iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** VII **Month of publication:** July 2026

DOI: https://doi.org/10.22214/ijraset.2026.84311

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue VII July 2026- Available at www.ijraset.com

Intelligent Tabletop Wet Grinder

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Abstract: ***The Intelligent Table top Wet Grinder is an advanced kitchen appliance designed to enhance traditional grinding processes through automation and smart control. This system integrates sensors, microcontroller-based control, and user-friendly interfaces to optimize grinding efficiency, consistency, and safety. It can automatically adjust grinding time, monitor load conditions, and preventoverheating, ensuring uniform batter quality with minimal user intervention. The grinderisalsodesignedwithenergy-efficientmechanismsandintelligentfeedback systems that alert users about operational status and maintenance needs. This innovation not only preserves the authenticity of traditional wet grinding butalsoimprovesconvenience,hygiene,andperformanceformodern households.The system may include preset grinding modes for various food preparations such as idli and dosa batter, ensuring consistent texture and quality. Noise reduction techniques are applied to provide quieter operation, while a smart timerwithautoshut-offpreventsover-grindingandconservesenergy. Additionally,loadsensingmechanismsallowthemotortoadjustspeed dynamicallybasedonthequantityandhardnessofingredients.***
Keywords: Intelligent Control, WetGrinder, Automation, Sensor Integration, Energy Efficiency

I. INTRODUCTION

A. Background

The traditional wet grinder has been an essential appliance in many households, especially for preparing staple foods like idli and dosa batter. However, conventional tabletop wet grinders operate with minimalautomation and require continuous user supervision to achieve the desired consistency. With the advancement of technology and the growing demandfor smart home appliances, there is a need to enhance these traditionalsystems with intelligent features. The development of the Intelligent Tabletop Wet Grinder is driven by the aim to improve efficiency, reduce manual effort, and ensure consistent grinding quality. By integrating modern technologies such as sensors, microcontrollers, and automation techniques, the system can monitor parameters like load, temperature, and grinding time. This not only increases user convenience but also enhances safety, energy efficiency, and overall performance. Thus, this project bridges the gap between traditional kitchen practices and modern smart appliance innovations.

B. Problem Statement

Theexistingtabletopwetgrinders,whilewidelyusedforpreparing batter,sufferfromseverallimitationsduetotheirlackofautomationand intelligentcontrol.Usersmustcontinuouslymonitorthegrindingprocesstoachievethedesiredconsistency,whichcanbetime-consumingand inconvenient.

Thesesystemsdonothavemechanismstocontrolgrindingtime,detect loadvariations,orpreventoverheating,leadingtoinconsistentresults, energywastage,andpotentialdamagetotheappliance.Additionally,issuessuchasexcessivenoise,vibration,andlimitedsafetyfeaturesfurthe rreduceefficiencyandusercomfort.Theabsenceofsmart monitoring and control capabilities highlights the need for an improved system.Therefore,thisprojectaimstodevelopanIntelligentTabletopWetGrinderthatovercomesthesechallengesbyincorporatingautomati on, sensor-basedmonitoring, anduser-friendlyfeaturesto enhanceperformance,safety,andconvenience.

C. Objectives

The main objective of the Intelligent Tabletop Wet Grinder project is to enhance the traditional grinding process by incorporating automation and smart control features. The system aims to provide consistent and efficient grinding by automatically adjusting parameters such as time, speed, and load conditions. It focuses on reducing manual effort through the use of a microcontroller-based control system and user-friendly interface. Another objective is to improve safety by integrating features like auto shut-off, overload protection, and temperature monitoring. The project also seeks to minimize noise, vibration, and energy consumption, thereby increasingoverall efficiency and user comfort. Additionally, it aims to ensure better hygiene and ease of maintenance through improved design, making the appliance more reliable and suitable for modern smart kitchens.

D. Scope of The Project

The scope of the Intelligent Tabletop Wet Grinder project focuses on the design, development, and implementation of a smart and efficient grinding system that enhances traditional wet grinding methods. This project covers the integration of mechanicalcomponentssuchasthegrindingdrum,rollerstones,andbasestructurewithadvancedelectronicsystemsincludingsensors,microcontrollers, andcontrolcircuits.Itaimstoautomatekeyfunctionslikegrindingtime,motor speedcontrol, and loadmanagement to ensure consistent batter quality with minimaluserintervention.Thesystemalsoincludessafetyfeaturessuchas overload protection, temperature monitoring, and automatic shut-off to preventdamage and ensure safe operation. Additionally, the project scope extends to improvinguserinteractionthroughasimpleinterfacewithdisplayindicators,buttons,oroptionalIoTconnectivityforremotemonitoringandcontrol.

ThescopeoftheIntelligentTabletopWetGrinderprojectfocusesonthedesign,development,andimplementationofasmartandefficientgrindingsystemthatenhancestraditionalwetgrindingmethods.Thisprojectcoverstheintegrationofmechanicalcomponentssuchasthegrinding drum,rollerstones,andbase structurewithadvancedelectronicsystemsincludingsensors,microcontrollers, andcontrolcircuits. Itaimsto automatekeyfunctionslikegrindingtime,motorspeedcontrol,andloadmanagementtoensureconsistentbatterqualitywithminimaluserintervention.Thesystemalsoincludessafetyfeaturessuchasoverloadprotection,temperaturemonitoring,andautomaticshutofftopreventdamageandensuresafeoperation.Additionally,theprojectscopeextendstoimprovinguserinteractionthroughasimpleinterfacewithdisplayindicators, buttons,oroptionalIoTconnectivityforremotemonitoringandcontrol.

II. LITERATURE REVIEW

RESEARCHSTUDIESOFDESIGNANDMATERIALANALYSIS OF TABLETOP WET GRINDER STRUCTURES

Recent research studies on the Intelligent Tabletop Wet Grinder focus on enhancing traditionalgrinding systems through automation,energyefficiency,andsmart controlmechanisms.Studiessuchas“DesignandDevelopmentofanAutomatic Wet Grinder with Smart Control System” by R. Karthikeyan and S. Prakash (2019) emphasizetheuseofmicrocontroller-basedautomationtoregulategrindingtime and improve consistency. Similarly, “IoT-Based Smart Kitchen Appliance Control System” by P. Suresh and M. Anitha (2020) highlights the integration of IoT technology to enable remote monitoring and control of household appliances, including wet grinders. Research by A. Kumar and V. Singh (2018) on energy- efficient motor control focuses on reducing power consumption while maintaining optimal performance in domestic devices. Furthermore, the study “Sensor-Based Automation in Household Appliances” by N. Rajalakshmi and K. Devi (2021) explores the use of sensors to monitor parameters such as load, temperature, and vibration and ensuring safety

1) *Title: A Soft Sensor for Inferring Energy Efficiency of Wet-Closed Ball Mills*
Authors: D.R.M. Diniz, G.O. Morais, A. J. R. Reis, and A. K. R. Segundo

Abstract: This paper proposes a soft sensor model to estimate energy efficiency in wet grinding systems. The approach reduces the need for direct measurement and improves overall system performance. The study highlights the importance of intelligence.
Year: 2026

2) *Title: Review of Advanced Sensor System Applications in Grinding Operations*
Authors: D. Y. Pimenov, L. R. Ribeiro da Silva, M. Kuntoğlu, and B. S. Abrão

Abstract: This study reviews various sensor technologies such as vibration, acoustic, and force sensors used in grinding processes. It emphasizes real-time monitoring and improved product quality through sensor integration.
Year: 2025

3) *Title: IoT-Based Smart Home Appliances with Energy Optimization*
Authors: Y.Zhang, H.Liu, and X.Chen

Abstract: This paper presents an IoT-based system for smart home appliances that focuses on energy efficiency. It enables remote monitoring and intelligent control, making appliances more efficient and user-friendly.
Year: 2024

4) *Title: Energy-Efficient Motor Control Strategies for Household Appliances*
Authors: X. Li, J. Wang, and Y. Zhao

Abstract: The study discusses advanced motor control techniques that optimize speed and torque based on load conditions. This improves energy efficiency and enhances the performance of domestic appliances.
Year: 2024

5) Title:IoT-BasedSmartKitchenApplianceControlSystemAuthor:P. Suresh, M. Anitha

Abstract: The study "IoT-Based Smart Kitchen Appliance Control System" presents amodern approach to managing household appliances through Internet of Things (IoT)technology.Thesystemenablesuserstomonitorandcontrolkitchen devicesremotely using a mobileapplicationorwebinterface.Itintegratessensorsandcommunicationmodulestoproviderealtimedataonappliance status, improving efficiency and usability.

Year: 2023

6) Title:DevelopmentofEnergyEfficientMotorControl for Domestic Appliances

Author:A.Kumar,V.Singh

Abstract:Thestudy"DevelopmentofEnergyEfficientMotorControlforDomesticAppliances"focusesonimprovingtheperformanceandreducingthepowerconsumptionofmotorsusedinhouseholddevices.Itproposesadvancedmotorcontroltechniquestooptimizespeedandtorque basedonloadconditions.The systemhelpsinminimizingenergywastagewhilemaintainingefficient operation.

Year:2023

7) Title:Sensor-BasedAutomationinHousehold Appliances

Author:N.Rajalakshmi,K.Devi

Abstract: The study "Sensor-Based Automation in Household Appliances" focuses on the integration of sensor technologies to enhance the functionality, efficiency, and safetyof modern home appliances. With the rapid advancement of embedded systems and automation,sensorsplayavitalroleinenablingappliancestooperateintelligentlywith minimal human intervention. This research highlights the use of various sensors such as temperature sensors, load sensors, motion sensors, and vibration sensors to continuously monitor the working conditions of appliances. These sensors collect real- time data, which is processed by a microcontroller or embedded system to make appropriate decisions, such as adjusting operating parameters or triggering safety mechanisms. For example, temperature sensors help prevent overheating by automatically switching off the device, while load sensors ensure optimal performance by regulating motor speed according to the workload. The study also emphasizes the importance of automation in improving energy efficiency and reducing power consumption in household devices. By using sensor-based control, appliances can operate only when required and at optimal levels, thereby minimizing energy wastage. Additionally, the integration of sensors enhances user conve. nience by reducing the need for manual monitoring and control. The system can provide real-time feedback through displays, indicators, or alerts, allowing users to stay informed about the appliancestatus.Safetyisanothermajoradvantage,assensor-basedsystemscandetect faults, abnormal conditions, or misuse and take corrective actions immediately.

Year: 2022

III. PROPOSED SYSTEM

A. Existing System

The existing system refers to conventional tabletop wet grinders that are widely used in households for preparing batter. These systems operate using a basic electric motor that drives the grinding stones inside a drum. The user is required to manually add ingredients, control the grinding duration, and monitor the consistency of thebatter throughout the process.

Traditionalwetgrinderslackautomationandintelligentcontrolmechanisms.Thereare no provisions for monitoring parameters such as load, temperature, or grinding time. As a result, users must rely entirely on their experience to achieve the desired output, which often leads to inconsistent batter quality. Over-grinding or under-grinding is common due to the absence of precise control.

Overall,whileconventionalwetgrindersaresimpleandcost-effective,theyarelimited by manual operation, lack of consistency, and absence of smart features

B. Proposed System

The proposed system is an Intelligent Tabletop Wet Grinder designed to overcome the limitations of traditional grinders by integrating automation and smart control technologies. The system incorporates a microcontroller-based control unit that acts as the brain of the appliance, managing all operations efficiently.

Inthissystem,varioussensorssuchasloadsensors,temperaturesensors,andvibration sensors are used to continuously monitor the working conditions. The collected data is processed by the microcontroller, which automatically adjusts parameters like motor speed and grinding time to ensure optimal performance and consistent batter quality.

Theproposedsystemincludespresetmodesfordifferentfoodpreparationssuchasidli and dosa batter, allowing users to select the desired option easily. A smart timer and automated control reduce manual effort, making the operation user-friendly and efficient.
Safety is significantly improved through features such as auto shut-off, overload protection,andfaultdetectionmechanisms.Thesefeatureshelppreventdamagetothe appliance and ensure safe usage. Additionally, the system is designed to be energy- efficient by optimizing motor operation based on load conditions.
An optional IoTmodule can also be integrated to enable remote monitoring and controlthroughamobileapplication,makingtheappliancesuitableformodernsmart kitchens.
Thus, theproposedsystemenhancesperformance,safety,efficiency,andconvenience compared to existing systems.

C. Features & Innovations

The Intelligent Tabletop Wet Grinder incorporates several advanced features that significantly improve its functionality and user experience compared to traditional systems. It includes a microcontroller-based automation system that enables precise control over grinding time and motor speed, ensuring consistent batter quality. The integration of sensors such as load, temperature, and vibration sensors allows real- time monitoring and intelligent decision-making, enhancing efficiency and safety. Innovative features like preset grinding modes, auto shut- off, and overloadprotection reduce manual effort and prevent damage to the appliance.
Key Features and Benefits:

- Providesautomatedgrindingforconsistentbatterquality.
- Reducesmanualeffortwithsmarttimerandpresetmodes.
- Enhancessafetythroughautoshut-offandoverloadprotection.
- Improvesefficiencywithsensor-basedmonitoringandcontrol. 5.Minimizes noise and vibration for better user comfort.
- Ensuresenergyefficiencyandreducedpowerconsumption.
- Offers easy cleaning and maintenance with user-friendly design.

The Intelligent Tabletop Wet Grinder offers several key features and benefits that enhance its overall performance and usability. It provides automated grinding with consistentbatterqualitythroughsmartcontroloftimeandmotorspeed.Thesystem reduces manual effort by incorporating preset modes and a smart timer, making operation simple and convenient.
Safety is improved with features such as auto shut-off and overload protection, ensuring reliable usage. Sensor-based monitoring enhancesefficiencybyadjustingoperationsbasedonloadandtemperature conditions.
Additionally, the design minimizes noise and vibration, offering a more comfortable user experience. The grinder is also energy-efficient, reducing power consumption whilemaintaininghighperformance,anditsuser-friendlydesignensureseasy cleaningand maintenance.

1) Block Diagram &Workflow

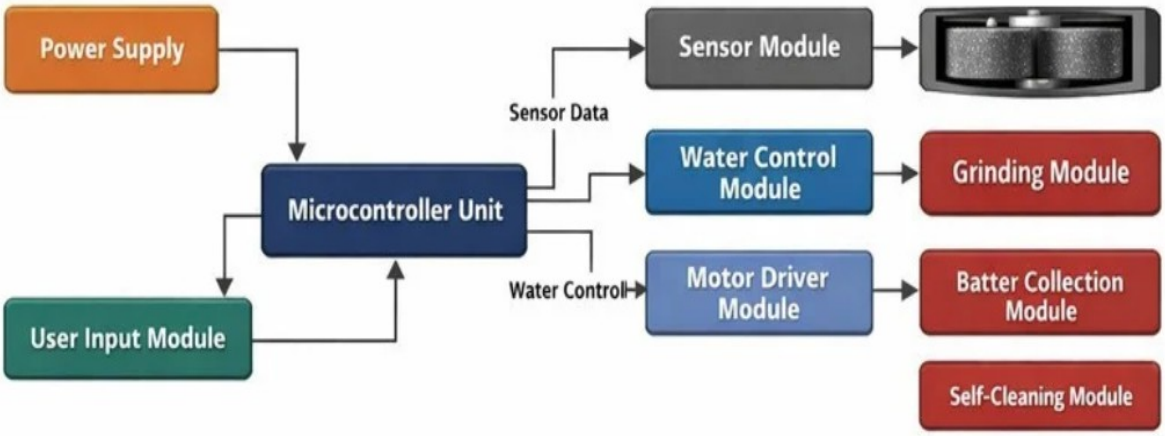

Fig3.24 Block Diagram

Fig3.25 Work Flow

2) WORKFLOW

The workflow of the Intelligent Tabletop Wet Grinder begins with the user adding soaked ingredients into the grinding drum and selecting the desired mode or setting through the user interface.

- SystemWorkingFlow

Thesystemworkingflowbeginswiththeuserinputandactivationofthegrinder, followed by automated motor operation controlled by a microcontroller.

- Process Flow of Wet Grinder

Theprocessflowofawetgrinderstartswithaddingsoakedingredientsintothedrum and selecting the required settings.

- Operational Workflow System

TheoperationalworkflowsystemoftheIntelligentTabletopWetGrinderbeginswith the user loading soaked ingredients into the drum and selecting the desired settings through the control interface

- Working Procedure Flow

Theworkingprocedureflowinvolvesloadingingredients,activatingthesystem, automatic grinding with sensor monitoring, and completion through timed or controlled shut-off.

- Smart Grinder Process Flow

The smart grinder process flow starts with user input, followed by automated grinding controlledbysensorsandamicrocontroller,ensuringefficientoperationandautomatic completion.

- EnergyConsumption

Energyconsumptionisoptimizedbyautomaticallyadjustingmotorspeedand operating time based on load conditions, reducing unnecessary power usage.

D. Modules

1) Modules & Their Description

The Intelligent Tabletop Wet Grinder consists of several functional modules thatwork together to ensure efficient and automated operation. The Power SupplyModule provides stable and regulated power to all electronic components and themotor.

The Motor Control Module manages the speed and functioning of the motor based on input conditions, ensuring proper grinding performance. The Grinding Mechanism Module includes the drum and roller stones, which carry out the actual grinding process. The Sensor Module monitors parameters such as load, temperature, and vibration, providing real-time data to the system. The Microcontroller Unit acts as the central control system, processing sensor inputs and controlling overall operations. The User Interface Module allows users to interact with the system through buttons, displays, or touch controls. The Safety and Protection Module ensures secureoperation by including features like auto shut-off, overload protection, and fault detection.

2) Power Supply Module

The Power Supply Module is responsible for providing a stable and regulated electrical supply to all components of the Intelligent Tabletop Wet Grinder. It converts the available AC mains power into the required DC voltage levels suitable for the microcontroller, sensors, and control circuits. This module suitable for the microcontroller, sensors, and control circuits. This module typically includes components such as a transformer, rectifier, voltage regulator,typically includes componentssuchasatransformer,rectifier,voltageregulator,andfilteringelements to ensure smooth and noise-free power output.

3) Motor Control Module:

TheMotorControlModuleisresponsibleforregulatingthespeedandoperationof the motor used in the wet grinder.

Itreceivessignalsfromthemicrocontrollerandadjuststhemotorperformancebased on load conditions and user input. This module ensures smooth starting, efficient operation, and prevents overloading by controlling voltage or current supplied to the motor.

4) Grinding Mechanism Module:

TheGrindingMechanismModuleconsistsofthegrindingdrumandrollerstones, which perform the actual grinding process. The soaked ingredients are crushed and mixed between the rotating stones and drum to produce a smooth batter. The design and quality of these components directly affect grinding efficiency and output consistency This module primarily consists of the grinding drum, roller stones, and a rotating shaft connected to the motor. The soaked ingredients are placed inside the drum, where the motor-driven rotation of the stones crushes and mixes them into afine and uniform batter. The design, material, and arrangement of the roller stonesplay a crucial role in achieving efficient grinding, as they ensure proper pressure and friction between the ingredients and the drum surface.

5) *Sensor Module***:**

The Sensor Module includes various sensors such as load sensors, temperature sensors, and vibration sensors that monitor the operating conditions of the system. These sensors provide real-time data to the microcontroller, enabling intelligent decision-making and automatic adjustments. By continuously tracking system parameters, this module helps improve efficiency, safety, and performance.

6) Safety And Protection Module

The Safety and Protection Module ensures safe operation of the wet grinder by preventing damage and hazards. It includes features such as overload protection, auto shut-off,andfaultdetectionmechanisms.Ifabnormalconditionslikeexcessiveloador overheating are detected, the system automatically stops or adjusts operation. This module enhances user safety, protects components, and increases the overall reliability of the system. This module includes features such as overload protection, which prevents the motor from operating under excessive load conditions, and temperature monitoring to avoid overheating. It also incorporates an automatic shut-off mechanism that stops the grinder when abnormal conditions like excessive vibration, improper lid placement, or prolonged operation are detected. Additionally, safety switches and protective circuits help in preventing electrical faults and short circuits. By continuously monitoring system parameters and responding to unsafe conditions, this moduleenhancesdurability,ensuresusersafety,andimprovestheoverallreliabilityof the grinder.

E. Hardware Components

ThehardwarecomponentsoftheSmartWasteManagementSystemarecarefully selected to ensure optimal performance, durability, and cost-efficiency. These components form the physical backbone of the system, enabling each module to function seamlessly.

1) Electric Motor

Fig3.41 Electric Motor

The electric motor is a vital component of the Intelligent Tabletop Wet Grinder, responsible for driving the grinding mechanism. It converts electrical energy into mechanical energy to rotate the grinding stones inside the drum. Typically, a single-phaseACmotorisusedfordomesticapplicationsduetoitsreliabilityandefficiency.

Key Specifications

Motor Type:

The IntelligentTabletop Wet Grinder uses a single-phase AC motor, which is commonly preferred for domestic kitchen appliances due to its reliability, ease of operation, and efficient performance. This motor provide ssufficient torquetorotate therollerstonesandgrindingredients uniformly.

Motor Power

The motor of the Intelligent Tabletop Wet Grinder typically ranges from 150Wto250W,providingenoughtorquetogrindingredientsefficiently.

Control Unit:

TheControlUnitoftheIntelligentTabletopWetGrinderservesasthebrain of the system, managing and coordinating all operations.

SensorsUsed:

TheIntelligentTabletopWetGrinderincorporatesvarioussensorstomonitor and optimize its operation.

GrindingCapacity:

TheIntelligentTabletopWetGrinderisdesignedwithadomesticgrinding capacity ranging from 1 to 2 liters, making it suitable for household usage

OperatingModes:

The grinder offers manual and preset automatic operating modes, giving users flexibility and convenience. In manual mode, users can control the duration and speed of grinding according to their preference

SafetyFeatures:

Safety is a critical aspect of the Intelligent Tabletop Wet Grinder, and it incorporates multiple protective mechanisms. The auto shut-off feature stopsthemotorwhenthegrindingprocessiscompleteorintheeventof abnormal operation

User Interface:

The user interface of the Intelligent Wet Grinder is designed to be simple,intuitive,andefficient.Ittypicallyincludespushbuttonsandan LCD or LED display, allowing users to select grinding modes, monitor process status, and receive alerts for any faults

Optional Feature (IoT Connectivity):

The grinder can optionally include IoT connectivity via a Wi-Fi module, enabling remote monitoring and control through a smartphone or tablet.

Material:

Thegrinderisconstructedwithfood-grademater ials,ensuringsafetyand hygiene during the grinding process. The drum is typically made from stainless steel or other corrosion-resistant metals, while the roller stones are crafted from granite to provide effective grinding and durability

Energy Efficiency:

Energy efficiency is a key consideration in the design of the Intelligent TabletopWet Grinder. Thesystemoptimizesmotorspeedandoperating time based on the load and type of ingredients, reducing unnecessary power consumption.

2) Micro Controller

Fig 3.42 Microcontroller

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue VII July 2026- Available at www.ijraset.com

The microcontroller serves as the central processing unit of the Intelligent Tabletop Wet Grinder, acting as the brain that controls and coordinates all system operations. It receives inputs from various sensors, including load, temperature, and vibration sensors, and processes this data to make real-time decisions for optimal grinding performance. Based on sensor readings and user-selected settings, the microcontroller regulates motor speed, grinding duration, and safety mechanisms such as auto shut-off or overload protection. It also manages the user interface, displaying operationalstatus, alerts, and preset modes for different types of batter

3) Power Supply Unit

Fig 3.43 Power Supply Unit

The Power Supply Unit (PSU) of the Intelligent Tabletop Wet Grinder is responsible for providing stable and regulated electrical power to all the system components,
It typically converts the standard AC mains voltage (230V, 50Hz) into the required DC voltage levels for electronic modules, ensuring smooth and consistent operation. The PSU includes components such as transformers, rectifiers, voltage regulators, and filters to eliminate voltage fluctuations and electrical noise that could affect system performance. A reliable power supply is essential to prevent interruptions, protect sensitive electronic components, and maintain the overall efficiency and safety of the grinder. The unit is designed to deliver consistent energy while minimizing power loss and enhancing the longevity of the appliance. Some designs may include voltage stabilization features to handle minor fluctuations in the mains supply, ensuring that sensitive components like the microcontroller and sensors operate without interruption. The PSU is designed to efficiently handle the varying power demands of the motor during startup, high- load grinding, and idle states, preventing energy wastage and overheating. By delivering consistent and clean power.

4) Load Sensor

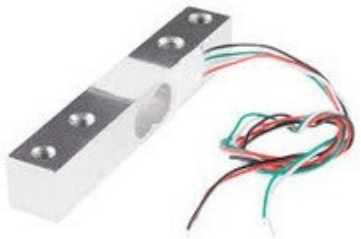

Fig3.44 Load Sensor

The Load Sensor is a critical component of the Intelligent Tabletop Wet Grinder, responsible for monitoring the weight or quantity of ingredients placed inside the grinding drum. By measuring the load in real time, the sensor provides essential data to the microcontroller, allowing the system to adjust the motor speed and grinding duration accordingly
This ensures that the grinder operates efficiently regardless of the quantity or consistency of the ingredients, preventing under-grinding or over-grinding. Load sensors are typically based on strain gauge technology, where the deformation caused bytheweightoftheingredientsproducesameasurablechangeinelectricalresistance, which is then converted into a digital signal for processing

In addition to enhancing grinding efficiency, the load sensor also contributes to the safetyandlongevityoftheappliance. Bydetectingexcessiveloadconditions,itcan signal the microcontroller to reduce motor speed or temporarily stop operation, preventing motor overload, overheating, and mechanical wear.

5) Display Unit (LCD / LED Display)

Figure3.45 Display

Figure3.46 Display

The Display Unit, typically an LCD or LED screen, serves as the primary interface between the user and the Intelligent Tabletop Wet Grinder. It provides real-time information about the system's operational status, such as selected grinding mode, remaining time, motor speed, and any active safety alerts.

pIn addition to showing operational parameters, the display unit also communicates alerts or warnings from sensors, such as overload, overheating, or abnormal vibration, allowing users to take timely action. It enhances usability by guiding users through preset modes and automated operations, making the appliance accessible even for those unfamiliar with smart kitchen devices. Some advanced systems may use LCDs with touch functionality or backlighting to improve visibility and interaction in different lighting conditions. Overall, the display unit is a key component for improving user convenience, monitoring, and control, ensuring a smooth and intelligent operation of the wet grinder.

6) Safety Switch

Figure3.46 Safety Switch

The Safety Switch is an essential component of the Intelligent Tabletop Wet Grinder, designed to ensure the safe operation of the appliance and protect users from potential hazards. It acts as a physical or electronic interlock that prevents the grinder from operatingunderunsafeconditions,suchaswhenthelidisnotproperlyclosedorwhen parts are incorrectly assembled.

By interrupting the power supply or signaling the control unit, the safety switch ensures that the motor and grinding mechanism cannot start accidentally, reducing the riskofinjuryordamage.Thisfeatureisparticularlyimportantinhouseholdappliances wherechildrenorinexperiencedusersmaybepresent,providinganadditionallayerof protection and peace of mind.

In addition to preventing accidental operation, the safety switch works in coordination with other system modules to enhance overall appliance reliability. It candetectabnormalconditions,suchasjamsormisalignmentofthegrindingdrum and roller stones, and immediately stop motor operation to prevent mechanical damage.

The switch is integrated with the microcontroller and safety protection module, which allows the system to generate alerts or notifications on the display unit when an unsafe condition is detected.

This integration ensures that the grinder not only protects the user but also safeguards internal components, increasing the longevity and durability of the appliance. By providing real-time protection and intelligent feedback, the safety switch is a critical element in creating a reliable, user-friendly, and safe intelligent wet grinder.

Automated grinding ensures consistent batter quality. Sensor-based monitoring improves safety and efficiency. Preset modes and smart timer reduce manual effort.

Autoshut-offandoverloadprotectionpreventdamage. Energy-efficient motor control minimizes power consumption. Easy-to cleanfood-gradedrumwithdurablerollerstones.

7) Blower

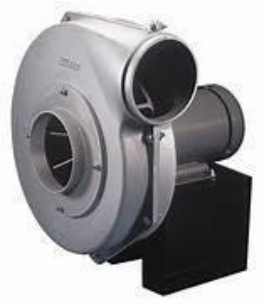

Figure3.47 Blower

Blowers are widely used for cleaning purposes, both in industrial and household settings. The high-velocity air stream dislodges dust, debris, and other particles from surfaces, making it an efficient tool for maintaining cleanliness.

8) Power Adapter

Figure3.48 Power Adapter

Power adapters are essential for converting AC to DC power, providing the correct voltage and current to electronic devices, ensuring their safe and efficient operation, and enabling us to use our devices conveniently

9) PIPES

Figure3.49 Pipes

PVC pipe represents a versatile and cost-effective material, it is utilized across numerousapplications. PlumbingsystemsoftenincorporatewhitePVCpipe;thepipesensurereliablewaterdistribution.IrrigationprojectscommonlyusePVCpipebecause of its durability

10) WIRES

Figure3.50 Wires

An electrical wire is a fundamental component in electrical systems, serving as a medium for the transmission of electrical power or signals. It typically consists of a single conductor made from materials with high electrical conductivity, such as copper or aluminum.
Electricalwiresaregenerallyclassifiedintotwotypesbasedontheirphysical construction:

- Solid Wire: This type comprises a single, solid conductor of metal. It is knownfor its strength and resistance to wear and corrosion. Solid wires are typically used in permanent or semi-permanent installations, such as residential and commercial building wiring, where minimal movement or flexibility is required.
- Stranded Wire: This variant is made up of multiple thin strands ofmetal that aretwistedorbraidedtogether. Stranded wiresoffergreaterflexibilityandarelesslikely to break when bent repeatedly.

11) USB Power Supply

Figure 3.51
USB Power Supply

USB power adapters are essential for charging and powering a wide range of electronic devices. Their importance lies in their universality, convenience, and efficiency, adapting to various charging needs and standards like USB-C, which offers faster charging and data transfer.

F. SOFTWARE

1) Software Configuration &Description:

The Intelligent Tabletop Wet Grinder system is supported by a combination of embedded programming and software tools that enable control, monitoring, and automation of the grinding process.

The software is primarily developed tointerface with the microcontroller and manage system operations such as motor control, sensor data processing, and user interaction.

Software Tools Used

- Python Programming Language
- ArduinoIDE(formicrocontrollerprogramming) •Embedded Firmware
- SensorInterfacingLibraries •Motor Control Program
- LCDDisplayControlProgram •Simulation Software

2) Key Tools &Utilities:

Python Programming Language

Pythonisusedfordevelopingcontrollogicandhandlingsystemoperations.It supports easy integration with sensors and provides flexibility for testing and simulation.

Arduino IDE

Arduino IDE is used for writing, compiling, and uploading the program to the microcontroller.Itprovidesasimpleplatformforembeddedsystemdevelopment.

Microcontroller Firmware

Firmwareistheprogramstoredinthemicrocontrollerthatcontrolstheentire system. It manages input/output operations, sensor data processing, and execution of control logic.

Sensor Interfacing Libraries

These libraries are used to connect and communicate with sensors such as load, temperature, and speed sensors. They simplify data acquisition and processing.

Motor Control Program

Thisprogramcontrolstheoperationofthemotorthroughthemotordriver.It ensures proper rotation and speed of the grinding drum.

LCD Display Control Program

Thedisplayprogramisusedtoshowsystemstatus,grindingtime,andother information to the user.

3) Summary

The software system of the Intelligent Tabletop Wet Grinder plays a crucial role in enabling automation and efficient operation. By integrating programming tools, firmware, and control utilities, the system ensures proper coordination between all modules. The use of appropriate software tools simplifies development, improves reliability, and enhances the overall performance of the system.

IV. RESULT

A. Result & Discussion

The Intelligent Tabletop Wet Grinder system was tested to evaluate its performance, automation capability, and efficiency in batter preparation. The system integrates sensors, a microcontroller, and control mechanisms to automate the grinding process.

The following results were observed:

System Performance

The microcontroller successfully controlled all modules of the system.

The grindingmotoroperatedsmoothlyunderdifferentloadconditions.

Thesystem responded effectively to user input and executed operations without delay.

Automation and Efficiency

The system reduced manual effort significantly. Continuousmonitoringwasnotrequiredfromtheuser. Automated operation improved overall efficiency.

Output Observation

- Batteroutputwasconsistentintextureandquality.
- System performed reliably for repeated operations.

Output Snapshots

Thesystemoperationcanbevisuallyobservedduringdifferentstages: •Grinding process inside the drum

- Batter collection at the outlet

- Cleaning operation after grinding

Fig4.1
MobileAppControl
(Mode Select)

Fig4.2
Walter inlet
(DosaMode)

Fig4.3
GrindingProcess (cleaning)

Fig4.4 Tilting Mechanism

Summary of Observations

- Automatedgrindingwasachievedsuccessfully •Consistent batter quality was obtained Manual•effort was reduced System performance was
- stable and reliable

Conclusion of Results

The results demonstrate that the Intelligent Tabletop Wet Grinder **performs effectively** and meets the intended objectives. The integration of sensors, microcontroller,andautomationtechniquesimprovesefficiency,consistency,and user convenience compared to traditional wet grinders.

V. CHALLENGES

A. Challenges & Limitations

Duringthedesign,development,andtestingoftheIntelligentTabletopWetGrinder, several challenges and limitations were encountered. Understanding these factors is essential to improve system performance and guide future upgrades.

B. Technical Challenge Sensor Calibration:

Load and temperature sensors required precise calibration for accurate measurements. Initial inconsistencies caused slight delays in motor response and safety triggers.

- Motor Vibration and Noise

Atmaximumgrindingcapacity,themotorexhibitedslightvibrationsandincreasednoiselevels,requiringmechanicalreinforcementandadjustmentofthedrum mounting.

- User Interface Limitations

Limiteddisplaysizerestrictedtheamountofinformationshownatonce.Detailed status updates and troubleshooting messages were difficult to display effectively.

C. Hardware Constraints

- Limited Processing Capability

The microcontroller used in the system has limited computational power and memory. Thisrestricts theimplementationofcomplexalgorithms,advanceddata processing, and real-time analytics within the device.

- Sensors such as load sensors and temperature sensors may have limited precision and can be affected by environmental conditions like moisture, vibration, and heat. This can lead to inaccurate readings and affect automation performance.
- The system depends on a stable power supply. Voltage fluctuations or power interruptions may affect the functioning of components.

D. Cost and Maintenance

- The overall cost of the intelligent table top wet grinder must be kept affordable for domestic users, which limits the selection of high-end components and advanced technologies.
- Regular maintenance is necessary to ensure the efficient operation and long lifespan of the grinder. Components such as the motor, grinding stones, and sensors may require periodic inspection, cleaning.

E. Deployment Barriers

Integrating sensors, control units, and automation features into a compact wetgrinder design can be complex, leading to difficulties during real-timeimplementation and testing.Integrating advanced components like sensors and control systems into a compact design increases system complexity and may lead to implementation difficulties. Additionally, users who are accustomed to traditional wet grinders may find it difficult to adapt to automated features and digital interfaces. Limited technical knowledge among users can also create hesitation in operating and maintaining the system effectively. Furthermore, factors such as cost sensitivity and availability of technical support can impact the widespread adoption of the product.

VI. CONCLUSION

The intelligent table top wet grinder project successfully integrates automation and smart features to improve efficiency and user convenience in domestic grinding applications. It enhances safety, reduces manual effort, and ensures consistentgrinding performance through the use of sensors and control systems.

Keyaccomplishmentsofthesysteminclude:

- Successfulintegrationofsensorsandcontrolunitsforautomatedgrinding operations
- Improvedefficiencyandreducedmanualeffortcomparedtotraditionalwet grinders
- Implementationofsafetyfeaturessuchasoverloadprotectionandautoshut-off •Enhanced user interaction through a simple display and control interface
- Consistent grinding quality with optimized performance and monitoring
- Developmentofacompactandcost-effectivesmartappliancesuitablefor domestic use

Thesystemsuccessfullyintegratessensorsandcontrolmechanismstoenableautomatedandefficientgrindingoperations.ItreducesmanualEffort whileimproving consistencyandoverallperformancecomparedtotraditionalwetgrinders.Theinclusionofsafety features such as overload protection and auto shut-off enhances user safety and reliability.

VII. ACKNOWLEDGEMENT

We are very truly indebted to Late Col. Dr. Jeppiaar, M.A., B.L., Ph.D., Founder, JeppiaarEducationalTrust,Dr. M. Regeena J Murali, B.Tech., M.B.A.,Ph.D.,ourChairmanandManagingDirectorandourPrincipalDr. K. SenthilKumar,M.E., Ph.D.,FIE,MISHREA,MISTEfortheirblessingsandthefacilitiesto carry out the project.

We would like to express our gratitude to Dr. J. Jebastine, M.E., Ph.D., Professor and Head of the Department. We thank our project coordinator Dr. J. Jebastine M.E., Ph.D., We are thankful to our supervisor Mr. J. Ranjith Kumar, M.E.,for giving valuable suggestions and guiding us in all stages of the project. We finally thank all the faculty members of the Department of Electronics and Communication Engineering for their constant support.

We would also like to thank our parents and friends for all their support and we thank the Almighty God for helping us complete this project, successfully.

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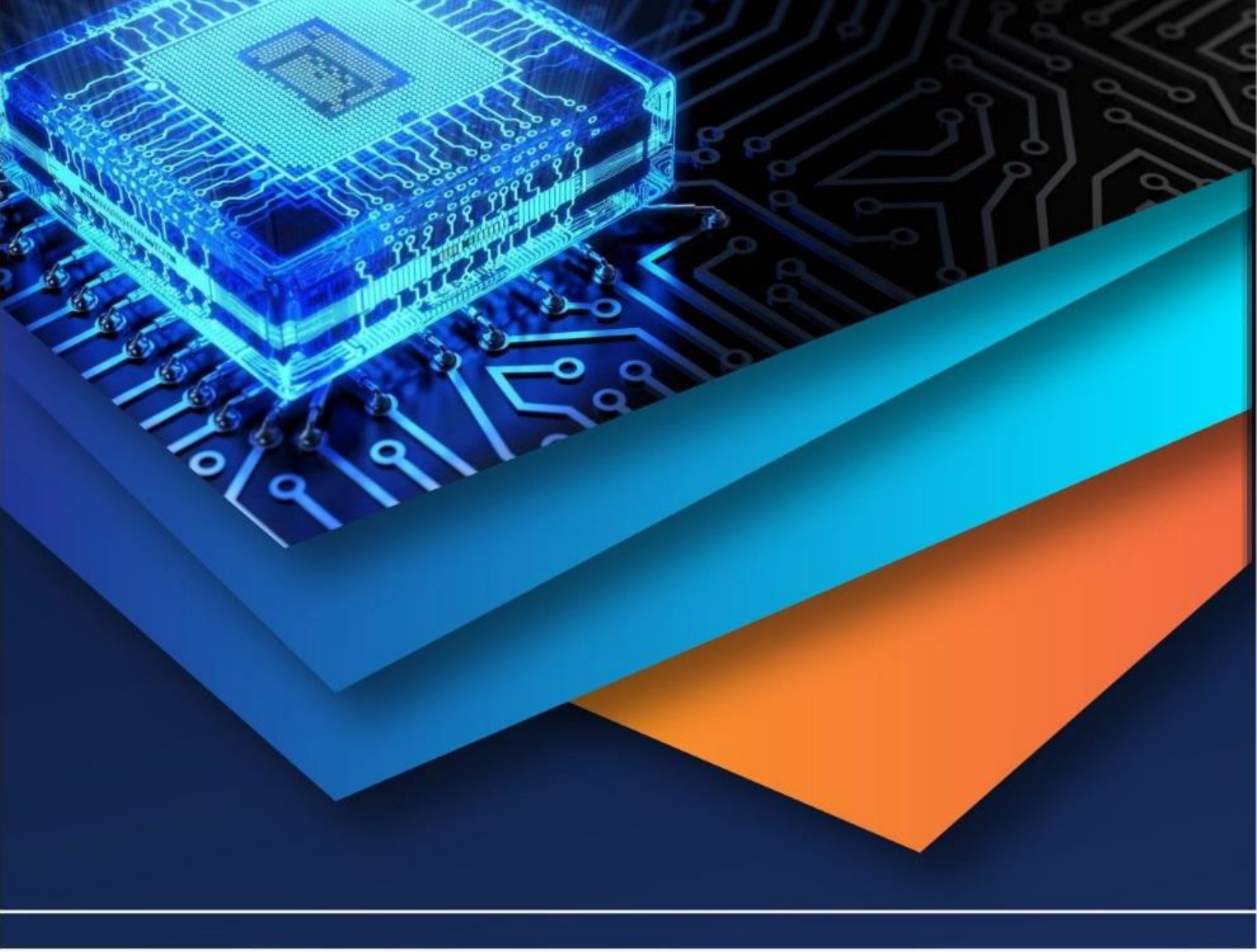

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