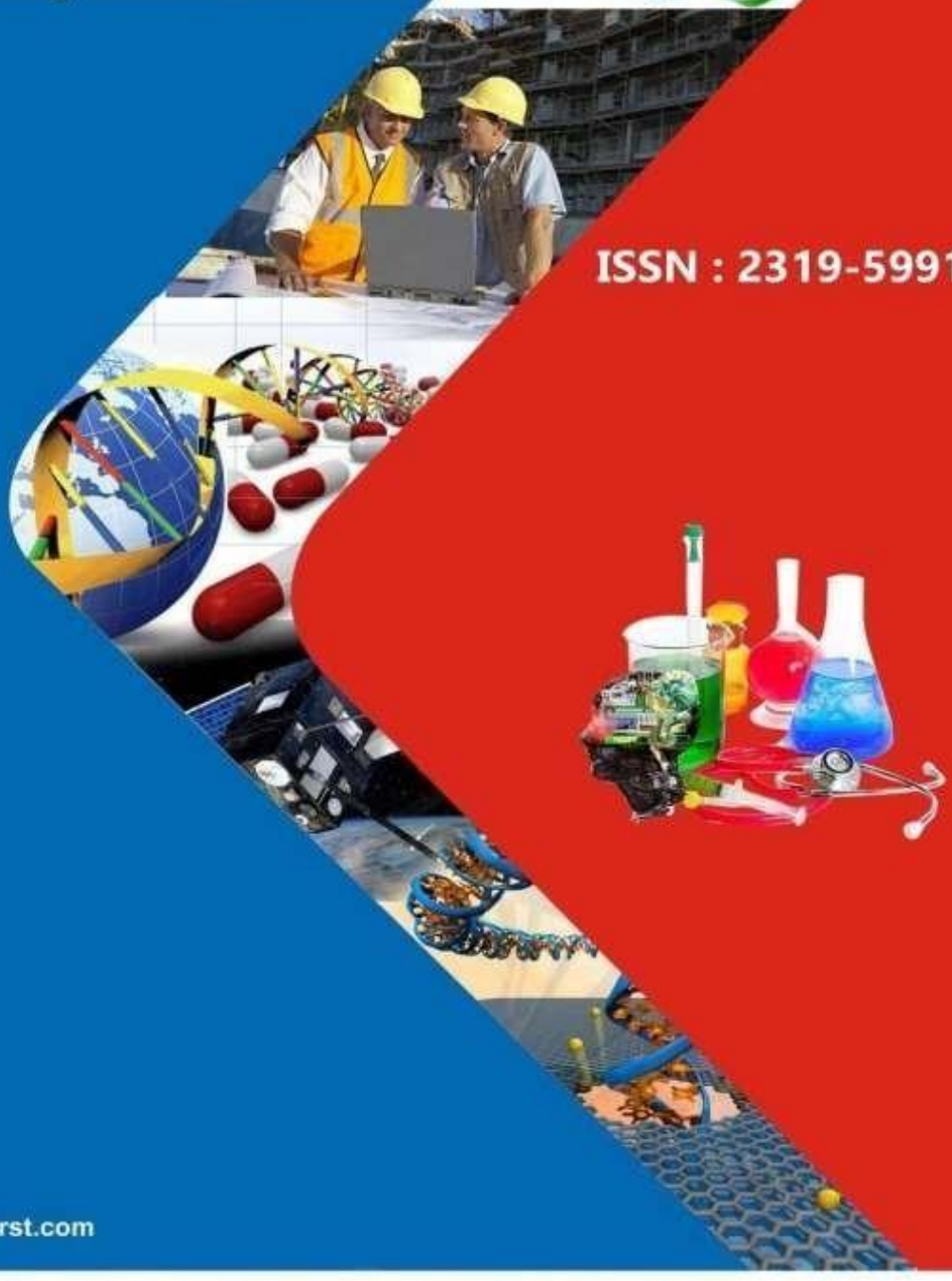
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Home Automation Using Google Assistance

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Abstract:
This project presents the development of a home automation system utilizing ESP32 microcontroller, 4-channelrelays,andvarioussmartdevicesincluding LEDs and sockets.Theprimaryobjectiveofthissystem is to enable users to remotely control and automate household appliances through a custom-built Cadio mobile application, as well as through popular voice assistantssuchasGoogle AssistantandAmazonAlexa.The hardware setup consists of an ESP32 microcontroller interfaced with 4-channel relays, allowing for the control of multiple appliances simultaneously. Additionally, LEDs and sockets are integratedintothesystemtodemonstratethepractica l application of home automation.The Cadio mobile application serves as the central control interface for the system, providing users with intuitivecontrolsandautomationfeatures.Throught he app, users can remotely monitor and control their connecteddevices,setupautomationroutinesbased on schedules or triggers, and receive notifications for important events.Integration with Google Assistant and Amazon Alexa furtherenhancestheaccessibilityandconvenienceo fthe system, allowing users to control their home appliances using voice commands. This seamless integration enables hands-free operation and expands the usability of the system across various smart home ecosystems.The project emphasizes user-friendliness,reliability,and security. Efforts are made to ensure the privacy and integrity of user data, with secure authentication mechanismimplementedinboththemobileapp lication and voice assistant integrations.Overall,thishomeautomationsystem demonstratesthe practical implementation of IOT technologies for enhancing home convenience, energy efficiency, and user experience. The combination of ESP32 microcontroller, 4-channel relays, and smart devices, alongwiththeversatilecontroloptionsprovidedbyt he Cadio app and voice assistants.

I. Introduction

In recent years, the proliferation of Internet of Things (IOT) technologies has revolutionized the way we interactwithourhomes,offeringunprecedentedlevels of convenience, energy efficiency, and automation. Home automation systems, in particular, have gained significantpopularityfortheirabilitytoremotelycontrol and monitor household appliances, lighting, security systems, and more. This project aims to contribute to the advancement of home automation by developing a comprehensive system utilizing ESP32 microcontroller, 4-channel relays, and various smart devices. The integration of these components allows for the remote control and automationofhouseholdappliances,facilitatedthrough a custom-built mobile application named Cadio.Furthermore,thesystemintegrateswithpopular voice assistants like Google Assistant and Amazon Alexa, enabling users to control their home appliances using voice commands. This integration adds an additional layer of accessibility and convenience, allowing for hands-free operation and expanding the system's compatibility with different smart home ecosystems.Home automation, also known as smart home technology, is a rapidly growing field that aims to enhance the comfort, convenience, efficiency, and securityofresidentiallivingthroughtheintegration of advanced technologies. With the proliferation of internet-connected devices and the advancement of artificial intelligence, home automation systems

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Vol. 20, Issue.2, April 2024

have become increasingly sophisticated, offering homeowners unprecedented control over various aspectsoftheirhomes.These system sencompassa



Fig 1: Home automation kit

several decades, with early iterations focusing on simple tasks such as remote control of lights and thermostats. However, recent advancements in sensor technology, wireless communication, and machine learning algorithms have propelled home automation to new heights, enabling seamless integration and intelligent automation of various home functions. Today, homeowners can create personalized environments tailored to their referencesandlifestyles,whetherit'sadjustingthe temperature, dimming the lights, or playing music with a voice command.

One of the key drivers behind the adoption of home automation is the promise of increased energy efficiency and cost savings. By optimizing the use of energy-consuming devices and implementing smartenergymanagementsystems



Fig 2: ESP32

Can reduce their utility bills while minimizing their environmental footprint. For example, smart thermostats can learn the occupants' schedules and adjust the temperature accordingly, while smart lighting systems can automatically dim or turn off lights in unoccupied rooms.

and comfort. Imagine being able to control your home'slighting,heating,andsecuritysystemfrom anywhere in the world using your smartphone. Whetheryou'reonvacationorstuckintraffic,you can remotely monitor and manage your home, ensuring peace of mind and reducing the risk of emergencies such as break-ins or accidents.

The rise of the Internet of Things (IOT) has further fueled the growth of home automation, enabling seamless communication and interoperability between different devices and platforms. Today, homeowners can choose from a wide array of smarthomeproductsfromvariousmanufacturers, all of which can be integrated into a unified ecosystem using common communication protocols such as Wi-Fi, Bluetooth, Zigbee, or Z-Wave.

eroperability. As more devices become connected to the internet, they also become potentialtargets

In conclusion, home automation holds immense promiseinrevolutionizingthewaywelive,offering unprecedented levels of comfort, convenience, efficiency,andsecurity.Astechnologycontinuesto advance and consumer demand grows, we can expect to see even more innovative solutions and seamless integration of smart home devices into our daily lives. However, it is essential to address the various challenges and concerns associated with home automation to ensure that it remains safe, secure, and accessible to all. In addition to energy savings, home automation.

1.1 ESP32:

A feature-rich MCU with integrated Wi-Fiand Bluetooth connectivity for a wide-range Of applications.



Fig 3: Thermometer

1.2 RobustDesign:

ESP32 is capable of functioning reliably in industrial environments, with an operating temperature ranging from –40°C to +125°C. Powered by advanced calibrationcircuitries,ESP32candynamicallyremove external circuit imperfections and adapt to changes in external conditions

Fig 4: Battery

1.3 Ultra-LowPowerConsumption:

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Vol. 20, Issue.2, April 2024

Engineeredformobiledevice, wearableelectronics and IOT applications, ESP32 achieves ultra-low power consumption with a combination of several types of proprietary software. ESP32 also includes state-of-the-artfeatures,suchasfine-grainedclock gating, various power modes and dynamic power scaling.

The ESP32 can pull, as much as 250mA during RF transmission, but we've generally measured it to consume around 150mA -- even while actively transmitting over WiFi..

1.4 ESP32 Active Mode:

Normal mode is also referred to as Active Mode. In this mode, all peripherals of the chip remain active.Since everything is always active in this mode (especially the Wi-Fi module, processing core, and Bluetooth module), the chip consumes about 240 mA of power. It has also been observed that the chip draws more than 790 mA at times, particularly when both Wi-Fi and Bluetoothare used simultaneously.

1.5 HighLevelof Integration:

ESP32 is highly-integrated with in-built antenna switches,RFbalun,poweramplifier,low-noisereceive amplifier, filters, and power management modules.

ESP32 adds priceless functionality and versatility to yourapplicationswithminimalPrintedCircuitBoard (PCB) requirements.

1.6 HybridWi-Fi&BluetoothChip:

ESP32canperformasacompletestandalonesystemor as a slave device to a host MCU, reducing communicationstackoverheadonthemainapplication processor. ESP32 can interface with other systems to provide Wi-Fi and Bluetooth functionality through its SPI / SDIO or I2C / UART interfaces.

1.74Channel5VOpticalIsolatedRelayModule:



Fig 5: 4Channel relay

This is a LOW Level 5V 4-channel relay interfaceboard,needs a15-20mAdrivercurrent. Itcanbeusedto control various appliances and equipment with large current.Itisequippedwithhigh-currentrelaysthatwork underAC250V 10Aor DC30V 10A. It has a standard interface that can be controlled directly by microcontroller. This module is optically isolated from highvoltagesideforsafetyrequirementandalsoprevent ground loop when interface to microcontroller.**BriefData:**

- OperatingVoltage:5Vdc.
- RelayMaximumoutput:DC30V/10A,AC250V/10A.
- 4ChannelRelayModulewithOpto-coupler.LOW LevelTrigger expansion board,whichis compatible with Arduino control board.
- Standard interface that can be controlled directly by microcontroller
- (8051,AVR,*PIC,DSP,ARM,ARM, MSP430, TTL logic).
- Relay of high quality low noise relays SPDT.A commonterminal,anormallyopen,onenormallyclosed terminal.
- Opto-Coupleisolation,forhighvoltage safetyand prevent ground loop with microcontroller.
- 1.9 OperatingPrinciple:

See the picture below: A is an electromagnet, B armature, C spring, D moving contact, and E fixed contacts.Therearetwofixedcontacts ,normallyclosed one and a normally open one. When the coil is not energized, the normally open contact is the one that is off,whilethenormallyclosedoneis theotherthat is on

WhatisCADIO?

CADIO is complete home automation platform allows

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ISSN 2319-5991 www.ijerst.com
Vol. 20, Issue.2, April 2024

youtobuildandcontrolsmarthomedevices,Withmany new features developed to give you the best smart home experience.

1.10 MainCADIOfeatures:

- Veryeasydeviceconfiguration.
- Controloverlocalwi-Finetwork.
- ControloverCADIOcloud.
- Newfullyautomatedhybridinterface.
- Unlimitednumberofdevicescanbeadded.
- Supportdevicesondifferentnetworks.
- Units/Groupsview.
- Notificationsforeverydevice.
- ON/OFFdevices.
- Dimmerdevices.
- RGBdevices.
- Shuttersdevices.
- IRdevices.
- Fanspeedregulator.
- Datadevices.
- Digitalhumidity/temperaturedevices.
- Digitalsensors.
- 433MHZSensors.
- Linkingdeviceswithsensors,humidityand temperature.
- Timers.
- Schedules.
- Syncwithphysicalpowerswitches.
- 433MHZremotecontrollersupport.
- Infrared remotecontrollersupport.

1.11 Operatingmodes:

- **Servicemode**
  - Inservicemode,Theunitconnectsto the **router Wi-Fi network** and you can **control the unit's devices using CADIO app**.
- **Configurationmode**
  - In configuration mode,Theunit createa**configurationWi-Finetwork**andyou can connect to it and **edit unit**
  - **configuration** using CADIO app.
  - **Pressing config button for 3 seconds**willmakestheunitenter the **configuration mode**.

Software

1.12 Infofile:

- ContainstheUnit**information'sabout the unit's structure and GPIOs**.
- Info file is created **after flashing the firmware**from**CADIO apposingavery simple interface**.
- **Info file can't be edited**, So if you want to changeanythinginInfofileyoumust **erase**the flash and **re-flashing** the firmware using **ESP Flash Download Tools**.

1.13 Configuration:

- Containstheunitsettingsforconnecting to the **router Wi-Fi network and the unit's associated account**.
- Unitconfigurationcanbeeditedanytime by**pressingfor3seconds**onthe**configbutton**, the unit will create a **configuration Wi-Fi network** you can connect to it and edit the unit configuration.

II. ProblemFormulation

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Vol. 20, Issue.2, April 2024

The rapid growth of IOT technologies has presented numerousopportunitiesforenhancinghome automation andimprovinguserexperience.However,ma nyexisting home automation systems are either complex to set up anduseorlack integration withpopularvoiceassistants, limiting their accessibility and usability. Additionally, concerns surrounding data privacy and security remain significant barriers to widespread adoption.

2.1 ComplexityofSetupandUsage:Existinghome automation systems often require extensive technicalknowledgefor setupandconfiguration, making them inaccessible to users without a background in electronics or programming. This complexity hinders widespread adoption and limits thepotential benefits of home automation technology.

2.2 Lack of Integration with Voice Assistants: Many home automation systems do not seamlessly integrate with popular voice assistants like Google Assistant and Amazon Alexa.Thislimitationrestrictstheconvenience and accessibility of controlling household appliances through voice commands, a feature that is increasingly desired by users.

2.3 DataPrivacyandSecurityConcerns:Withthe increasing connectivity of household devices, ensuring the privacy and security of user data becomes paramount. Existing home automation systems may not adequately address these concerns, leading to apprehension among users about sharing sensitive information over networked devices.

2.4 Limited Compatibility and Flexibility: Some home automation systems may have limited compatibilitywithdifferenttypesofdevicesand protocols, limiting the flexibility and scalability of the system. This lack of interoperability can hinder the integration of new devices and technologies into the existing setup.

Inlightofthesechallenges,thegoalofthisprojectisto develop a home automation system that addresses the aforementioned issues by providing a user-friendly interface, seamless integration with popular voice assistants, robust data privacy and security measures, and enhancedcompatibility with a wide range of smart devices.

III. Results&Discussion

The development of the home automation system utilizingESP32microcontroller,4-channelrelays,and variousmartdeviceshasresultedinacomprehensive solution for enhancing home convenience, energy efficiency, and user experience

Functionality and Performance: The system successfully enables users to remotely control and automate household appliances through the Cadio mobile application. The integration with popular voice assistants like Google Assistant andAmazonAlexa further enhancesaccessibility and convenience, allowing for hands-free operation. The hardware setup, including the ESP32 microcontroller and 4-channel relays, provides reliable performance in controlling multiple.

3.1 UserInterfaceandExperience:

TheCadiomobile application serves as the central control interface for the system, offering intuitive controls, automation features, and notifications for important events. Users can easily monitor and control their connected devices, set up automation routines based on schedules or triggers, and receive real-time feedback on the status of their appliances. The seamless integration with voice assistants enhances the userexperiencebyproviding alternative control methods.

3.2 CompatibilityandFlexibility: Thesystemdemonstrate s compatibility with a wide range of smart devices, including LEDs and sockets, showcasing the practical application of home automation. The flexibility of the system allows for the integration of new devices and technologies, enabling users to customize and expandtheirhomeautomationsetupaccordingto their needs and preferences.

3.3 EnergyEfficiency: Byenablinguserstoremotely monitor and control household appliances, the system promotes energy efficiency by allowing users to optimize their energy usage based on their preferences and schedules. This contributes to reducing energy consumptionandlowering utilitybillsovertime

In conclusion,thedevelopmentofthehomeautomation system presented in this project represents a significant advancement in enhancing home convenience, energy efficiency, and user experience. By leveraging ESP32 microcontroller, 4-channel

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Vol. 20, Issue.2, April 2024

relays, and various smart devicesincludingLEDsandsockets,thesystemenables users to remotely control and automate household appliances through a custom-built Cadio mobile application.

Additionally, the system demonstrates compatibility with a wide range of smart devices, offering flexibility and scalability for users to customize and expand their home automation setup according to their needs and preferences.Byenablinguserstoremotelymonitorand control household appliances, the system promotes energy efficiency and contributes to reducing energy consumption and lowering utility bills over time.

Overall, this project demonstrates the practical implementationof IOTtechnologiesforenhancing home automation, offering users a comprehensive and accessible solution for managing their home environmentremotely.Itisexpectedthatthesystemwill contribute to the widespread adoption of home automation technology and improve the overall quality of life for users..

Here are some additional points you could consider addingtofurtheremphasizethesignificanceandimpact of the home automation system

3.4 CustomizationandFlexibility:Highlighthow users can customize automation schedules, scenes, and device interactions through the mobileapplication,providingtailoredsolutions for individual preferences and lifestyles.

3.5 DataAnalyticsandInsights:Discusshowthe system collects and analyzes data on energy usage patterns, appliance runtime, and user behavior, providing valuable insights for optimizing energy efficiency and identifying potential cost-saving opportunities.

3.6 Remote Monitoring and Notifications: Emphasize the system's capability to provide real-time notifications and alerts to users, allowing them to stay informed about the status of their home appliances and take immediate actionifnecessary,enhancing peaceofmindand security.

Integration with Home Security Systems: If applicable, mention how the home automation systemcanintegrate withexistinghomesecurity systems,offeringusersacomprehensivesolution for managing both household tasks and security measures from a single platform.

3.7 ScalabilityandFutureExpansion:Discussthe scalability of the system, highlighting its ability to seamlessly integrate with additional smart devices and technologies in the future, ensuring long-termrelevanceandadaptabilitytoevolving userneedsandadvancementsin IOTtechnology.

3.8 Environmental Sustainability: Emphasize the environmental benefits of reduced energy consumption and carbon footprint associated withusingthehomeautomationsystem,aligning with global efforts to mitigate climate change and promote sustainability.

3.9 Community and Support Ecosystem: If applicable, mention any community forums, onlineresources,orcustomersupportchannels available to users for troubleshooting, sharing experiences, and seeking advice, fostering a sense of community and collaboration among users.

3.1.0 CostSavingsandReturnonInvestment:
Provide estimates or case studies demonstrating potential cost savings achieved through energy efficiencyimprovementsandreducedutilitybills over time, showcasing the tangible financial benefits for users investing in the system.

3.1.1 **Research and Development Contributions**: Acknowledge any innovative features or technological advancements developed during the project that contribute to the broader field of homeautomationand IOT,showcasingtheteam's expertise and commitment to advancing the industry.

3.1.2 **User Testimonials or Case Studies**: If available,includequotesoranecdotesfromearly adopters or beta testers of the home automation system, highlighting their positive experiences, satisfaction, and tangible benefits gained from using the system in their daily lives

IV. Acknowledgement

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12 .CharithPerera_y, Arkady Zaslavskyy, Peter Christen_ and Dimitrios Georgakopoulosy Research School of Computer Science, The AustralianNationalUniversity,Canberra,ACT 0200,AustraliayCSIROICTCenter,Canberra, ACT 2601, Australia " CA4IOT: Context Awareness for Internet of Things".