



Arduino Smart Home Design

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ABSTRACT

Smart home design and home automation systems are spreading rapidly worldwide. Partly from the contribution of communication technology, the IoT gadgets are increasingly enabling homeowners to completely control any device or home gadgets through their mobile phone through an internet connection. Amid this, the presence of efficient gadgets like Arduino boards has made the process simpler and more cost-effective. This paper is a complete guide of what role Arduino boards play in home automation and how these boards have made smart home designing simpler and convenient. It also extends to elaborate why Arduino is a smart innovation and better option which makes it stand out over other IoTs.

Keywords:

Arduino, IoTs, home automation, smart home design

Introduction

1.1 Smart home design

A smart home is a house that employs gadgets that are internet-connected and provide administration and remote monitoring of the appliances and system in the residence. The home system that these internet-connected gadgets help monitor can be heating, air conditioning, ventilation, and lighting.[1]

This advanced technology is often regarded as home automation and is an ultimate modern source of integrating convenience, efficiency, and comfort in your residence system. Home automation through this innovative technology can either be

operated through an app or a networked device. Monitoring the electronic devices in this way enables to release the overload on energy and makes operations manageable and convenient.

Home automation sources are an output of IoT, which is internet of things involving a system that operates with an internet connection.[2] These networked devices can operate through Bluetooth, Wi-Fi, or ZigBee connections. The electronic interfaces allow the homeowner or system operator to monitor the device through voice activation or a manual remote. Many of the gadgets also operate through smart apps.

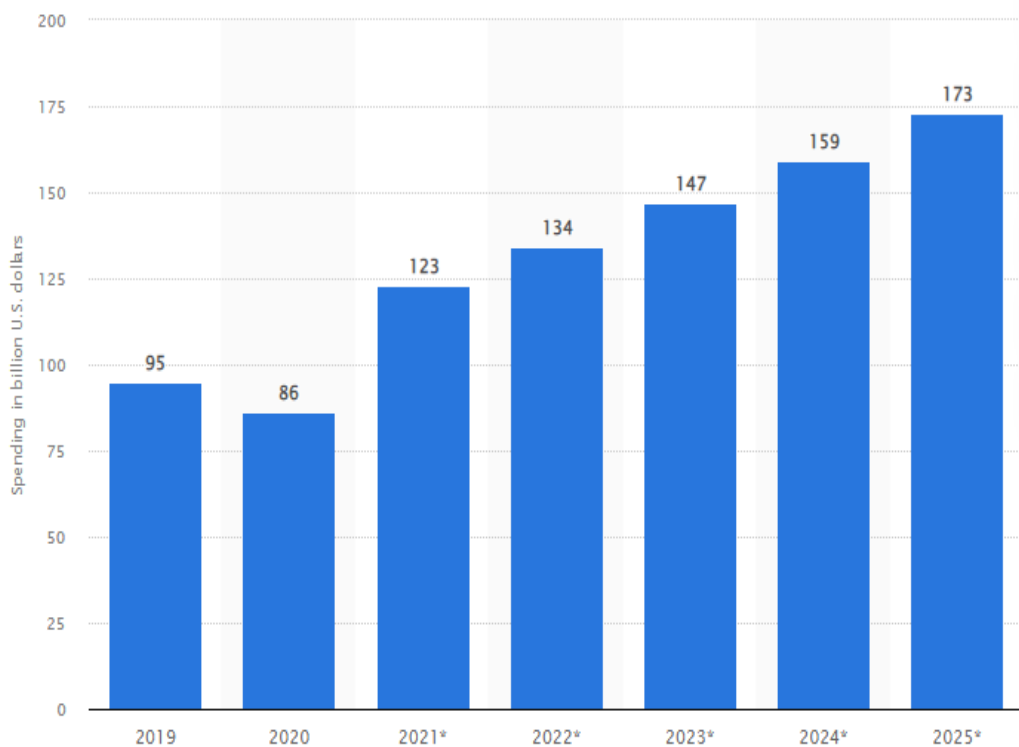


Fig 1.1 Global spending on smart home gadgets 2019-2025. Source from <https://www.statista.com/statistics/873607/worldwide-smart-home-annual-device-sales/>

A recent report reveals that the global spending on smart home devices was recorded at \$134 billion in 2022 which is likely to increase by 29% in 2025. [3] The mentioned statistics portray the rapid integration of smart home gadgets in households which increases the rate of smart home automation globally. Home automation is not a recent concept, which actually originates with the invention of appliances like the thermostat. Ever since residents globally responded in favor of smart home automation and enjoy the comfort of controlling their residences through IoT.[4] Overall, the home automation industry is very dynamic and profitable. There are numerous gadgets that businesses withhold and the technology varies from company to company.

Today, if we calculate, there are approximately 175 million smart homes globally. [5]

1.2 Smart Home Design Basics

Smart home integration is an option for both newly built residences and old houses. New houses are built along the integration of this innovation and old homes are often retrofitted. According to a 2016 poll, 45% of Americans either had or intended to purchase smart home devices. The innovation was responsible for generating a revenue of \$90.97 billion for the global market in 2020 and Europe alone built 22.5 million smart homes in 2017. The rising numbers showcase the potential growth for smart home innovation in the future as well.



Fig 1.2.1 Smart Home Design Source from <https://www.techtarget.com/iotagenda/definition/smart-home-or-building>

There are numerous ways to make your residence a smart home. The technology provides complete control over your house, whether it is inside or outside the residence.

1.2.1 Smart Lighting

The incorporation of smart lighting allows the resident to monitor and control their home lights from anywhere. The ultimate benefit of this smart technology is the ability to schedule the program of the home lights and find the best option for an energy-efficient, innovative, and beneficial lighting system. Furthermore, the smart design also enables the lights to switch tints and hues. The owner can easily operate the lights through the mobile application and transition lights that align with their mood.[6]

1.2.2 Smart Entertainment Devices

These devices take the entertainment experience to a whole new level. From speakers to DVDs, and TVs, smart entertainment devices operate through Wi-Fi and Bluetooth connections. The gadgets are

also very simple to set up and have a long useful life. A stable wireless connection is a great benefit when it comes to smart entertainment devices.[7]

1.2.3 Smart Home Appliances

Every appliance in your home whether the dishwasher, oven, doors, or doorbell, every device can be a smart home gadget. Many of these appliances are designed to compliment home automation, however, others can be customized. This is possible through smart communication technology devices which make it possible for the users to manually control any of their devices. With the existence of such IoTs, users can integrate smart home device features into any other gadgets.

2. Arduino Smart Home Design

2.1 Introduction

Arduino is a fully accessible technology that is built on simple software and hardware used to create a variety of electronic applications and projects. The board has the

ability to interpret input data through which it operates and monitors appliances such as motor activation, turning LED on, and even publishing online content.[8] The user can direct the functions of the board by sending instructions to its microcontroller. This is enabled through Arduino's software called IDE, centered on its processing and programming language. Through these mechanisms, a homeowner can create a wide range of home automation appliances.[9]

The Arduino board so far has immensely contributed to numerous projects through its modern innovation. This smart technology single-handedly has attracted a global community that relies on the innovative board for staggering easily accessible

knowledge for both experts and beginners. Arduino is the source for taking home automation to a next level. It eliminates the wiring and mechanical switches for connecting and controlling appliances and makes the process more accessible and manual.[10]

2.2 Arduino Components

There are many types of Arduino boards available, however, some of these types stand out the most. The Arduino boards are open source which makes it possible for the user to construct and customize their projects and devices. All the boards vary in functions, specifications, and features. All of these boards are sourced for many types of electrical projects in smart home design.[11]

2.2.1 Arduino UNO

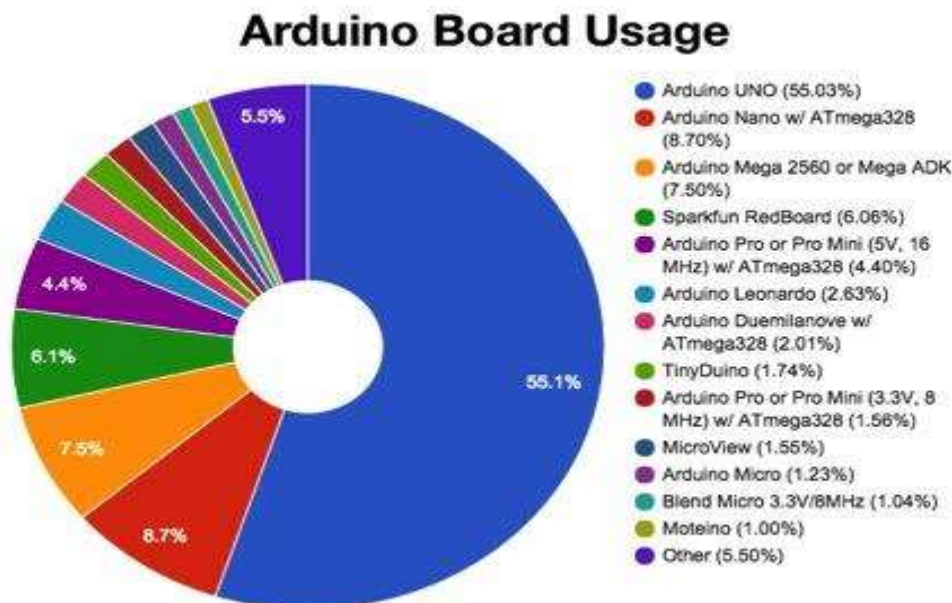


Fig 2.2.1 Most Used Arduino Boards Source from <https://www.sparkfun.com/news/1982>

Arduino UNO is the most used and popular board, securing 55.03% of the overall usage. The Arduino UNO board is the low-cost board available for a range of electrical applications. This board is not just easy to function with but is also an adaptable microcontroller. The UNO board holds the potential to link and communicate with other boards of Arduino. Not just this, it can also interface with Raspberry Pi boards, and Arduino shields along with controlling LEDs,

motors, and servos. The Arduino boards initiate the Amtega328 AVR microcontroller, 14 digital I/O, and six input pins.[12]

The various features of the Arduino UNO boards make it easy for the users to use in various applications. The Amtega16U2 microprocessor of Arduino UNO speeds p data transfer and adds more memory to the board as compared to others. It does not require any additional hardware for operation. The board also has a couple of extra pins located near the

RESET pin. The Arduino UNO board is licensed under a GNU permit, which makes it accessible to anyone. A USB cable can be used to enhance

the system's permissible voltage range which falls within 7-20 V.[13]



Fig 2.2.1 Arduino UNO Components Source from

<https://www.hackerearth.com/blog/developers/a-tour-of-the-arduino-uno-board/>

2.2.2 Arduino Mega

The Arduino MEGA is intended for applications that call for greater RAM, sketch memory, and I/O lines. The design of the MEGA board makes it the most suitable for robotic applications and 3D printing. The ability for these tasks is granted through its 16 analog inputs and 54 digital I/O pins. Overall, the Arduino MEGA board is highly efficient yet simple. The projects are allowed to proceed with plenty of room and potential. The

Software IDE of the MEGA board runs both offline and online.[14]

The Arduino MEGA board operates at the maximum speed of 16 MHz. The microprocessing power of the board generates from its ATmega2560 microcontroller which accelerates its potential and utilization. The Arduino MEGA board uses the same UNO USB Type-B cable. It has an input voltage range of 7 to 12 V and is capable of handling difficult tasks. The Arduino MEGA is the ultimate board for remote-controlled applications.[15]

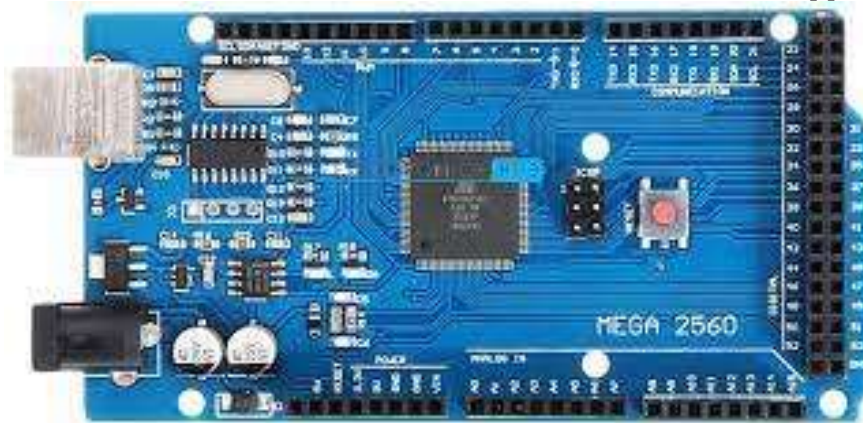


Fig 2.2.2 Arduino MEGA source from <https://www.electronicshub.org/arduino-mega-pinout/>

The Arduino MEGA features 256KB of flash memory which is sufficient for data storage. The board also connects to a computer via USB. DC or AC adaptors are often used as

battery power sources for the Arduino MEGA board. Overall, it is appropriate for applications requiring multiple pin installments.

2.2.3 Arduino Due

Arduino Due board has the Atmel SAM3X8E as its microcontroller's foundation. The 32-bit ARM core-based Arduino board is the first of its kind. Arduino Due has 12 analog inputs, and 54 digital output and input pins. Furthermore, the microcontroller board also features an 84 MHz clock, 4 UARTs, 2 DAC, JTAG header, 2 TWI, USB OTG connection, and a reset button.[16] The 32-bit ARM microcontroller of the Arduino Due is regarded as the hallmark of this class of Arduino boards.

The board perfectly compliments projects with a broad scope. The Arduino Due is powered through a USB wire.[17] The ultimate feature of the Arduino Due board is that it's faster than Arduino MEGA and Arduino UNO. It operates at the maximum speed of 83 MHz and has 3.3 V of voltage output. The shield compatibility of the Arduino Due is relatively less compared to the MEGA board. Furthermore, it does take the lead in software compatibility. The processor of the Arduino Due board is also impressive and faster.

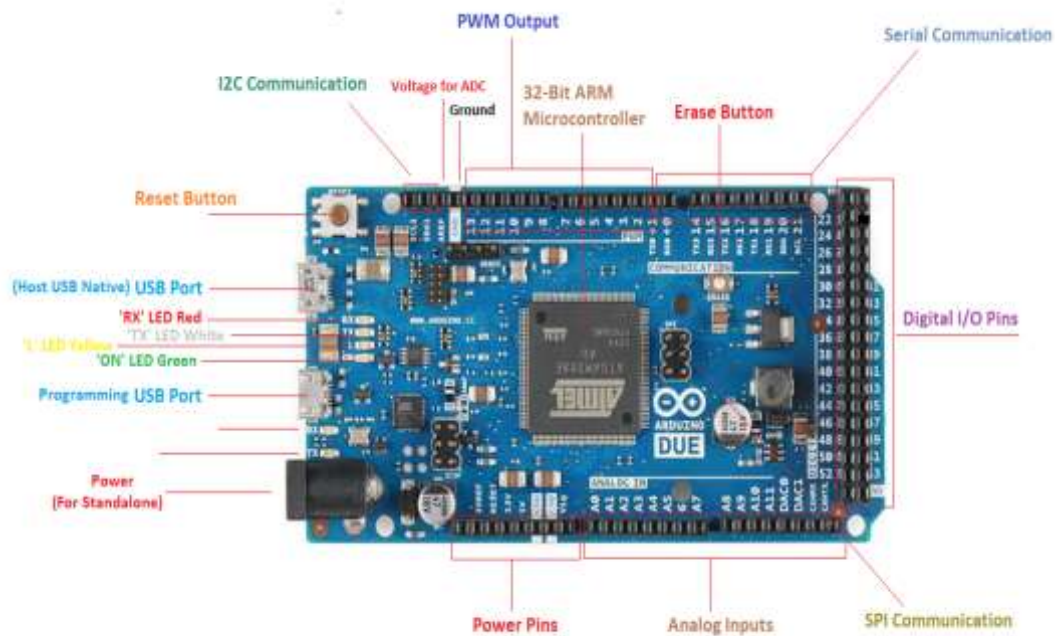


Fig 2.2.3 Arduino DUE Board Source from
<https://eph.com.pk/product/arduino-due/>

3. Why Choose Arduino

Smartphones have easily become the human go-to gadget for everything. The ability to operate projects and control appliances through your smartphone has made life a lot easier and energy efficient. Smart home devices or automation types of equipment operate diligently, eliminating the risk of error, and often offer a lot of variety. The integration of smart home automation devices like the Arduino boards has enabled humans to reduce human labor and save energy, time, and sources. The Bluetooth or USB connection-

based devices are not just inexpensive but also more efficient in operations.[18]

The accessible and simple-to-use nature of Arduino boards has made them a part of countless applications and projects. The Arduino program is extremely easy for beginners to operate and skilled users can customize the boards to their own will. Furthermore, the boards have been used for various scientific projects and are an ultimate source for learning and demonstrating programming and robotics.

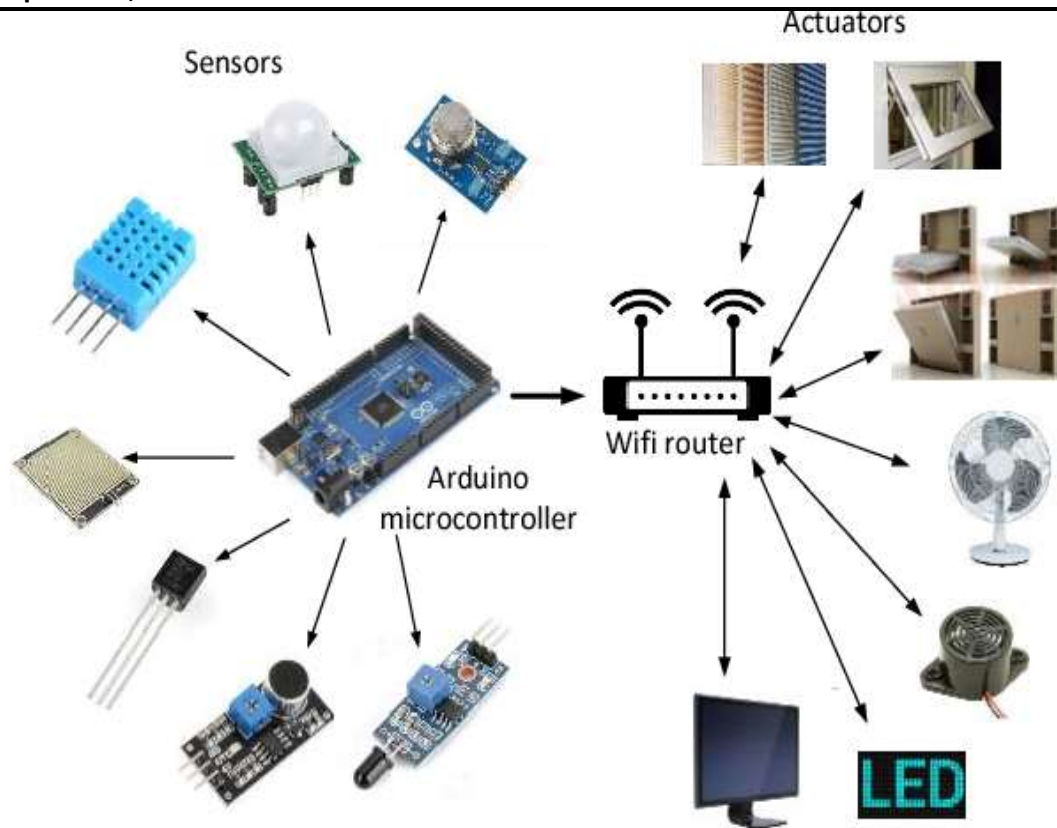


Figure 1. Block diagram of system.

Fig 3.1 Arduino Smart Home System Source from

<https://www.semanticscholar.org/paper/Design-and-implementation-of-a-low-cost-smart-home-Gunpath-Murdan/5acb9b5eec46c1722d97f46fc379cb0c69839d49/figure/0>

Comparatively, Arduino boards are more affordable than other microcontrollers. The inexpensive board can easily be assembled manually and pre-assembled modules are also not heavy not on the pocket. The IDE software of the Arduino board is highly compatible, especially with Macintosh, Windows, Linux, and OSX. This is the ultimate benefit of choosing Arduino boards since other microcontrolling systems have compatibility with Windows only. IDE software is designed with versatility for ease of use for both skilled and novice. Arduino board software is both extendable and open source.

It is accessible enough to be modified by users and the language can be expanded through C++ libraries. The blueprints of the Arduino boards are accessible through a Creative Commons license. The license enables qualified circuit designers to remodify the module as per their liking.

3.1 Comparison of two IoTs- Arduino and Raspberry Pi.

Arduino is a better and more suitable option than Raspberry Pi, especially because Arduino boards are cheaper and simpler. Consequently, Arduino is easier to operate and program when it comes to smart home design.[19] The Arduino boards are designed to consume less power which makes them ideal for projects that rely on batteries as the power supply. The operating system of the Raspberry Pi is insufficient for accessing hardware since it requires an additional layer of code. Arduino, comparatively, does not need an operating system for hardware access. There are also fewer components required while processing the Arduino boards. Raspberry, on the other hand, relies on additional components when getting started. A USB cable and Arduino Board are sufficient to get started with Arduino. However, the Type-C USB cable, keyboard, SD card, mouse, HDMI cable, and the Raspberry Pi

itself should be assembled before the project is started.

The transition to product design from the prototype is easier and simpler via Arduino

because the replication of circuits is a complex process using Raspberry Pi. Arduino features a simple circuit that makes prototype translation easy.

| Arduino Board | Raspberry Pi |
|-------------------------------------|---|
| Microcontroller | Fully functional computer |
| Executes Written codes | Runs on full operating system |
| Interfaces with sensors | Linux Software are easy to install mostly |
| Ideal for hardware projects | No internal Storage |
| Easy interfacing with other devices | Independent network connectivity |

Table 3.1 Arduino and Raspberry feature comparison

When it comes to Arduino, code lines, analog sensors, electrical components, and motors are easily connected to the board. However, the same interfacing requires installing software and libraries for the Raspberry to read the sensors. Additionally, utilizing Arduino requires less coding experience as compared to the Raspberry Pi which requires familiarity with Linux.[20] The

Arduino is a simple plug-and-play gadget that switches ON and OFF whenever you want. Turning the power On or Off also does no damage to the device and the user can resume running code after restoring power. All these features give benefits to Arduino over Raspberry in many projects, especially for beginners. The absence of networking makes the Arduino operations easy and manageable.

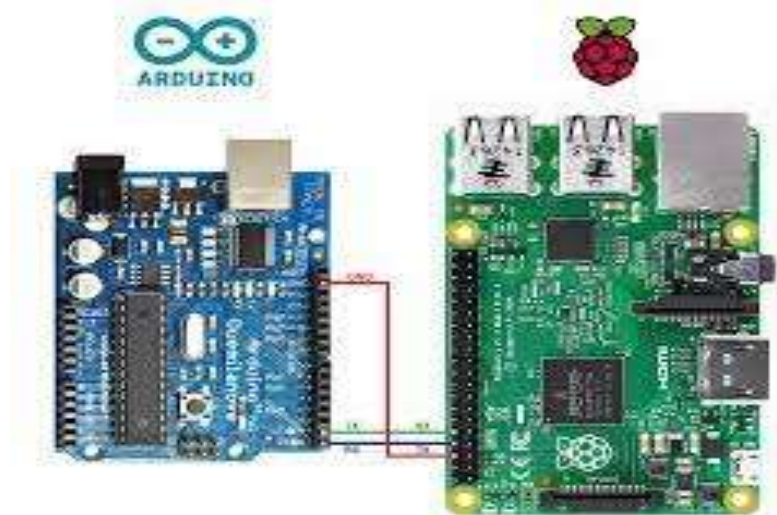


Fig 3.2 Arduino vs Raspberry Pi Source from

<https://www.eeworldonline.com/arduino-vs-raspberry-pi-which-one-is-better-for-robotics-projects/>

3.2 DIY Smart Home Device Using Arduino

Smart home AUTomation using Arduino is very easy, especially for beginners. It enables

the owner to control any electronic gadget whether fans, speakers, lights, or doors. Many of the smart home devices are available in the

market and are purchased globally in big numbers. Where smart home automation has become such a trend, users can manually create these devices on their own. The DIY process allows the person to customize their gadgets along with saving a good amount of money.[21]

Any electrical appliance can be manually controlled through the mobile phone using Arduino. The whole process requires only a handful of components such as the Arduino board, an Android phone, SSR, and wif-fi connection. SSR is the relay used in this

project. Relay is a switch module that creates a linkage between a high voltage device and Arduino. The Arduino board used in this project is the Arduino Nano 33 IoT. This microcontroller board has similar features as the Arduino UNO and is based on the former Arduino Nano's layout. It has a total of 30 upper right and 16 lower right pins. The board operates through 3.3 voltage and has a faster processor than UNO.[22] Designing the circuit involves mounting the SSR and the Arduino board. The project requires two voltage inputs to power Arduino and other parts.[23]

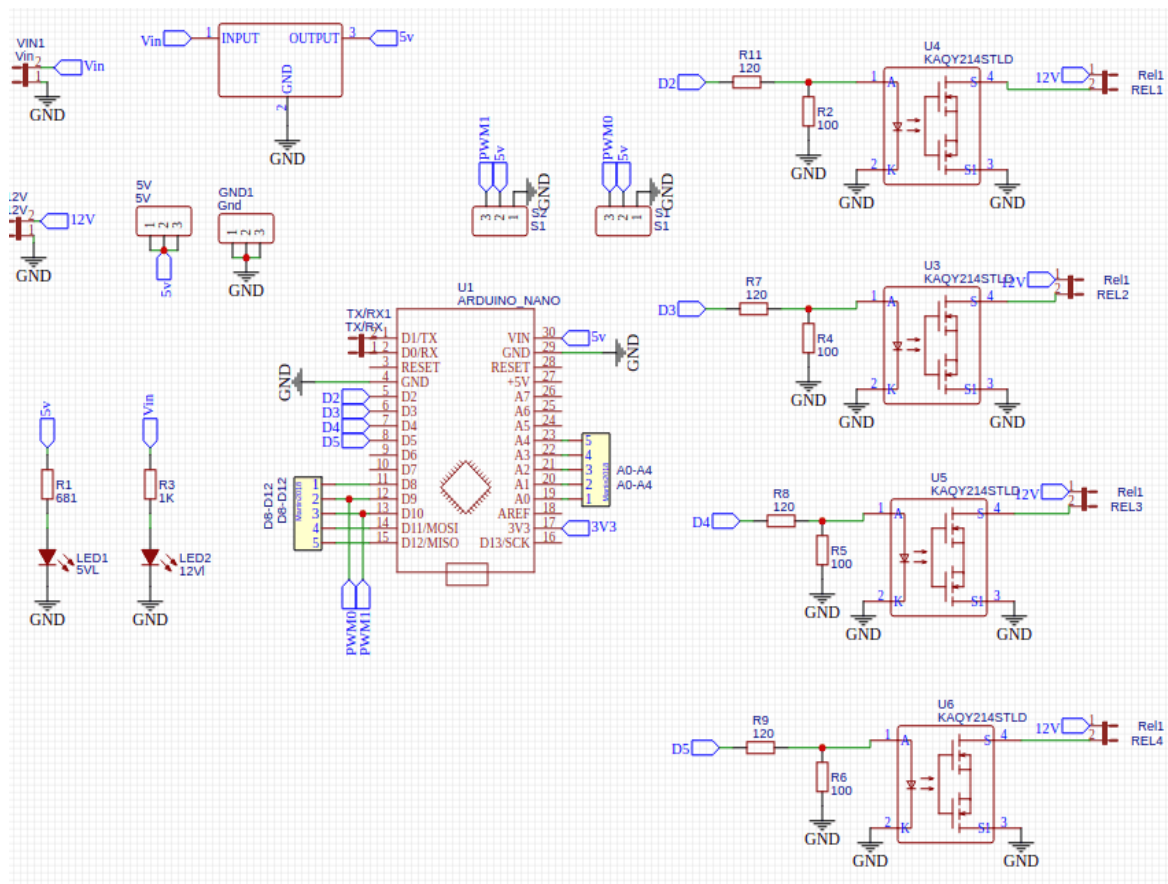


Fig 3.2.1 Arduino Nano 33 IoT circuit design source from <https://rootsaid.com/arduino-smart-home/>

LED strips operating on 12 V are connected to a DC adapter of the same 12 V voltage. A 7805 regulator is connected to the input power. To proceed with the operation, the Arduino mobile is required. After a successful coding attempt, the RootSaid WiFi Command Center application connects the devices and allows the user to control any of

their LED lights or any other connected device.[24]

4.Methodology

The paper proposed home automation and smart home designing through Arduino's perspective. The research was conducted using articles both online and in journals published. It mentions both qualitative and quantitative

data to thoroughly assess Arduino's role in smart home design. It also involves a brief insight into controlling LED through Arduino connection. The project involved the Arduino Nano 33 IoT board, an Android phone, and a Wi-fi connection.

The project was easy to set up and operate based on successful coding, circuit setup, and mobile application for controlling the connected device.

5.Results

The proposed research is to reduce human effort through utilizing smart home devices. The Arduino board system can be integrated into many devices both residential and public. The IoT-connected model enables the person to have more control and command over their devices from anywhere around the world. Therefore, it reduces the effort of functioning and operating electronic gadgets, The mentioned Arduino board is easy to use which is a great benefit for beginners. The users can easily customize their devices and increase the global movement towards integrating smart home design.

6.Discussion

Smart home design and home automation through Arduino are very cost-effective and energy-efficient. The proposed model is fairly easy to set up and operate, without requiring any additional components, In just a few steps it enables the owner to manually control their connected devices through the mobile app. The Arduino boards are leaving a remarkable print in the smart home industry.

In many ways, the IoT is proving to be a lot more beneficial and effective as compared to other IoTs. Since 69% of U.S households have implemented smart home design, the need for such IoT has become inevitable. The global smart home market is likely to extend its share to \$11.7 billion by 2028 which highlights the significance of the industry's impact and the importance of integrating smart home design into our lifestyle.[25]

7.Conclusion

Smart Home design is not a new phenomenon. Many buildings have been altered to integrate home automation for more convenience and innovation. The simultaneous invention of gadgets like the IoT boards is a huge achievement and paves new routes towards innovation and modernity. The simple to use and cost-effective devices are models of convenience and efficiency that humans have designed for themselves. Working through the perfect fusion of physics and modern technology, the Arduino boards have made smart home designing more accessible and less time-consuming.

Where smart building requires a broad roadmap to follow, the presence of such innovative devices has allowed home automation of existing houses without investing a huge time and effort. The presented model in this research is one way of portraying the ease and effectiveness of integrating smart home automation through smart devices like Arduino boards.

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