unit for handling and managing system inputs.

•AI Model Integration

A CNN-based AI model analyses the fruit image to identify important features. It compares these features with the trained dataset to classify the fruit. The model then predicts whether the fruit is organic or inorganic.

• Sensor Fusion

The system combines image-based AI predictions with pH sensor readings. This fusion increases the reliability and accuracy of the classification. Both chemical and visual cues work together to support the final result.

• Result Display

The final classification outcome is shown on a 3.5-inch LED display. Users can easily view whether the fruit is organic or inorganic. This provides a quick and clear output directly from the system.

• Data Storage

All images, pH readings, and classification results are uploaded to a web interface. This allows proper storage, tracking, and management of data. Users can access previous results for analysis or documentation.

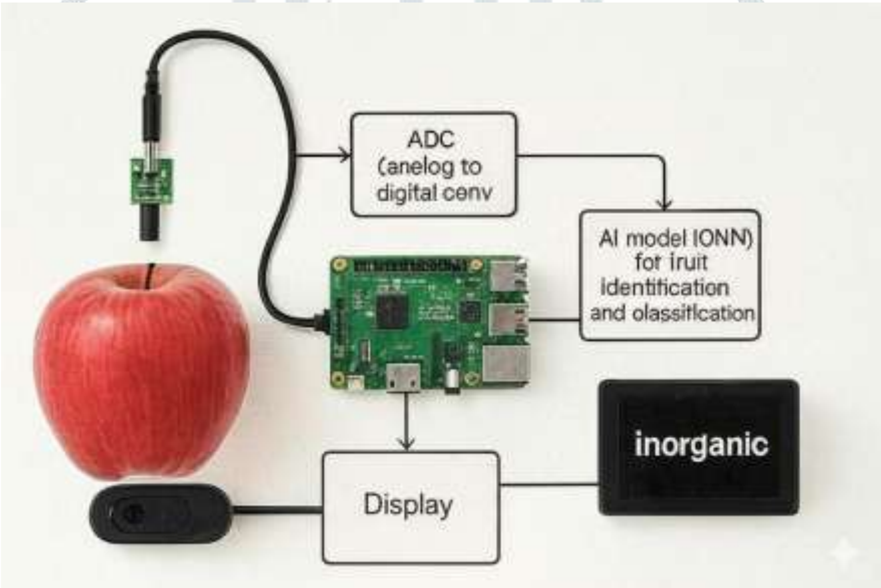

figure 2: circuit diagram of ai-based differentiation of fertilized and organic fruits.

- The image displays a real-time hardware setup designed for fruit identification and classification. A fresh apple is placed on the left, representing the fruit sample being analyzed by the system. Above it, a pH sensor is connected through a probe and interface board, used to measure the fruit's chemical properties.
- The sensor's analog signal is routed to an ADC module, which converts it into digital data. At the center of the setup, a Raspberry Pi acts as the main processing unit, receiving both pH data and the fruit's image. A webcam placed below the fruit captures highresolution images for visual analysis.
- The Raspberry Pi processes these inputs using an AI model (CNN) trained to identify whether the fruit is organic or inorganic. On the right side, a 3.5-inch LED display shows the classification result clearly.
- All components are connected logically with labeled blocks, demonstrating the data flow in the system. The white background and real components make the diagram visually clear and easy to understand.
- The layout highlights how hardware and AI software work together in real time to make accurate predictions. Every component is placed neatly on a white background, making the system easy to understand for project documentation and presentation.
- This setup visually represents the practical implementation of your AI-based fruit differentiation project from sensing to prediction.

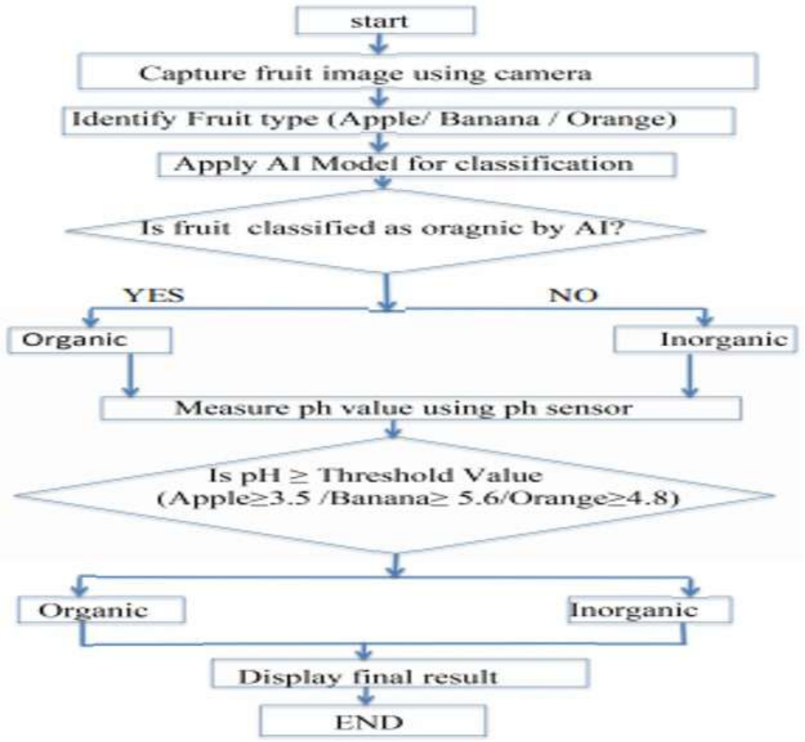

figure 3: flowchart of ai-based differentiation of fertilized and organic fruits.

The flowchart illustrates the operational workflow of the Gesture-Controlled Multi-Instrument System, showing how live video input is processed to detect hand gestures and generate corresponding musical sounds in real time. Each step in the flowchart represents a crucial stage in the system's logic, ensuring smooth operation from initialization to sound output. The detailed explanation of each step is given below:

1. Start

The system begins by initializing all required hardware and software components. This includes activating the camera, pH sensor, and processing modules. It ensures that the Raspberry Pi and AI model are ready for operation. The workflow then moves to the image capturing stage.

2. Image Capturing

At this stage, the camera captures a clear image of the fruit placed in front of the system. Proper lighting and positioning help ensure accurate visual analysis. The captured image is prepared for processing by the AI model. This step forms the basis for fruit type identification.

3. AI-Based Classification

The AI model analyzes the fruit image using trained CNN algorithms to identify the fruit type. It evaluates texture, color, and surface features to classify the fruit as organic or inorganic. This initial classification is based solely on visual cues. The output then moves to the pH measurement stage for confirmation.

4. pH Measurement

The pH sensor measures the acidity or alkalinity of the fruit's juice or surface. This chemical data provides insight into ripening method or chemical usage. The analog pH value is converted into digital form through an ADC. The system then checks the pH against a fruit-specific threshold.

5. Threshold Checking

The measured pH value is compared with a predefined threshold, such as 3.5 for apples. This decision block determines whether the fruit meets natural pH characteristics. If the pH is greater than or equal to the threshold, the fruit tends to be organic. If it falls below, it is likely inorganic or chemically treated.

6 Organic Classification

If the pH value satisfies the threshold condition, the fruit is classified as organic. This classification is reinforced by both AI image analysis and chemical data. The output is stored for display and record-keeping. The flow then moves to the final display step

7. Inorganic Classification

If the pH value does not meet the threshold, the fruit is labeled as inorganic. This suggests possible artificial ripening or chemical residues. The decision is supported by combining image-based and sensor-based results. The system then prepares this conclusion for display**.**

8. Display Result

The final classification—organic or inorganic—is displayed on the screen for the user. This provides a clear, immediate indication of the fruit's status. The display is designed to be simple and readable for quick interpretation. This marks the completion of one full analysis cycle.

V. APPLICATIONS

. Supermarkets Sorting

Automated sorting systems help supermarkets label organic and fertilized fruits accurately. This increases consumer trust, ensures compliance with labeling regulations, and speeds up the sorting process compared to manual inspection.

3. Farms Monitoring

Farmers can use AI systems to continuously monitor fruit health and quality on the farm. This allows them to optimize fertilizer use, detect early signs of diseases, and make data-driven decisions to improve yield and reduce environmental impact.

4. Export/Import Quality Fruits

Exporters and importers can use AI systems to verify that fruits meet international organic certification standards. This reduces the risk of shipment rejection and ensures that only high-quality, certified fruits reach global markets.

5. Consumers

Mobile-based applications allow consumers to scan fruits and verify whether they are organic or fertilized. This empowers informed purchasing decisions and increases transparency in the food supply chain.

6. Research

Researchers can use AI to study the impact of different fertilizers and pesticides on fruit quality. It provides precise, quantifiable data for agricultural studies, helping develop safer and more sustainable farming practices.

VII. RESULTS

figure 4, ai-based differentiation of fertilized and organic fruits.

figure5,output1

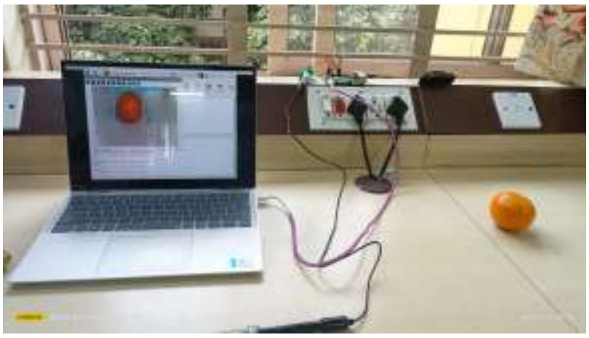 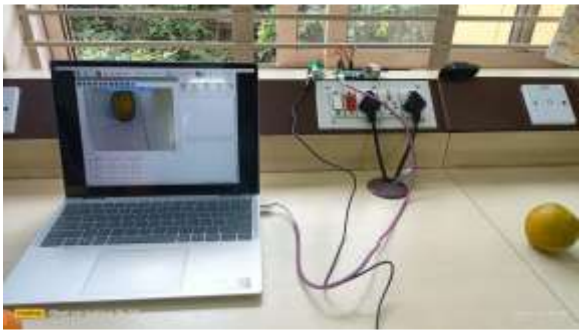

figure6, output2

VIII. CONCLUSIONS AND FUTURE SCOPE

The project successfully demonstrates an efficient AI-based system for differentiating fertilized fruits from organic fruits by combining image processing, sensor data, and machine learning techniques. By integrating a pH sensor with a Raspberry Pi and a trained CNN model, the system provides a reliable method to evaluate fruit quality in real time. This approach reduces human error, increases accuracy, and offers a scientific method for fruit classification that goes beyond visual inspection alone. The compact design makes the system portable, affordable, and suitable for practical use in markets, farms, and storage facilities. The model's ability to process both chemical and visual features strengthens its performance compared to conventional methods. Through consistent testing and validation, the project proves the feasibility of automated fruit quality assessment using modern technologies. It highlights how AI and IoT can benefit agriculture by improving transparency and consumer trust. The work also promotes healthier consumption by identifying fruits cultivated with fewer chemicals. Overall, the project contributes to creating smarter quality-control systems and showcases how technology can support sustainable and authentic fruit production.

Future Scope

The future scope of this project on AI-based differentiation of fertilized and organic fruits is highly promising, as advancements in artificial intelligence, sensor technologies, and embedded systems will continue to enhance accuracy, speed, and scalability. In the coming years, the system can be expanded to support a wide variety of fruits and vegetables, making it a universal tool for quality verification across agricultural markets

Integrating more advanced deep-learning models, such as CNNs and vision transformers, will further improve classification performance under different lighting and environmental conditions. The pH sensor module can be upgraded to include additional chemical sensors, enabling multiparameter analysis of pesticide residues, ripeness, and nutrient levels. The solution can also be connected to cloud platforms and IoT networks, allowing farmers and vendors to monitor fruit quality in real time and maintain traceability.

With mobile app and web dashboard integration, consumers can instantly verify the authenticity of organic produce before purchase. Future versions of the system can incorporate large datasets collected from multiple regions, ensuring more robust and generalized predictions. The model can also be trained to detect spoilage patterns, providing early warnings for storage and supply-chain management. More compact hardware using advanced Raspberry Pi or edge AI chips can make the device portable and suitable for field-level inspections.

Collaboration with government agencies and food certification authorities can promote the adoption of this technology for organic labeling and food-safety auditing. The project can be scaled for industrial automation by integrating conveyor belts and robotic arms for high-speed fruit sorting. Machine learning algorithms can be improved to offer detailed grading such as premium, standard, or low-quality categories. Additional features like QR-code generation for quality reports can help in maintaining transparency across the supply chain. The system can serve as an educational platform for agriculture students and researchers exploring AI applications in food technology.

Over time, cost optimization can make the solution affordable for small farmers and cooperative markets. Enhanced battery-powered versions can be deployed in rural and remote areas with minimal resources. The architecture can also be adapted for livestock feed quality assessment and grain classification. Integration with blockchain will ensure secure and tamper-proof storage of fruit-quality data. Ultimately, the project holds vast potential to transform the agriculture and retail sectors by ensuring better quality, trust, and safety in organic food verification.

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