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Voice recognition stop watch

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Abstract – *The Voice Recognition Stopwatch is a smart embedded system designed using the ESP32 WROOM to perform timing operations through voice commands. Unlike traditional stopwatches, this system eliminates manual control by enabling hands-free interaction using speech recognition technology.*
The project utilizes an ESP32 microcontroller along with supporting hardware such as an expansion board, push buttons, resistors, and a lithium-ion battery for portable operation.TheESP32processesvoicecommands(suchas "Start," "Stop," and "Reset") either through an external voice module or mobile-based voice input via Wi- Fi/Bluetooth. Based on the recognized command, the controller activates its internal timer to measure elapsed time accurately.
Thesystemispoweredusinga3.7Vlithium-ionbatterywith a battery holder and DC jack interface, ensuring mobility andeaseofuse.Additionalcomponentsliketactileswitches are included for manual override or backup control. The output can be displayedon aconnected display module or monitored via a serial interface.
This project demonstrates the integration of IoT-enabled microcontrollerswithvoice-basedcontrolsystems,offering improved usability, flexibility, and real-time performance. It has practical applications in sports timing, laboratory experiments, and assistive technologies, highlighting the growingimportanceofvoice-controlledembeddedsystems in modern electronics.

Keywords: Voice Recognition, Stopwatch, ESP32 WROOM, Embedded System, IoT, Speech Control, Bluetooth, Wi-Fi, Real-Time Processing, Automation.

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I. INTRODUCTION

In recent years, the demand for hands-free and intelligent systems has increased significantly with the growth of embeddedandIoTtechnologies.Voicerecognitionhasemerged asaneffectivemethodofhuman–machineinteraction,allowing userstocontroldevicesthroughsimplespokencommands.This project,aVoiceRecognitionStopwatch,isdevelopedtoreplace conventional manual stopwatches with a more advanced and user-friendly solution.
The system is built using the ESP32 WROOM, a powerful microcontroller that supports wireless communication such as Wi-Fi and Bluetooth. By integrating voice recognition capability,thestopwatchcanperformoperationslikestart,stop, and reset based on user speech input. This eliminates the need for physical buttons and enables convenient operation, especially in situations where hands-free control is essential.
In addition to voice control, the system includes supporting components such as tactile switches for manual backup, resistors for circuit stability, and a lithium-ion battery for portable usage. The ESP32 processes the input commands and manages the internal timer to display accurate elapsed time.
This project highlights the practical implementation of speech recognition in embedded systems, demonstrating how modern technology can enhance usability and efficiency. It can be widely applied in areas such as sports timing, laboratory experiments, industrial processes, and assistive devices for individuals with physical limitations.

II. LITERATURESURVEY

Voicerecognitiontechnologyhasgainedsignificantattentionin recentyearsduetoitsapplicationinembeddedsystemsandIoT devices. According to a systematic review on voice activation systems, modern embedded devices increasingly incorporate voice control to enhance human–machine interaction and improve usability. These systems typically consist of modules for speech acquisition, feature extraction, and command processing, enabling efficient real-time operation

III. GLOBALOBSERVATION (INTERNATIONALSTATICS)

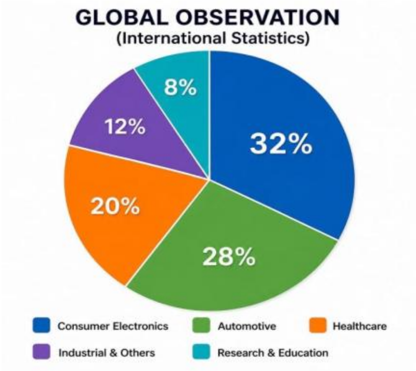

Fig.1PercentageBreakdown

In Fig.1 The given pie chart illustrates the global adoption ofvoicerecognitiontechnologyacrossdifferentindustries. It is evident that Consumer Electronics holds the largest share at 32%, indicating that voice recognition is most widely used in devices such as smartphones, smart speakers, and personal assistants.

INDIANSTATICS
India is emerging as a major hub for voice recognition technology, which directly supports the development of systemslikeaVoiceRecognitionStopwatch.TheIndianvoice recognition market reached approximately USD 462.8 million in2024andisprojectedtogrowtonearlyUSD2.98billionby 2033, with a strong annual growth rate of around 23% . This rapid growth indicates increasing acceptance of voice- controlled systems across the country.
In 2023, the Indian voice and speech recognition market generated about USD 322 million and is expected to exceed USD1.1billionby2030,showingcontinuousexpansiondriven by AI and IoT technologies . The rise in smartphone usage (over 150 million shipments in 2024) and affordable internet access has significantly increased the number of users interacting with voice-enabled systems .
For a Voice Recognition Stopwatch, these statistics highlight strongrelevanceintheIndiancontext.Thegrowingdemandfor hands-free operation, increasing familiarity with voice commands, and support for regional languages make such a system practical and user-friendly. Overall, India provides a rapidlyexpandingenvironmentforvoice-controlledembedded projects,ensuringgoodscope,usability,andfuturescalability.

PROBLEM STATEMENT
Traditional stopwatches require manual operation using physical buttons to start, stop, and reset the timer. In many situations such as laboratories, sports activities, industrial environments, and smart applications, manual control may be inconvenient, time-consuming, or difficult when the user's handsareoccupied.Additionally,conventionalstopwatchesdo notprovidehands-freeaccessibilityforuserswhorequireeasier and faster interaction with electronic devices.

To overcome these limitations, there is a need for a smart stopwatch system that can be controlled through voice commands. The proposed Voice Recognition Stopwatch uses the ESP32 WROOM and Ai-Thinker VC-02 voice recognition moduletoperformstopwatchoperationssuchasStart,Stop,and Reset through speech input. The system aims to improve convenience, accessibility, efficiency, and user interaction by providing accurate and reliable hands-free stopwatch control using embedded and voice recognition technology.

IV.METHODOLOGY

TheAutomotivesectorfollowswith28%,showingastrong integration of voice control in modern vehicles for navigation,infotainment,anddriverassistancesystems.
Healthcareaccountsfor20%,wherevoicetechnologyis
usedformedical documentation,patient monitoring,and ________ assistive tools.

The Industrial & Other sectors contribute 12%, reflecting moderate adoption in automation and industrial control systems. Meanwhile, Research & Education has the smallestshareat8%,indicatingthatalthoughdevelopment and experimentation are ongoing, large-scale

implementation is still growing.
Overall,thechartshowsthatvoicerecognitiontechnology is widely adopted in consumer-focused and automotive applications, while other sectors are gradually increasing

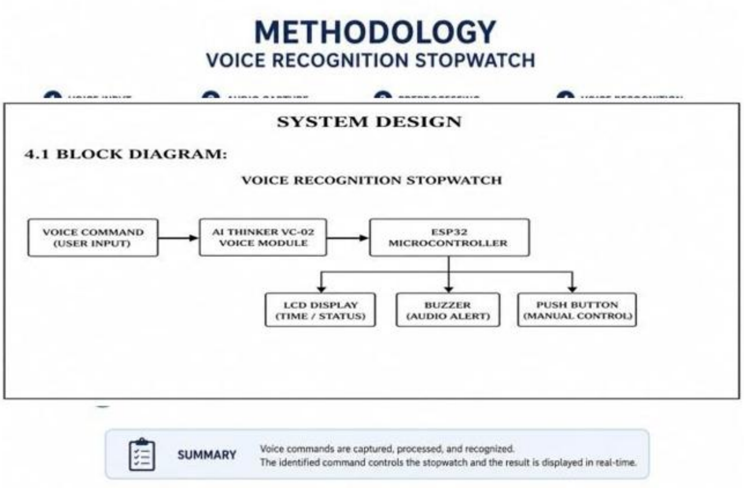

Fig.2BlockDiagram

The Voice Recognition Stopwatch system is designed to control stopwatch operations through voice commands using the ESP32 WROOM microcontroller. The complete system consists of several functional blocks connected together to perform voice-based timing operations.
Initially, the Voice Input block receives the user's speech commandssuchas"Start","Stop",and"Reset".These voicesignalsarecapturedthroughamicrophoneormobile applicationandsenttotheVoiceRecognitionModule/App. Thismoduleconvertsthespokenwordsintodigital commands that can be understood by the microcontroller. The converted command is then transmitted to the ESP32 Microcontroller, which acts as the main processing unit of thesystem.TheESP32analyzesthereceivedcommandand executes the corresponding stopwatch function. Due to its built-inWi-Fiandprocessingcapability,theESP32 provides fast and efficient operation.
TheTimerLogicblockperformsthestopwatchoperations such as starting, stopping, resetting, and counting elapsed time. The processed timing data is continuously updated and controlled by the ESP32.
The entire system is powered using a 5V DC supply or battery, which provides the necessary operating voltage to all components. Thus, the block diagram represents the complete working flow of the Voice Recognition Stopwatchsystemfromvoiceinputtotimedisplayoutput.

V .UNVEILINGTHEINNERWORKINGS

Fig.3AIthinkerVC-02

TheAi-ThinkerVC-02isacompactofflinevoicerecognition moduledesignedforembeddedsystemsandIoTapplications. ItisdevelopedbyAi-ThinkerTechnologyandmainlyusedfor recognizing voice commands without requiring an internet connection. The module is based on the powerful US516P6 voice AI processor, which provides fast and accurate speech processing.Itsupportsofflinerecognitionofupto150voice commands, making it suitable for applications such as smart home automation, robotics, industrial control, and voice- operated devices like the Voice Recognition Stopwatch.
IntheVoiceRecognitionStopwatchproject,theVC-02module receives voice commands such as “Start,” “Stop,” and “Reset” fromtheuserthroughamicrophone.Therecognizedcommand is then transmitted to the ESP32 microcontroller, which performs the corresponding stopwatch operation and updates the display unit. Due to its compact size, low power consumption, high accuracy, and easy integration, the Ai- Thinker VC-02(Fig.3) module is highly suitable for real-time voice-controlled embedded applications.

Fig.4Lithiumionbattery

TheLithium-IonBatteryisarechargeableenergystoragedevice widelyusedinportableelectronicsystemsduetoitshighenergy density, lightweight structure, and long operating life. It stores electrical energy chemically and supplies power to electronic circuits when required. Lithium-ion batteries are commonly used in mobile phones, laptops, IoT devices, electric vehicles, and embedded system projects because they provide stable voltage output and efficient performance.
A typical lithium-ion battery(Fig.4) operates at a nominal voltage of about 3.7V and can be recharged multiple times without significant memory effect.
In the Voice Recognition Stopwatch project, the lithium-ion batteryisusedasthemainportablepowersourcefortheESP32 WROOM, voice recognition module, and other connected components.Thebatteryprovidescontinuousandstablepower supply, allowing the system to operate efficiently without depending on external power sources. Due to its compact size, lowweight,fastcharging capability,and long backup time,the lithium-ionbatteryishighlysuitableforportableembeddedand IoT-based application.

Fig.5LCDdisplay

The LCD (Liquid Crystal Display) is an electronic output deviceusedtodisplaytext,numbers,andtiminginformation. It works by controlling liquidcrystals using electrical signals to form characters on the screen. In the Voice Recognition Stopwatch project, the LCD display(Fig.5) shows the stopwatch time and system status such as Start, Stop, and Reset. It is connected to the ESP32 WROOM and provides clear visual output with low power consumption and easy interfacing.

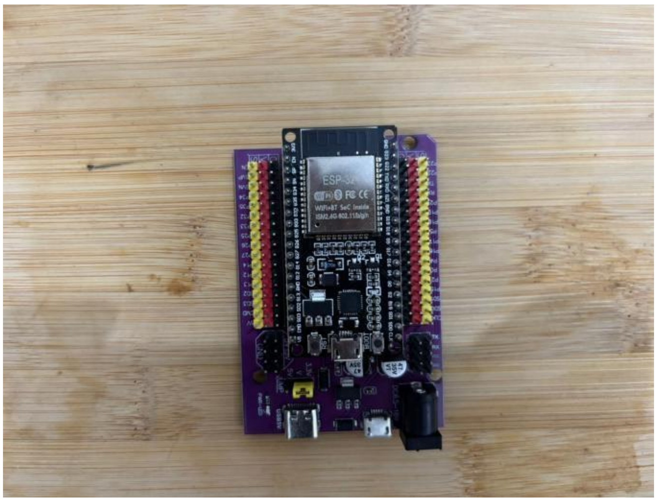

Fig.6ESP32WROOMkit

TheESP32WROOMisapowerfulandlow-costmicrocontroller module widely used in embedded systems and IoT applications. It is developed by Express if Systems and contains a dual-core processor that provides high-speed performance for real-time applications. The module has built-in Wi-Fi and Bluetooth connectivity, which allows wireless communication and easy integration with smart devices.

The ESP32 WROOM kit(Fig.6) includes digital and analog input/output pins, PWM support, UART, SPI, and I2C communication interfaces, making it suitable for connecting sensors, displays, and other electronic components. It operates with low power consumption and supports fast data processing, which is useful for automation and voice-controlled projects.

In the Voice Recognition Stopwatch project, the ESP32 WROOM acts as the main processing unit. It receives voice command data from the Ai-Thinker VC-02 voice recognition module and performs operations such as start, stop, and reset of thestopwatch.Theprocessedtiminginformationisthen displayed on the LCD screen. Due to its compact size, wireless capability, fast processing speed, and easy programming support, the ESP32 WROOM kit is highly suitable for modern embedded and IoT-based applications

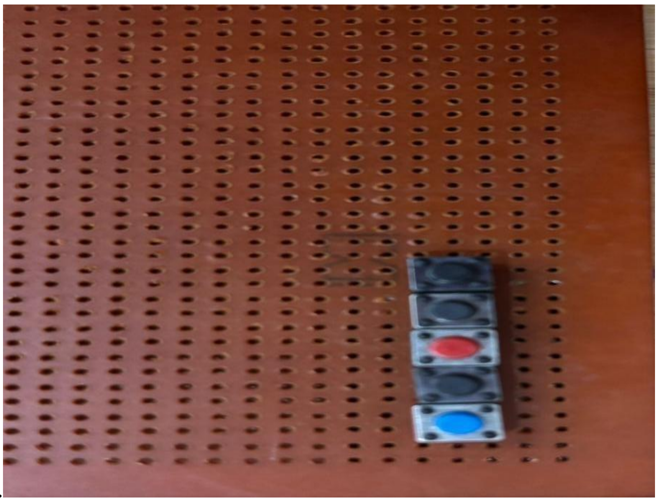

Fig.7Pushbuttonswitch

Thepushbuttonswitchisasimpleelectronicinputdeviceused tocontrolcircuitsmanually.Itworksbycompletingorbreaking theelectricalconnectionwhenthebuttonispressed.Pushbutton switchesarecommonlyusedinembeddedsystemsforfunctions such as start, stop, reset, and user control operations. In the Voice Recognition Stopwatch project, the push button switch is used as a manual backup control for stopwatch operations.Itallowstheusertooperatethesystemevenifvoice recognition is not used. The switch is connected to the ESP32 WROOM, which detects the button press and performs the required action. Push button switches(Fig.7) are widely used because they are compact, easy to use, reliable, and consume very little power.

VI .CONNECTED CIRCUIT

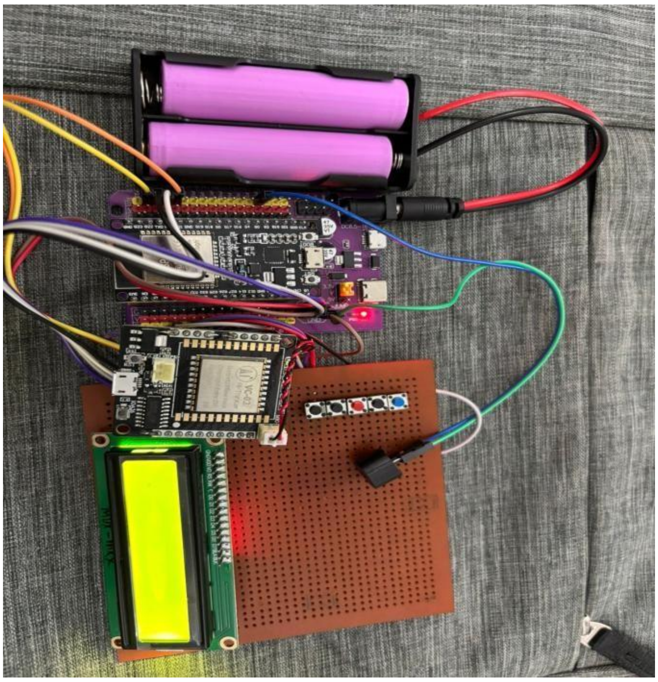

Fig.8Visualrepresentationofthecircuit

VII .HARMONIZINGTRADITIONAND TECHNOLOGY IN CULINARY INNOVATION":

The Voice Recognition Stopwatch demonstrates how traditional timing methods can be improved using modern technology to support innovation in culinary applications. In cooking and food preparation, accurate timing is essential for maintaining taste, texture, and quality. Traditionally, chefs and cooks use manual stopwatches or

timers, which require physical operation and may interrupt workflow. By integrating voice recognition technology withembeddedsystems,thestopwatchenableshands-freecontrol through simple voice commands such as “Start,” “Stop,” and “Reset.”
Using the ESP32 WROOM and Ai-Thinker VC-02 voice recognition module, the system combines traditional cooking convenience in the kitchen environment. The voice-controlled stopwatch is especially useful when handling ingredients or equipment, where touching devices may be difficult or unsafe.
The project represents the harmonization of traditional culinary methods with modern digital technology, improving accuracy, productivity, and user comfort. It highlights how embedded systems and voice recognition can contribute to smart kitchen environments and future culinary innovations.

VIII .THEFUSIONOFTRADITIONAND INNOVATION

The Voice Recognition Stopwatch represents a fusion of traditional timing methods and modern technological innovation. Conventional stopwatches have long been used in laboratories, sports, cooking, and industrial applications for accurate time measurement. However, these traditional systems require manual operationthroughphysicalbuttons,whichmaybeinconvenientin certain situations.
This project combines the reliability of conventional timing systems with the advantages of modern embedded and IoT technologies. The fusion of tradition and innovation not only enhances user interaction but also demonstrates the growing role ofsmartautomationineverydayapplications.Itshowshowvoice-controlledsystemscanmodernizesimpleelectronicdeviceswhile maintaining their original purpose and functionality.

IX .CONNECTINGCULINARYWORLDS

The Voice Recognition Stopwatch helps connect traditional culinary practices with modern smart technology by providing a hands-free timing solution for cooking and food preparation. In culinary activities, accurate timing is very important for maintaining food quality, taste, texture, and consistency. Traditional timers and stopwatches require manual operation, which may interrupt cooking processes when the user is handling ingredients or kitchen equipment.
By integrating the ESP32 WROOM with voice recognition technology, the stopwatch allows users to control timing operations through simple voice commands such as “Start,” “Stop,” and “Reset.” This improves convenience, hygiene, and efficiency in kitchen environments by reducing the need for physical contact with devices.

The project connectsculinarytraditionswith digitalinnovation by introducing smart automation into everyday cooking activities. It demonstrates how embedded systems and voice- controlled technology can support modern culinary environments, making food preparation safer, easier, and more efficient while preserving the importance of precise timing in traditional cooking method.

X .DECODINGTHETECHNOLOGICAL FRAMEWORK

The technical framework of the Voice Recognition Stopwatch is designed using embedded system technology, voice recognition processing, and real-time timing control. The system mainly consists of the Ai-Thinker VC-02 voice recognition module, ESP32 WROOM, LCD display, push button switches, and lithium-ion battery power supply. These components work together to provide hands-free stopwatch operation through voice commands.

Theframeworkbeginswiththevoiceinputstage,wheretheuser gives commands such as “Start,” “Stop,” and “Reset.” The Ai- Thinker VC-02 module captures the speech signal through its microphoneandconvertsthespokencommandintodigitaldata using offline voice recognition technology. This processed command is transmitted to the ESP32 microcontroller through serial communication.

The technical framework combines speech recognition, embedded processing, display interfacing, and portable power management into a single integrated system. This design improves user interaction, reduces manual effort, and demonstrates the practical implementation of voice-controlled embedded applications.

XI . CONCLUSION

The Voice Recognition Stopwatch project successfully demonstrates the implementation of voice-controlled technology in an embedded system application. By using the ESP32 WROOM and Ai-Thinker VC-02 voice recognition module, the system is capable of performing stopwatch operationssuchasStart,Stop,andResetthroughsimplevoice commands. The project provides a hands-free and user-friendly method of controlling timing operations with improved convenience and efficiency.

The integration of voice recognition technology with embedded hardware reduces manual effort and enhances accessibility in various applications such as sports, laboratories, industries, and smart devices. The LCD display provides clear real-time output, while the lithium-ion battery ensures portable operation of the system. The project also demonstrates the practical use of IoT and speech-processing technologies in modern electronic applications.

Overall, the Voice Recognition Stopwatch is a reliable, compact, and innovative system that combines traditional timingfunctionalitywithmodernautomationtechnology.The project highlights the future scope of voice-controlled embedded systems and their importance in smart and intelligent applications.

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