JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Smart Vegetable Cutter with Size Control, Automatic Force Adjustment and Self-Cleaning System

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***Abstract*—This project presents the design and development of a Smart Vegetable Cutter with Size Control, Automatic Force Adjustment and Self-Cleaning System. The system aims to reduce manual effort and improve efficiency in kitchen operations by automating the vegetable cutting process. The proposed system is built using the Arduino, which acts as the central control unit to coordinate various components such as motors, sensors and the cleaning mechanism.**

A feeding motor is used to push vegetables towards the cutting blade, while the cutting motor performs precise slicing based on predefined settings. The system is capable of adjusting cutting force to handle different types of vegetables, ensuring uniform and efficient results. Additionally, a self-cleaning mechanism using a water pump is incorporated to maintain hygiene and reduce manual cleaning effort.

The overall system is designed to be cost-effective, user-friendly and suitable for small-scale kitchen applications. This project demonstrates the practical implementation of automation and embedded systems in everyday appliances, contributing to the development of smart kitchen technologies.

Keywords— Smart Vegetable Cutter, Automated Vegetable Cutting, Size Control, Automatic Force Adjustment, Self-Cleaning System, Microcontroller-Based Control, Force Sensor, Motor Control, Cutting Mechanism, Food Processing Automation, Vegetable Cutting Machine, Automation.

I. INTRODUCTION

The In recent years, the advancement of automation and embedded systems has significantly improved the efficiency and convenience of everyday appliances. However, in most kitchens, vegetable cutting is still performed manually, which is time-consuming, labor-intensive and often results in non-uniform cuts. This creates a need for a system that can automate the process while ensuring consistency, safety and ease of use.

This project proposes a Smart Vegetable Cutter with Size Control, Automatic Force Adjustment, and Self-Cleaning System, designed to simplify kitchen operations. The system is built around the Arduino, which acts as the central control unit to manage all components efficiently.

It receives user inputs and controls the functioning of motors and other subsystems. The working of the system involves a feeding mechanism that pushes vegetables toward a rotating cutting blade. The cutting motor performs slicing based on the selected settings, ensuring uniform size and improved precision. The system is designed to handle different types of vegetables by adjusting the cutting process, thereby improving overall efficiency. Additionally, a self-cleaning mechanism using a water pump is incorporated to maintain hygiene and reduce manual cleaning effort after operation.

The proposed system focuses on providing a user-friendly, cost-effective and compact solution suitable for household and small-scale applications. By integrating automation into a common kitchen task, this project demonstrates the practical use of embedded systems in improving daily life and contributing to the development of smart kitchen technologies systems.

II. Related Work

Research and development in vegetable cutting machines have mainly focused on reducing manual effort, improving cutting efficiency, increasing uniformity, and developing compact mechanical structures. Conventional motorized vegetable cutters generally use rotating or reciprocating blades to perform the cutting operation. Such systems demonstrate that motor-driven mechanisms can significantly reduce the time and effort required for repetitive cutting tasks.

Recent developments have introduced embedded systems and sensor-based automation into food-processing applications. Microcontrollers can coordinate motors, sensors, displays, and actuators to provide automated operation. These systems improve control flexibility and allow different operating conditions to be programmed into the machine.

A. Automated Vegetable Cutting

Automated vegetable cutters use motor-driven mechanisms to reduce the effort required for repetitive cutting operations. Such systems demonstrate that mechanical automation can improve cutting speed and reduce dependence on manual operation.

B. Embedded Control Systems

Embedded controllers provide coordination between different components of an automated cutting machine. In the proposed system, the ESP32 acts as the main controller and coordinates the motors, sensors, LCD, pressing mechanism, and water pump.

C. Automatic Force Adjustment

Vegetables have different levels of hardness and require different amounts of force during cutting. The proposed system addresses this requirement by determining the vegetable characteristics and adjusting the pressing force accordingly. Softer vegetables require comparatively lower pressure, whereas harder vegetables require greater pressure.

D. Cutting Size and Shape Control

Different blade arrangements can be used to obtain different cutting patterns. The proposed system provides selectable cutting operations for producing slices, strips, grid patterns, and cube-like pieces.

E. Self-Cleaning Mechanism

Cleaning is an important part of food-processing equipment. The proposed system incorporates a water pump that can be activated after the cutting operation. This provides an automated cleaning function and reduces the need for separate manual cleaning of the cutting mechanism.

TABLE I. Comparison of Selected Related Works

Ref.	Key feature	Key feature
[1]	Motorized vegetable cutting	Limited cutting-size control
[2]	Automated cutting mechanism	Limited adaptability to different vegetables
[3]	Embedded-system-based vegetable cutting	Requires manual operation for some functions
[4]	Sensor-based cutting control	Limited automatic force adjustment
[5]	Size control, automatic force adjustment, vegetable identification and self-cleaning	Performance depends on image recognition, mechanical alignment, and cleaning efficiency

III. Problem Identification and Objectives

Problem Identification

A. Conventional vegetable cutting requires considerable manual effort and may result in variations in the size and shape of the cut pieces. Different vegetables also have different hardness levels, making it difficult to apply a suitable cutting force using a fixed mechanism. In addition, many conventional systems require manual intervention for selecting the cutting size and cleaning the machine after operation.

B. Therefore, there is a need for an automated vegetable-cutting system that can reduce manual effort, provide selectable cutting sizes and shapes, adjust the pressing force according to the vegetable, and provide an integrated self-cleaning function**.**

C. The proposed Smart Vegetable Cutter with Size Control, Automatic Force Adjustment and Self-Cleaning System addresses these requirements by integrating an ESP32-based controller, vegetable identification, motorized pressing and cutting mechanisms, selectable blade arrangements, and a water-pump-based cleaning system.

Objectives

The objectives of this work are to:

The main objectives of the proposed Smart Vegetable Cutter with Size Control, Automatic Force Adjustment and Self-Cleaning System are:

A. To develop an automated vegetable-cutting **system** that reduces manual effort.

B. To provide different cutting sizes and shapes using selectable blade arrangements.

C. To identify the vegetable using an ESP32-CAM-based image-processing system.

D. To automatically determine and adjust the required cutting/pressing **force** according to the vegetable characteristics.

E. To control the feeding and pressing mechanism using an ESP32 microcontroller and stepper motor.

F. To provide an LCD-based user interface for displaying vegetable, cutting, and system-status information.
G. To integrate an automatic self-cleaning mechanism using a relay and water pump.
H. To develop a compact, user-friendly, and efficient vegetable-cutting system.

IV. PROPOSED SYSTEM ARCHITECTURE

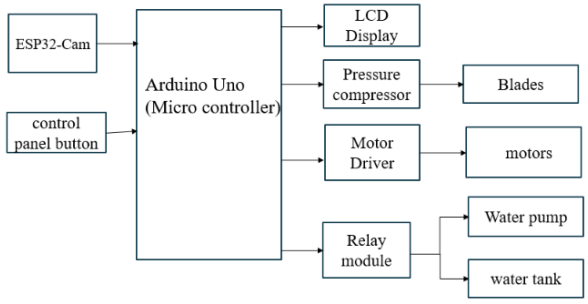


Fig. 1. Block diagram Smart Vegetable Cutter with Size Control, Automatic Force Adjustment and Self-Cleaning System.

A. Automatic Cutting with Size Control

A vegetable is detected using sensors/camera. The size and thickness of the vegetable are measured before cutting. A microcontroller processes the sensor readings. The cutting mechanism automatically adjusts the cutting position and slice thickness. This provides uniform-size slices and reduces manual effort. Similar to the paper's sensing-and-control approach, preset threshold values can be used for automatic decisions.

a. Automatic Force Adjustment

A force/pressure sensor can be placed near the cutting mechanism. The sensor detects the resistance offered by the vegetable. The controller continuously monitors this value. For soft vegetables, the motor operates with lower cutting force. For hard vegetables, the controller increases the motor torque/force automatically. This closed-loop adjustment helps prevent crushing, incomplete cutting, and excessive motor load. The concept follows the paper's approach of continuously sensing system conditions and adjusting operation when values move outside the desired range.

b. Self-Cleaning System

After the cutting operation, the system automatically starts a cleaning cycle. Water is sprayed through cleaning nozzles onto the cutting chamber and blade area. A small pump can circulate the cleaning water. The controller activates cleaning for a preset duration. After washing, an air blower can help remove remaining water. This reduces manual cleaning and improves hygiene. The paper similarly uses an automated multi-stage process controlled by a microcontroller, with the operation repeated automatically.

V. METHODOLOGY

The proposed Smart Vegetable Cutter follows a sequential methodology based on the flowchart presented in the system design. The process starts with capturing the vegetable image using the ESP32-CAM and identifying the vegetable from the trained dataset. The identified vegetable is then used to determine the required cutting pressure. The motor is controlled according to this pressure and the pressing mechanism performs the cutting operation. After cutting, the system provides an option for cleaning. If cleaning is selected, the water pump is activated. otherwise, the system returns to its initial condition and becomes ready for the next

A. Image Capture:

The process begins by capturing an image of the vegetable using the ESP32-CAM. The captured image acts as the input for the identification process.

B. Vegetable Identification:

The captured image is compared with the trained dataset to identify the vegetable. Based on the identified vegetable, its hardness and corresponding cutting requirements are determined.

c. Pressure Determination:

The system determines the appropriate pressing force according to the hardness of the vegetable. Softer vegetables require lower pressure, while harder vegetables require higher pressure.

d. Motor Control and Cutting:

The controller regulates the motor according to the required pressure. The pressing mechanism moves the vegetable toward the blade assembly to perform the cutting operation. Different blade arrangements can be used to obtain different cutting forms.

e. Cleaning Decision:

After the cutting operation, the system checks whether cleaning is required. If the user selects **Yes**, the cleaning mechanism is activated. If **No** is selected, the pressing mechanism returns to its initial position and the system becomes ready for the next vegetable. project15_publish paper

f. Self-Cleaning:

When cleaning is selected, the relay activates the water pump. Water is supplied to the cutting mechanism to remove remaining vegetable residues. After completion of the cleaning process, the pressing mechanism returns to its initial position, completing one operating cycle.

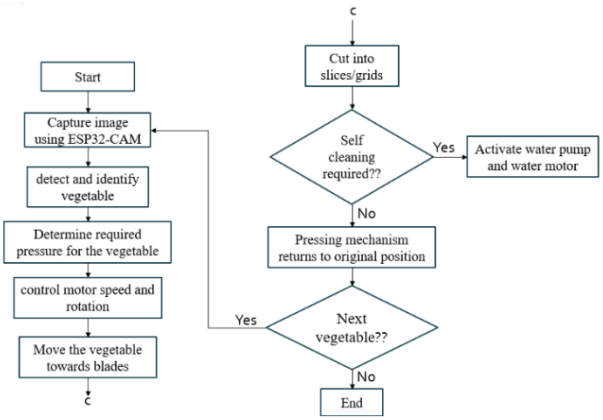


Fig.2. Flow chart of Smart Vegetable Cutter with Size Control, Automatic Force Adjustment and Self-Cleaning System

VI. EXPECTED BENEFITS AND LIMITATIONS

A. Expected Benefits

The proposed Smart Vegetable Cutter is theoretically expected to reduce manual effort and improve the efficiency of vegetable preparation. The system is designed to identify the vegetable, determine its required pressing force and perform the cutting operation automatically. Different blade arrangements are expected to provide different cutting sizes and shapes. The integration of a water pump is also expected to simplify the cleaning process after cutting.

TABLE II. DESIGN COMPARISON WITH A CONVENTIONAL VEGETABLE CUTTER

Aspect	Expected features	objectives
Size Control	Fixed or manually adjusted cutting size	Automatic and selectable cutting size Cutting Force
Cutting Force	Manually applied force	Automatic force adjustment based on vegetable hardness
User effort	High manual effort	Reduced manual effort
safety	User operates near cutting mechanism	Automated mechanism reduces direct contact
Cleaning	Manual cleaning required	Automatic self-cleaning system

B. Limitations and Future Work

The proposed system has some limitations related to vegetable identification, cutting accuracy, mechanical operation, and cleaning performance. The accuracy of vegetable identification depends on the ESP32-CAM and the trained dataset, and incorrect identification may affect the selection of cutting pressure. The cutting process depends on proper motor operation, mechanical alignment, pressing mechanism, and blade selection, while the available blade arrangements restrict the range of cutting sizes and shapes. The self-cleaning function depends on the water-pump performance and the design of the cutting area. Furthermore, the integration of image processing, motor control, mechanical mechanisms, LCD monitoring, and water-pump operation increases overall system complexity and requires proper calibration and maintenance. The system may also require further improvement to support a wider range of vegetables, cutting patterns, and operating conditions.

VII. **CONCLUSION**



The Smart Vegetable Cutter was developed by integrating an ESP32-based control system with a vegetable detection unit and a motor-driven pressing mechanism. The ESP32-CAM is used to capture vegetable images for identification using a trained dataset. Based on the identified vegetable, the controller is designed to select the appropriate pressing setting. The motor, coupler and Z-axis screw work together to move the pressing mechanism vertically and press the vegetable against the blades.

The proposed system supports different cutting sizes through suitable blade arrangements and includes an LCD display and control panel for user interaction. A water-based cleaning mechanism is also incorporated to help remove vegetable residues after cutting. The implementation provides a practical approach to reducing repetitive manual effort in vegetable preparation. Further testing is required to evaluate cutting accuracy, force settings, consistency of the cut pieces and cleaning performance under different operating conditions.

ACKNOWLEDGMENT

The authors thank Dr. Dilip Kumar K, Principal/Director, and Dr. P. N. Sudha, Dean Academics and Head of the Department of Electronics and Communication Engineering, K.S. Institute of Technology, Bengaluru, for their encouragement, and the project coordinators, Dr. Rekha N and Mrs. Suma Santosh, for their coordination and support.

REFERENCES

[1] M. A. Khan, R. Gupta, and S. Sharma, "Designing and manufacturing of vegetable slicing machine," *International Journal of Engineering Research*, vol. 10, no. 5, pp. 120–125, 2020.

[2] Kumar and P. Singh, "Development and performance evaluation of a slicing machine for selected vegetables," *Agricultural Engineering International Journal*, vol. 22, no. 3, pp. 45–52, 2020.

[3] S. R. Patil, V. B. Patil, and P. M. Desai, "Design and fabrication of vegetable leaf slicing machine," *International Journal of Mechanical Engineering*, vol. 8, no. 2, pp. 67–72, 2019.

[4] R. Verma and K. Mishra, "Design analysis of a vegetable slicer," *Journal of Mechanical Design*, vol. 12, no. 1, pp. 33–38, 2025.

[5] Patel and N. Shah, "Improved portable vegetable slicing machine design," *International Research Journal of Engineering and Technology (IRJET)*, vol. 7, no. 6, pp. 2345–2349, 2020.

[6] J. Mwangi, P. Otieno, and R. Ochieng, "Designing and manufacturing vegetable slicing machine," *Tanzania Journal of Engineering and Technology*, vol. 39, no. 2, pp. 98–105, 2021.

[7] S. Tiwari and A. Yadav, "Development of fruit and vegetable slicing machine," *International Research Journal of Engineering and Technology (IRJET)*, vol. 7, no. 3, pp. 1500–1504, 2020.

[8] R. K. Singh and V. Kumar, "Design and fabrication of vegetable cutting machine," in *Proc. AIP Conf.*, 2022, pp. 16.

[9] P. Joshi, M. Kulkarni, and S. Patil, "Design and development of a compact motorized vegetable slicer machine," *International Journal of Innovative Science and Research Technology*, vol. 6, no. 8, pp. 210–215, 2021.

[10] S. Deshmukh and A. Pawar, "Multipurpose vegetable cutter design and fabrication," *International Journal of Scientific Development and Research*, vol. 4, no. 4, pp. 300–305, 2019.

[11] O. Adewale and T. Johnson, "Automated vegetable slicing machine with linear motion mechanism," *Journal of Innovative Science and Technology*, vol. 5, no. 2, pp. 75–80, 2021.

[12] Y. Chen, X. Li, and H. Zhang, "Robocop: Autonomous vegetable cutting using AI models," *arrive preprint arXiv:2307.13159*, 2023.

[13] R. Gupta and S. Jain, "Design and development of power-operated vegetable cutter," *International Journal of Engineering Trends and Technology*, vol. 68, no. 4, pp. 12–18, 2020.

[14] K. Reddy and M. Rao, "Automatic vegetable chopper using image processing techniques," *International Journal of Computer Applications*, vol. 176, no. 12, pp. 25–30, 2019.

[15] P. Sharma and A. Mehta, "PLC-based automated vegetable cutting system for food processing," *International Journal of Automation and Control Engineering*, vol. 9, no. 1, pp. 55–61, 2022.

[16] K. Srinivas and P. Reddy, "Smart vegetable cutter using embedded system," *International Journal of Embedded Systems and Applications*, vol. 10, no. 2, pp. 45–50, 2022.

[17] S. Mehta and R. Jain, "IoT-based smart kitchen automation system," *International Journal of IoT and Smart Applications*, vol. 5, no. 3, pp. 78–84, 2023.

[18] L. Kumar and D. Verma, "Automatic food processing machine using sensors," *International Journal of Automation and Control Engineering*, vol. 8, no. 1, pp. 33–39, 2020.

[19] H. Wang and Y. Liu, "Design of intelligent cutting system for food processing," *International Journal of Intelligent Systems and Applications*, vol. 11, no. 2, pp. 60–66, 2022.

[20] N. Sharma and V. Gupta, "Development of automated vegetable cutter with safety mechanism," *International Journal of Mechanical and Automation Engineering*, vol. 9, no. 3, pp. 101–107, 2021.