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Design And Fabrication IOT Based Automatic Kaju Katli Making Machine

Dr.Chinmay Pingulkar[1], Tanmay Panchal[2], Mukesh Prajapati [3] , Sumit Panchal[4]
[1](*Department of Mechanical Engineering, VIVA Institute of Technology, India)*
[2](*Department of Mechanical Engineering, VIVA Institute of Technology, India)*
[3](*Department of Mechanical Engineering, VIVA Institute of Technology, India)*
[4](*Department of Mechanical Engineering, VIVA Institute of Technology, India)*

Abstract : *The preparation of traditional Indian sweets, like Kaju Katli, often involves labor-intensive methods that are time-consuming and prone to inconsistencies. This project develops an Automatic Kaju Katli Sweet Making Machine that integrates IoT technology to enhance production efficiency and quality. The machine automates the entire process, from ingredient preparation to molding, minimizing manual intervention. Sensors monitor critical parameters such as temperature, humidity, and mixing times, enabling precise control over the cooking process. IoT capabilities provide real-time data access and remote control via a user-friendly interface, facilitating data-driven decisions.*

A detailed mechanical design is presented alongside control algorithms governing operations. A prototype was developed and tested for production efficiency, energy consumption, and product quality. Results demonstrate significant improvements in efficiency compared to traditional methods, with high customer satisfaction in taste tests. This project highlights the potential of automation and IoT in food processing, preserving traditional practices while advancing technology.

The Automatic Kaju Katli Sweet Making Machine addresses key challenges faced by manufacturers and lays the foundation for future innovations in automated food production. By balancing tradition with technology, it aims to contribute to the sustainability and growth of the Indian sweet-making industry.

Keywords - *Food processing, Product quality, Traditional sweets, Sustainability, Technology integration, Prototype development.*

I. INTRODUCTION

Kaju katli, a traditional Indian sweet, holds a special place in the culinary heritage of India, particularly in the regions of Maharashtra and Gujarat. This delectable treat is primarily made from high-quality cashew nuts, sugar, and a blend of aromatic spices, making it not only a favorite among sweet enthusiasts but also a popular choice for festivals and special occasions. The meticulous preparation of Kaju katli involves grinding the cashews, cooking the mixture to a specific consistency, and molding it into shapes. However, the traditional methods of preparing Kaju katli can be labor-intensive and time-consuming, often requiring skilled artisansto achieve the desired taste and texture. Need for Automation In today's fast-paced world, the demand for convenience and efficiency has driven the food industry to adopt automation in various processes. The manual preparation of Kaju katli posesseveral challenges, including variability in quality, inconsistent production rates, and high labor costs. As consumer preferences shift towards mass production while maintaining quality, the necessity for automated solutions becomes increasingly apparent. Automation not only streamlines production but also ensures that the end product is consistent in taste and appearance, thus meeting consumer expectations. 1 Technological Advancement Recent advancements in technology have paved the way for integrating automation and the Internet of Things (IoT) into food processing. IoT enables real-time monitoring and control of production processes through the use of sensors and data analytics. By leveraging IoT technologies, manufacturers can track various parameters, such as temperature, humidity, and mixing times, allowing for precise control over the sweet-making process. This integration enhances operational efficiency, reduces waste, and improves product quality, making it an ideal solution for traditional sweet-making industries.

II. LITERATURE REVIEW

S.Dhaniyasri, Dr. K.U. Pavitra krishna, et al., (2024) Standardization and Formulation of Nutririch Kaju Katli explores the development of a nutritious variation of traditional Indian kaju katli. This version incorporates beetroot, carrot, and dragon fruit peel extracts, aimed at enhancing its health benefits by adding fiber, antioxidants,

and essential nutrients. The study was conducted by evaluating three versions with varying concentrations of the extracts. The sensory evaluation revealed that the variant with 30% extract (NRK B) was the most preferred, scoring high in flavor, color, and texture. Nutritional analysis highlighted the product's potential as a healthful snack, rich in carbohydrates, iron, and calories. The product's shelf life was determined to be approximately 12 days without preservatives. Overall, Nutririch kaju katli offers a promising, nutrient-rich alternative to traditional sweets. [1]

Ch. Ravi, P. Sai Kiran et al. (2023), Design and Fabrication of Mutli Drink Vending Machine, This project focuses on designing and constructing a multi-drink vending machine, offering a wide variety of goods like water, drinks, coffee, and tea. The machine is designed to be automated, reducing manual handling and requiring user-friendly interfaces. The machine is made of plywood, fevicol gum, and DC motors, and can serve both hot and cold beverages. The project accurately pours beverages, saving time and making workplace work easier. The primary goal is to decrease beverage waste. [2]

Sandeep Jagtap, Hana Trollman et al., (2023) Food Processing 4.0: Current and Future Developments Spurred by the Fourth Industrial Revolution explores the transformative impact of Industry 4.0 technologies on the food processing sector. It examines how advanced technologies like artificial intelligence (AI), robotics, the Internet of Things (IoT), and big data analytics are being integrated into food processing to enhance efficiency, quality, and safety. The review highlights the potential benefits of these technologies, including improved quality control, automation of repetitive tasks, and predictive maintenance. The paper also addresses challenges such as high costs, standardization, and consumer acceptance, which are crucial for the widespread adoption of these technologies in the food industry. Overall, the document suggests that the Food Processing 4.0 concept could revolutionize food production, making it more sustainable and resilient. [3]

Haribalagurunath K, Dr. G. S. Vijaya, (2024), A Study on Operational Excellence in Sweet Manufacturing Industry During Festival Seasons, Sweets are popular snacks and desserts in the Indian subcontinent, with thousands of dedicated shops selling them during festivals. This demand boosts consumer spending, employment opportunities, and stimulates other sectors. However, sweet shops face challenges such as supply chain disruptions, production constraints, labor shortages, storage and preservation, price fluctuations, competition, and logistical challenges. Operational excellence in the sweet manufacturing sector during festival seasons is crucial for navigating these challenges and taking advantage of opportunities. Businesses can improve their performance by streamlining supply chain operations, optimizing manufacturing processes, minimizing risks, and capitalizing on the holiday spirit. [4]

Raghavendra et al. (2022), Case Studies of Successful Automation in Sweets Manufacturing Several case studies document successful implementations of automated systems in sweets manufacturing. A report by details the experiences of a leading Indian sweets manufacturer that adopted automated production lines. The results showed increased production capacity and improved quality, leading to a greater market share. [5]

Rifki Hidayat, Erwhin Irawan, Erwan Eko Prasetiyo, et al. (2022), This study focuses on the design of a mixer machine with heating elements to facilitate the mixing of composite materials and achieve better micro-mechanical properties. The experiment compared the mixing 6 of resin and iron sand using a mixer machine without a heating element and a mixer machine with a heating element. The results showed that the composite material was homogeneously mixed using a mixer machine without a heating element, but still had many white spots in micro- photos. However, when mixed with a heating element, the composite material was homogeneously mixed, and some white spots were observed in macro photos. The study concluded that the design of a mixer machine with a heating element is crucial for producing a homogeneous composite material. [6]

Gupta et al. (2021), IoT in Food Industry, IoT technology has gained traction in the food industry, enabling real-time monitoring and control of production processes. According to a study by IoT applications in food processing allow for the collection of data on environmental conditions and equipment performance. This data can be utilized for predictive maintenance, ensuring that equipment operates at optimal levels and minimizing downtime. [7]

Nair et al. (2021), Economic Viability of Automation Economic analyses of automated food production highlight the potential for cost savings and increased profitability. A paper by examines the return on investment (ROI) for food manufacturers adopting automation. The findings suggest that while initial investment costs may be high, the long-term savings in labor and improved product quality justify the expenditure. [8]

Nidhi Rajesh Mavani1, Jarinah Mohd Ali, Suhaili Othman, et al. (2022), Automation in Food Processing The introduction of automation in food production has been a game-changer in improving efficiency and consistency.

A review by discusses various automated systems used in food processing, emphasizing the reduction of human error and the enhancement of production speeds. The adoption of automation in sweets manufacturing can lead to significant improvements in throughput and quality control. [9]

Abdo Hassoun, Janna Cropotova, Monica Trif, et al., (2020) Consumer awareness of climate change and food sustainability is driving the adoption of emerging food trends, influenced by the fourth industrial revolution (Industry 4.0). This review explores the historical context of industrial revolutions from a food perspective and examines consumer acceptance of alternative proteins, including plant-based foods, insects, cell-cultured meat, and 3D-printed foods. The impact of digital technologies on promoting greener and healthier diets is emphasized. While plant-based options dominate, significant research is also focused on other alternatives. Advances in technology are expected to improve the sensory and nutritional qualities of these foods, enhancing consumer acceptance. However, there is a need for better convenience, nutrition, affordability, and positive marketing to highlight their safety and benefits.[10]

III. PROBLEM DEFINITION

3.1 Problem Statement

The traditional methods of preparing Kaju katli, a popular Indian sweet, are characterized by labor-intensive processes that often lead to inconsistent product quality, high labor costs, and inefficiencies in production time. These methods rely heavily on skilled artisans, resulting in variability in taste and texture, which can diminish customer satisfaction. Additionally, the lack of real-time monitoring during the cooking process limits control over critical parameters, further contributing to product inconsistencies. As consumer demand for high-quality, readily available sweets grows, traditional producers face significant challenges in scaling operations while maintaining the authenticity and qualityof Kaju katli. Therefore, there is an urgent need for an automated solution that integrates modern technology, specifically IoT, to enhance production efficiency, ensure consistent quality, and meet the evolving expectations of consumers. In the traditional methods of preparing Kaju katli, human intervention is required.

3.2 Objectives

1. To design an automatic machine capable of efficiently preparing Kaju katli while preserving its traditional taste and texture.
2. To incorporate IoT capabilities for real-time monitoring and control of critical production parameters such as temperature, humidity, and mixing times.
3. To develop an intuitive user interface that allows operators to monitor and control the machine remotely, facilitating ease of use and operational flexibility.
4. To create a modular design that allows for future upgrades and enhancements based on technological advancements and market needs.

IV. PROPOSED METHODOLOGY

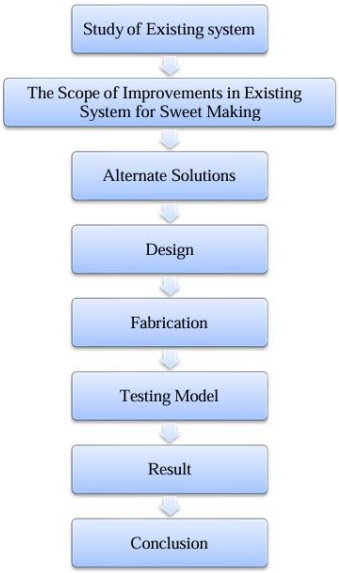

Fig.1 Flowchart

4.1 Study of Existing Systems

Overview of Existing Automated Sweet-Making Machines, Various automated machines are currently available in the market, designed for different types of sweets. Below is a brief overview of some notable systems:

4.1.1 Traditional Sweet-Making Machines

Batch Mixers: Used for mixing ingredients in large quantities. These machines often include temperature control features but require manual input for ingredient proportions. Fryers: Automated frying machines control temperature and cooking time, ensuring uniform cooking of sweets like gulab jamun and jalebi. They lack IoT connectivity for monitoring.

4.1.2 Semi-Automated Systems

Cashew Nut Roasting Machine: This machine is designed to roast raw cashews at controlled temperatures. The roasting process enhances the flavor and aroma of the nuts, which is crucial for the taste of kaju katli. Kaju Katli Burfi Making Machine: barfi sheeting machine, kaju katli roll making machine and barfi cutting cutting table. Semi-Automatic, Stainless steel.

4.1.3 Recent Advances in Automation

Recent advancements focus on improving automation through IoT and smart technologies.

Fully Automated Machines

Robotic Sweet Makers: These systems incorporate robotics for the entire sweet-making process, from mixing to cooking to packaging. They often come with user-friendly interfaces and programmable settings. However, the initial investment is high.

IoT-Enabled Systems

Smart Cooking Appliances: Devices like the Thermomix integrate IoT features for remote monitoring and control. Users can adjust settings via mobile applications, ensuring precision in cooking. However, these devices may not be designed specifically for traditional Indian sweets.

4.1.4 Comparative Analysis

Feature	**Traditional Machines**	**Semi-Automated Systems**	**Fully Automated Systems**	**IoT-Enabled Systems**
Automation Level	Low	Moderate	High	High
User Intervention	High	Moderate	Low	Low
Consistency in Quality	Variable	Moderate	High	High
Cost	Low	Moderate	High	High
Flexibility	Low	Moderate	Low	High

4.2 The Scope of Improvements in Existing Systems for Sweet Making

4.2.1 Customization for Traditional Sweets

Existing automated machines often lack versatility and are designed for specific types of sweets. Scope for Improvement: Developing machines that can be easily customized to accommodate various traditional sweets, such as Kaju katli, would cater to a broader market. This could involve adjustable settings for different ingredients, cooking times, and techniques.

4.2.2 Integration of IoT for Real-Time Monitoring

While some systems are IoT-enabled, many do not fully utilize real-time data for process optimization. Scope for Improvement: Enhanced IoT integration can provide real-time monitoring and analytics, allowing users to track cooking conditions (temperature, humidity) remotely. Implementing predictive maintenance features could also minimize downtime.

4.2.3 Quality Control Mechanisms

Many existing systems lack comprehensive quality control, leading to variability in product outcomes. Scope for Improvement: Incorporating sensors that monitor key parameters (e.g., texture, moisture content) can help ensure consistent quality. Automated feedback loops can adjust cooking parameters in real-time based on sensor data.

4.2.4 User-Friendly Interfaces

Some automated machines can be complex and challenging to operate, deterring potential users. Scope for Improvement: Developing intuitive user interfaces, possibly through mobile apps or touchscreens, can enhance user experience. Providing guided workflows for different sweet recipes can make operation easier, especially for non-technical users.

4.2.5 Cost-Effective Solutions

High initial costs of fully automated systems limit their accessibility for small and medium- sized enterprises (SMEs). Scope for Improvement: Creating modular systems that allow users to purchase components incrementally can lower the financial barrier. Additionally, focusing on local manufacturing can reduce costs and enhance affordability.

4.2.6 Enhanced Energy Efficiency

Many existing machines are not optimized for energy consumption, leading to higher operational costs. Scope for Improvement: Implementing energy-efficient designs and components can reduce energy usage. Utilizing renewable energy sources or hybrid systems could further enhance sustainability.

4.2.7 Flexibility in Production Scale

Most machines are either designed for large-scale production or manual processes, lacking flexibility for varying batch sizes. Scope for Improvement: Designing systems that can easily switch between batch sizes, from small artisanal batches to larger commercial quantities, would benefit a wider range of producers.

4.2.8 Safety and Hygiene Features

Many automated systems do not adequately address food safety and hygiene standards. Scope for Improvement: Incorporating features like automatic cleaning systems, materials that resist bacterial growth, and compliance with food safety regulations can enhance the usability of sweet-making machines.

4.3 Alternate Solutions

4.3.1 Smart Mixing and Cooking Equipment

Equipment: Smart mixers and cooking devices with IoT capabilities.
Mixing: The smart mixer can adjust speed and duration based on the type of cashew and desired consistency.
Cooking: Cooking devices can automatically regulate temperature and cooking time based on real-time data.
Benefits:

- Reduces human error in cooking and mixing.
- Optimizes conditions for perfect consistency.

4.3.2 Mobile Applications for Monitoring

Applications: Mobile monitoring systems linked to production equipment.
Process:

- Develop apps that allow remote monitoring of cooking and mixing parameters.
- Enable alerts for any deviations from set parameters, allowing for quick adjustments.

4.4 Design

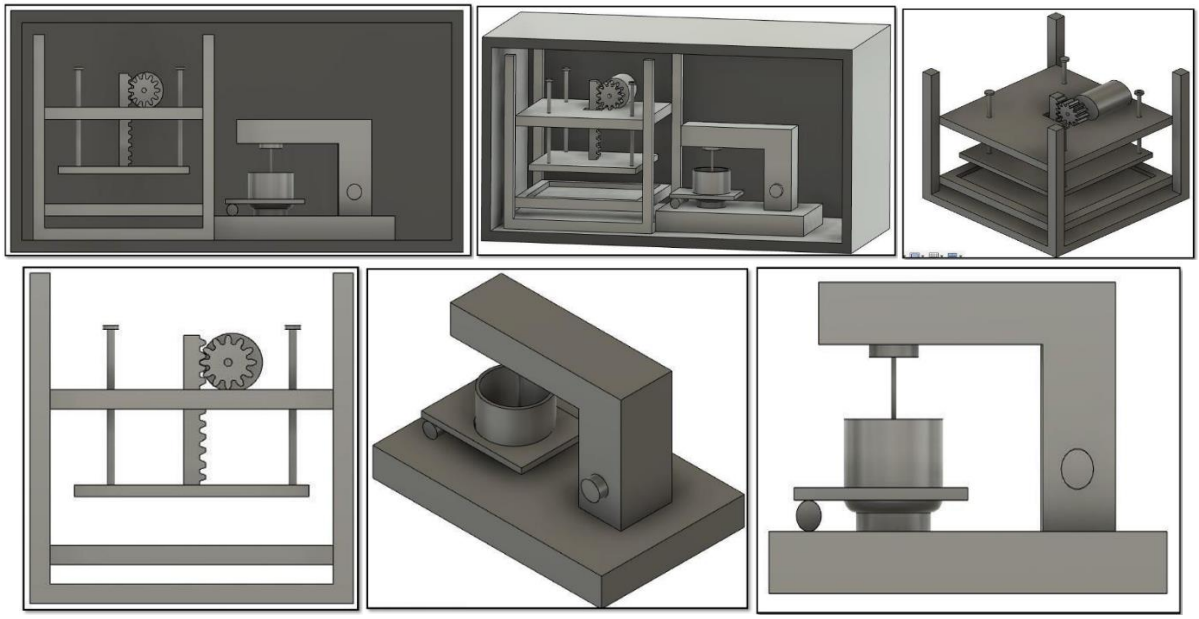

Fig.2 CAD Model

V. CONCLUSION

The IoT-based Automatic Kaju Katli Making Machine marks a breakthrough in the traditional Indian sweet-making industry, integrating automation and IoT to address challenges in traditional methods. By automating processes like ingredient preparation, cooking, and molding, the machine reduces manual intervention, improves efficiency, and ensures consistent quality. Sensors enable real-time monitoring and precise control of parameters such as temperature, humidity, and mixing times, delivering a uniform product with the desired texture and taste. This project blends tradition with modern technology, advancing food processing while preserving the cultural significance of Kaju Katli and fostering future innovations.

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