Chapter 1

INTRODUCTION

1.1 Overview

The smart plug project aims to develop a device that allows users to remotely control and monitor their appliances through a smartphone app the main goal of this project is to provide a convenient and energy efficient solution for managing household appliances. This project comes under the domain Internet of Things (IoT). Internet of Things is a domain that connects devices such as appliances, vehicles and industrial equipment to the Internet. These devices are equipped with sensors software and connectivity capabilities that allow them to collect share and act on data. In the case of Smart Plug developed by us, the device is equipped with ESP 8266 Wi-Fi module which connects the device to the internet.

1.2 Basic Concepts

Following are the basic concepts involved in the development of a smart plug:

- Connectivity: Smart plugs rely on a connection to the internet in order to be controlled and monitored remotely. This is typically achieved through Wi-Fi or a cellular connection.
- Sensors: Smart plugs typically incorporate various sensors, such as temperature or energy usage sensors, that allow them to collect data and make decisions based on that data.
- Power management: Smart plugs are designed to control the power supply to connected appliances, allowing users to turn them on and off remotely or schedule them to turn on and off at specific times.
- Control: Smart plugs can be controlled and monitored through a smartphone app, web interface, or other connected device.

1.3 Motivation

Smart plugs allow users to remotely control and monitor their appliances, which can help to reduce energy consumption and costs. By being able to turn off devices that are not in use or schedule them to turn on and off at specific times, users can save energy and money. Smart plugs allow users to control their appliances from anywhere, using a smartphone app or other connected device. This can be especially useful for people who are frequently away from home, or who want to make sure that they haven't left any appliances on when they leave. Smart plugs can be programmed to automatically turn on and off based on certain conditions, such as a schedule or sensor data. This allows for greater energy efficiency and convenience for users, as they do not have to manually control the devices. Smart plugs can be integrated with other smart home devices such as voice assistants, security cameras, and smart lighting systems to create a more comprehensive smart home ecosystem. This allows for easy control and monitoring of multiple devices from a single app or interface. Smart plugs can also include security features that can detect and alert the user of any suspicious activity or potential intrusion. Smart plugs can help households reduce their environmental impact by reducing the energy consumption. With the rapid advancements in technology, more and more devices are becoming connected to the internet, creating a demand for smart devices such as smart plugs to control them.

1.4 Problem Description

The current methods of controlling and monitoring household appliances are often inconvenient and energy inefficient. Many appliances are left on unnecessarily, resulting in wasted energy and increased electricity costs. Additionally, users often have difficulty monitoring and controlling their appliances when they are away from home. There is a need for a device that allows users to easily control and monitor their appliances remotely, in order to increase energy efficiency and convenience. The objective of this project is to develop a smart plug that addresses these issues and provides a convenient, energy-efficient solution for managing household appliances.

1.5 Objectives

The primary objective of the project is to design and develop a compact, user-friendly smart plug that can be easily installed and controlled via a smartphone app. The project also aims at providing ease to control household appliances.

1.6 Scope of the work

Developing a design for the smart plug, including the hardware, firmware, and software components. Implementing the design by developing the hardware, firmware, and software components of the smart plug. This would include the sensor, connectivity interfaces, and control. Conducting testing to ensure that the smart plug functions as intended and meets the requirements. This would include functional testing, performance testing, and user acceptance testing. Producing and assembling the smart plugs, including sourcing components, assembling the devices and packaging them. Deploying and testing the smart plugs in a real-world setting and collecting user feedback.

1.7 Organization

The various teams involved in the development of Smart Plug are as follows:

- Manufacturing: This team would be responsible for producing and assembling the smart plugs, including sourcing components, assembling the devices, and packaging them.
- Quality Assurance: This team would be responsible for conducting testing to ensure that the smart plug functions as intended and meets the requirements. This would include functional testing, performance testing, and user acceptance testing.
- IT: This team would be responsible for maintaining the IT infrastructure, such as servers and databases, required for the smart plug to function.
- Services: This team would be responsible for providing ongoing support and maintenance for the smart plugs, including troubleshooting and bug fixes, as well as updating the software and firmware as needed.

1.8 Summary

In this section of the report, an overview of smart plugs will be presented, as they are a relatively new technology that is gaining increasing popularity in modern households. The section will start by defining smart plugs and explaining their functionality, followed by a discussion of the advantages they offer, including convenience, efficiency, and cost savings. Additionally, the design and methodology of smart plugs will be explored, highlighting the key considerations that go into creating a safe, reliable, and user-friendly product. Lastly, the section will conclude with an analysis of the current market landscape for smart plugs, featuring the top products and future trends. Overall, the aim of this section is to provide a comprehensive introduction to smart plugs and their potential to revolutionize energy usage in our homes.

Chapter 2

LITERATURE SURVEY

2.1 Introduction

Smart plugs have been gaining popularity in recent years due to their ability to improve energy efficiency, reduce electricity bills, and provide convenience to users. The purpose of this literature survey is to review the existing research on smart plugs, including their features, benefits, drawbacks, and potential applications.

Wipro is an Indian technology company that produces a smart plug called the Wipro Smart Plug. The plug allows users to control their home appliances remotely through a smartphone app, and it is compatible with Amazon Alexa and Google Assistant for voice control. The plug can also be set to turn devices on or off automatically based on a schedule or triggered by other smart devices in the home.

2.2 Related Work

One of the major works related to smart plugs is Wipro's smart plug. Wipro is an Indian technology company that produces a smart plug called the Wipro Smart Plug. The plug allows users to control their home appliances remotely through a smartphone app, and it is compatible with Amazon Alexa and Google Assistant for voice control. The plug can also be set to turn devices on or off automatically based on a schedule or triggered by other smart devices in the home.

2.3 Comparison of Related Work

Comparing our work with Wipro's smart plug helps us to understand our drawbacks better and also hints us at our future development so as to make a better product in the market. The bellow comparison lists a few features of both the smart plugs.

Smart Plug

Our smart plug	Wipros smart plug
Compatibility : Our smart plug is compatible with any 3 pin socket and also with inputs of different sizes	Voice Control: The smart plug is compatible with Amazon Alexa and Google Assistant for voice control.
Easy control: the software developed to control the smart plug is simple and straight to point.	Energy Monitoring: The smart plug can monitor energy consumption of the device that is plugged in and provides detailed reports on usage patterns.
Cost effective: the smart developed by us, if launched in the market, will be launched at a cheaper price	Cost Effective: The smart plug is priced competitively, making it an affordable option for those looking to try out smart home technology.

2.4 Summary

Smart plugs are a versatile and useful device that can provide many benefits to users, including energy savings, convenience, and improved safety. While there are some drawbacks and limitations to these devices, the literature suggests that they have significant potential in a variety of settings and can be an important part of a broader strategy to improve energy efficiency and sustainability.

Chapter 3

DESIGN AND METHODOLOGY

3.1 Introduction

The design and methodology behind smart plugs involves a combination of hardware and software components. On the hardware side, the plug itself typically includes a Wi-Fi module, a microcontroller, and a relay that controls power to the outlet. The software side includes a mobile app or web interface that allows users to control the smart plug, often featuring features such as scheduling, remote access, and energy monitoring.

One of the key design considerations for smart plugs is ensuring compatibility with a range of different appliances, from lamps and fans to TVs and coffee makers. As such, smart plugs are typically designed with a standard electrical socket that can accept a wide range of different plugs, ensuring maximum flexibility for users. The methodology of smart plug design involves a user-centric approach, with a focus on ease of use, reliability, and safety. This means ensuring that the smart plug is easy to set up and use, with clear instructions and a straightforward user interface.

3.2 Methodology

The methodology of smart plugs involves a number of key steps and considerations, from initial design and prototyping to testing and evaluation. Below are some of the key aspects of the methodology of smart plugs:

Research and Requirements Gathering: The first step in developing a smart plug is to conduct research into existing products on the market, as well as gathering requirements and feedback from potential users. This may involve conducting surveys, focus groups, and user testing to gain insights into the features and functionality

that users want.

Conceptual Design and Prototyping: Once the requirements have been established, the next step is to create a conceptual design and prototype of the smart plug. This may involve developing a 3D model of the plug, as well as designing the electrical and software components.

Electrical and Software Design: The electrical and software design is a critical component of smart plug development, and involves designing the microcontroller, Wi-Fi module, and relay that control the plug, as well as developing the user interface software and mobile app.

Testing and Evaluation: Testing and evaluation is a crucial step in the development of smart plugs, and involves a range of different tests to ensure that the plug is safe, reliable, and effective. This may include testing for electrical safety, connectivity, and performance, as well as user testing to ensure that the plug is user-friendly and meets the needs of the target market.

Manufacturing and Quality Control: Once the smart plug has been developed and tested, the next step is to manufacture the plug in bulk. This may involve establishing a manufacturing process, as well as implementing quality control measures to ensure that the plugs meet the required standards.

Launch and Marketing: Finally, once the smart plug has been manufactured, it is ready for launch and marketing. This may involve creating marketing materials, such as advertising campaigns, and establishing distribution channels to get the plug into the hands of consumers.
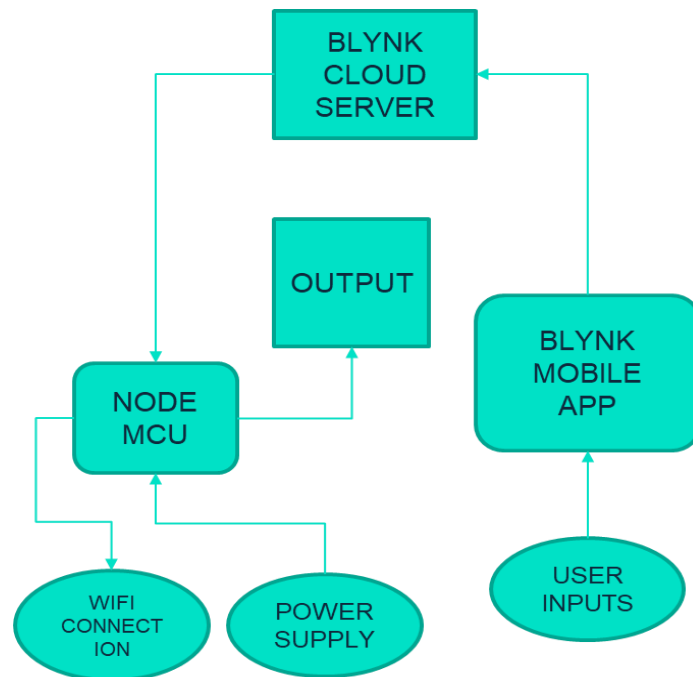
3.3 Block Diagram and Working

fig 1

Working:

A block diagram for a basic smart plug may include the following components:

- Power input: The smart plug is connected to an AC power source and converts the AC power to DC power.

- Node MCU: This is the main processing unit that controls the smart plug. It manages the communication with the user's smartphone or other device and implements the logic for controlling the device connected to the smart plug.

- Wi-Fi module: This component allows the smart plug to connect to a Wi-Fi network and communicate with other devices on the network, such as a smartphone app or voice-activated assistant.

- Relay: A relay is an electrically controlled switch that turns the device connected to the smart plug on and off.

- Power output: The smart plug provides a socket for connecting the device that the user wants to control.

3.4 Summary

In summary, the methodology of smart plug development involves a range of different steps and considerations, from initial research and prototyping to testing, manufacturing, and launch. By following these steps and considering the needs of users at every stage of development, engineers and developers can create smart plugs that are safe, reliable, and effective at helping users save energy and live more efficiently.

Chapter 4

IMPLEMENTATION AND RESULTS

4.1 Introduction

Smart plug implementation and results can vary depending on the specific use case and research question. However, in general, smart plug implementation involves the installation of one or more smart plugs in a home or building, and the collection of data on energy usage or other relevant parameters. This data can then be analysed to identify patterns and opportunities for energy savings or other improvements.

There are a variety of smart plugs available on the market with different features and capabilities. It's important to select a smart plug that meets the needs of the specific use case, such as the type of devices it will be used with, the required level of automation, and any necessary integrations with other smart home devices.

The smart plug is typically plugged into a standard electrical outlet, and then connected to the home's Wi-Fi network using the manufacturer's mobile app or web interface. The app will guide the user through the setup

process, which usually involves creating an account, registering the smart plug, and setting up any necessary automations or schedules.

Once the smart plug is set up, it can be controlled using a mobile app, voice commands through a virtual assistant, or other compatible devices. The user can turn devices on and off remotely, monitor energy usage, and set schedules or automations for their devices.

Smart plugs often provide data on energy usage, which can be used to identify patterns and opportunities for energy savings. The user can analyze this data and adjust the settings of their smart plug or other devices to optimize energy usage.

Some smart plugs also have additional features that can be used to enhance their functionality, such as power monitoring, which allows the user to track how much energy a device is using in real-time, and compatibility with IFTTT (If This Then That), which enables the creation of custom automations between different smart home devices.

Overall, the implementation of a smart plug is relatively straightforward, and can provide a convenient and efficient way to control electrical devices and manage energy usage in the home.

The results of using a smart plug in a home or business environment can vary depending on the specific use case and implementation. However, in general, the use of smart plugs can lead to several benefits, including increased convenience, improved energy efficiency, and cost savings.

One of the main benefits of using a smart plug is increased convenience. By being able to remotely control devices, users can easily turn on and off appliances or electronics from anywhere using a smartphone or other smart device. This can be particularly useful for devices that are in hard-to-reach areas or are often left on when not in use.

Another benefit of using smart plugs is improved energy efficiency. Smart plugs can be used to monitor and control the energy usage of devices and can even automatically turn devices off when they are not in use. This can lead to significant energy savings over time, which can help to reduce energy bills and minimize the environmental impact of using electrical devices.

In addition to these benefits, the use of smart plugs can also provide insights into energy usage patterns and help users to identify areas where they can further optimize their energy consumption. By analyzing data provided by smart plugs, users can better understand their energy usage and adjust their behaviors or settings to further reduce their energy consumption.

Overall, the results of using a smart plug can be significant in terms of increased convenience, improved energy efficiency, and cost savings. By taking advantage of the features and capabilities of smart plugs, users can enjoy a more streamlined and energy-efficient home or business environment.

4.2 Hardware and software requirements

Hardware requirements:

Node MCU ESP8266

AC to DC converter

Relay module

3-pin socket

3-pin plug Connecting

wires

Software requirements:

Arduino IDE

Blynk IOT

4.3 Budget estimation

Node MCU ESP8266 – Rs 326

Relay module **–** Rs 50

AC to DC converter – Rs 200 Connecting

wires – Rs 30

3 pin plug and socket – Rs 80

Hot glue and soldering – Rs 40

Total Budget – Rs 726

4.4 Specification of Hardware and Software

Specification of hardware:

- Node MCU ESP8266

Smart Plug

    a. Processor: Tensilica L106 32-bit RISC microcontroller with a clock speed of up to 80 MHz

    b. Memory: 80 KB of user-accessible RAM and 4 MB of flash memory

    c. Wi-Fi: 802.11 b/g/n Wi-Fi with WPA/WPA2 authentication and support for soft AP and station mode

    d. GPIO: 17 GPIO pins, including 11 analog inputs.

    e. Interfaces: SPI, I2C, I2S, UART, and one-wire interfaces

    f. Power supply: 3.0 to 3.6 V DC

    g. Current consumption: around 80 mA during active Wi-Fi transmission

    h. Programming language: C/C++ with support for the Arduino IDE and other development environments

- AC to DC Converter
  a. Input: 100-240V (AC)
  b. Current In: 0.1A
  c. Frequency: 50-60Hz
  d. Output: 5V (DC)
  e. Current Out: 0.6A
  f. Wattage: 3W

- Relay Module
  a. Input voltage: 5 V DC
  b. Current consumption: around 70 mA
  c. Relay rated voltage: 250 V AC / 30 V DC
  d. Relay rated current: 10 A
  e. Switching voltage: 220 V AC / 30 V DC
  f. Relay life: up to 100,000 cycles

- Connecting Wires
  a. Cross Section Area: 1.5 mm^2
  b. Rated Current: 16A.

- 3-Pin Plug

Smart Plug
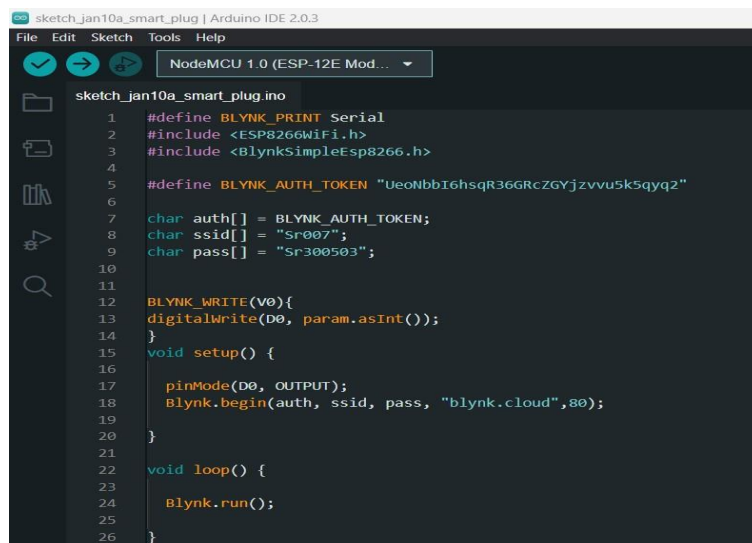
    a. Rated Voltage: 240V.

    b. Rated Current: 16A.

- 3-Pin Socket

    a. Rated Voltage: 240V.

Specification of software:

- Arduino IDE

    a. Version: 2.0.3

    b. Platforms: Windows, macOS and Linux

    c. Programming Languages: C and C++

- Blynk IoT

    a. Platform: Android and iOS mobile apps, web-based dashboard

    b. Hardware Support: Arduino, Raspberry Pi, ESP8266 *4.5*

Implementation Details Code:

fig 2

Smart Plug

fig 3
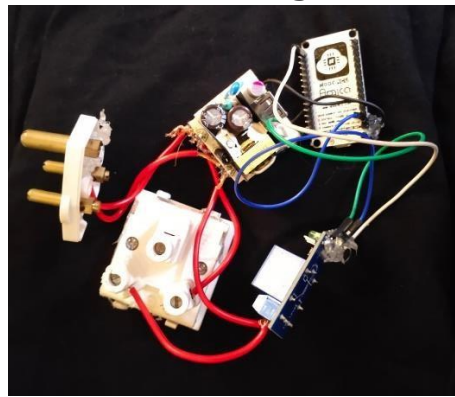
4.6 Results and Issues

Results

fig 4

fig 5

Smart Plug
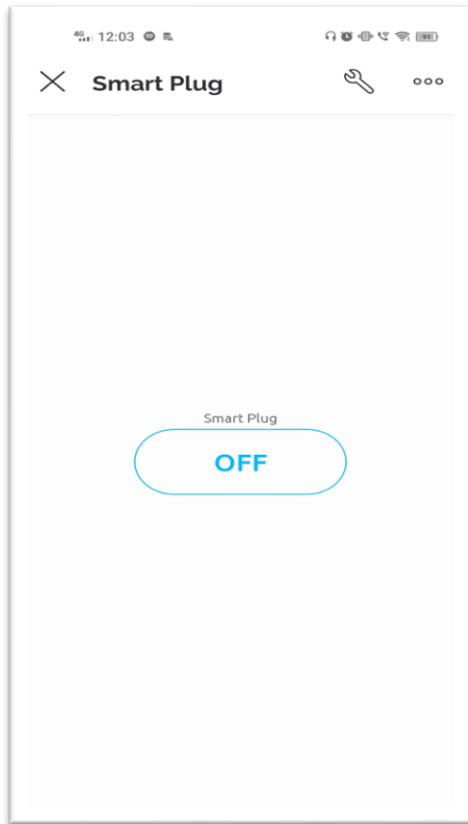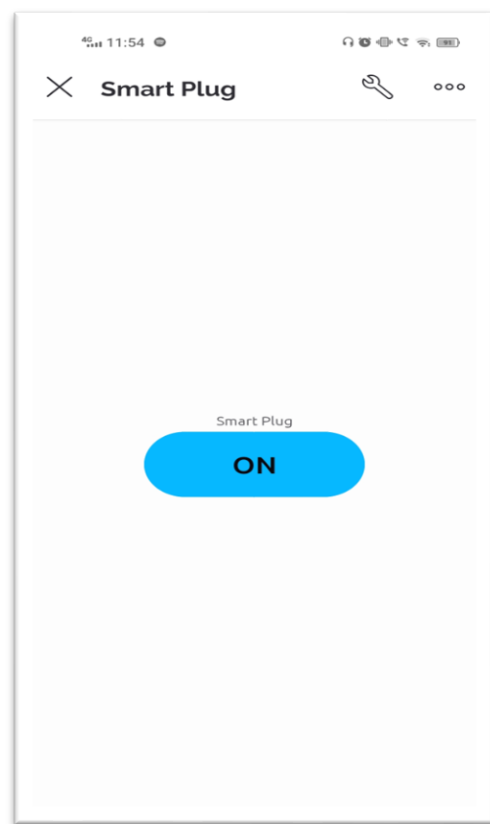
Fig 6   ## Fig 7

Issues

Smart plugs are devices that allow users to control electrical devices remotely, via a smartphone or voice assistant, and can provide a convenient way to manage your home's energy consumption. However, there are several issues that users may encounter when using smart plugs:

- Compatibility: One of the most common issues is compatibility. Smart plugs may not be compatible with all electrical devices, so it's important to ensure that the device you want to control is compatible with the smart plug you're using. Incompatibility can cause the smart plug to malfunction or not work at all.

- Connectivity: Smart plugs need to be connected to the internet to function, and connectivity issues can cause problems with their operation. This can result in the device not responding to commands or taking longer than usual to respond. Additionally, if your internet connection is unstable, the smart plug may disconnect frequently, making it difficult to use.

- Security: Smart plugs are connected devices, which means they can be vulnerable to cyberattacks. If the device's security features are not properly implemented, hackers can gain access to your home network and access personal data or take control of connected devices. It's essential to choose a reputable brand that offers strong security measures, such as encrypted connections and regular software updates.

4.7 Components for the real time implementation

To implement a smart plug, there are several key components that are needed to enable real-time control and monitoring of the connected device. Here are some of the key components for real-time implementation of smart plugs:

Microcontroller: A microcontroller is a small computer on a single integrated circuit. It is the "brain" of the smart plug and controls the device's operation. The microcontroller can receive input from sensors, process data, and send output to other components in the system.

Wi-Fi or Bluetooth Module: The Wi-Fi or Bluetooth module provides wireless connectivity between the smart plug and the internet or other devices. This allows users to remotely control the smart plug and monitor the status of the connected device through a mobile app or web portal.

Relay: The relay is an electrical switch that is used to turn the connected device on or off. It is controlled by the microcontroller and can handle the electrical load of the device.

Power Supply: The power supply provides the necessary power to operate the smart plug. It can be a simple AC-DC adapter that converts the AC power from the wall outlet to the DC power required by the smart plug's components.

Capacitors and Resistors: Capacitors and resistors are electronic components that can be used to filter and stabilize the power supply to the smart plug's components. They can also be used in other circuits within the smart plug, such as in the relay driver circuit.

Plastic Casing: A case to hold the above components in order to implement the functionality of the smart plug efficiently and safely. This casing also helps in portability of the device.

4.8 Summary

A smart plug is a device that allows users to remotely control and monitor the power consumption of a connected device through a mobile app or web portal. The implementation of a smart plug requires several key components, including a microcontroller, Wi-Fi or Bluetooth module, relay, current sensor, voltage sensor, temperature sensor, power supply, memory, real-time clock, and other electronic components such as capacitors, resistors, transistors, and fuses.

Smart plugs have numerous benefits, including the ability to monitor energy consumption and reduce energy waste, automate scheduling of devices, and increase home security by controlling devices remotely. They can also be integrated with voice assistants and other smart home devices to enable more sophisticated control and automation.

The adoption of smart plugs is growing rapidly, with increasing demand for energy-efficient and connected devices in homes and commercial settings. As the Internet of Things (IoT) continues to expand, smart plugs are expected to become more ubiquitous and sophisticated, with new features and functionality to enable even greater control and automation of devices.

Overall, the results and implementation of smart plugs demonstrate their potential to improve energy efficiency, convenience, and security in homes and businesses.

Chapter 5

CONCLUSION AND FUTURE SCOPE

5.1 Conclusion

In today's digital age, the demand for smart and energy-efficient solutions is constantly growing. Smart plugs are an innovative solution that has revolutionized the way we consume and control energy. With smart plugs, it's possible to remotely control and monitor the energy consumption of connected devices through a mobile app or web portal.

One of the most significant benefits of smart plugs is their ability to reduce energy waste by monitoring and controlling the energy consumption of devices. This is particularly important in households and commercial settings, where energy consumption is often high, and electricity bills can be costly. By allowing users to schedule the usage of their devices, smart plugs can significantly reduce energy consumption and save money in the long run.

Smart plugs can also increase home security by allowing users to control devices remotely. For example, they can schedule lights to turn on and off at specific times to make it look like someone is home, even when they're not. This can deter potential intruders and increase the overall security of a home.

In addition, smart plugs can be integrated with other smart home devices, such as voice assistants, to enable even greater control and automation. This can create a truly smart and interconnected home environment, where everything works together seamlessly to improve energy efficiency and convenience.

As the Internet of Things (IoT) continues to expand, smart plugs are expected to become more ubiquitous and sophisticated, with new features and functionality to enable even greater control and automation of devices. This, in turn, will further enhance the benefits of smart plugs, making them an essential component of a modern, connected home or business.

In conclusion, smart plugs are an important technology that offers numerous benefits, including energy efficiency, convenience, and security. As their adoption continues to grow, they have the potential to revolutionize the way we consume and control energy in our daily lives. The future of smart plugs looks bright, and we can expect to see even more exciting developments in this space in the years to come.

5.2 Future Scope

The future of smart plugs looks very promising as the technology continues to evolve and new use cases emerge. In the coming years, we can expect to see a wide range of new features and capabilities that will make smart plugs even more valuable for consumers and businesses alike.

One of the most significant trends in the future of smart plugs is the increasing focus on sustainability and energy efficiency. With the growing concerns over climate change and the need to reduce carbon emissions, smart plugs are expected to play a crucial role in helping consumers and businesses reduce their energy consumption and carbon footprint. For example, smart plugs could be used to automate the charging of electric vehicles, enabling users to charge their cars during off-peak hours when energy is cheaper and more renewable sources of energy are available.

Another trend in the future of smart plugs is the integration with other smart home devices, such as smart speakers and home assistants. This will enable users to control all of their devices from a single app or voice command, making it even easier to automate and manage their homes. For example, users will be able to turn off all of their lights and devices with a single voice command or button press.

As the technology behind smart plugs continues to improve, we can also expect to see more advanced features, such as machine learning and artificial intelligence. These technologies will enable smart plugs to learn from users' behaviors and make intelligent decisions about when to turn devices on and off, based on patterns in energy consumption and user preferences. This will further improve energy efficiency and convenience, making smart plugs an even more valuable technology for consumers and businesses.

In addition, the future of smart plugs will also be shaped by the growing demand for security and privacy. As more devices become connected to the internet, the need for robust security and privacy measures will become even more critical. Smart plugs are no exception, and we can expect to see new features and technologies that will make them more secure and protect user data.

Finally, the future of smart plugs will also be shaped by the growing adoption of smart cities and the Internet of Things (IoT). As more devices become connected and integrated, smart plugs will play a crucial role in

managing energy consumption and reducing waste in smart homes and businesses. In the long run, this will have a positive impact on the environment and help us build a more sustainable future.

The future of smart plugs looks very promising, with a wide range of new features and capabilities that will make them even more valuable for consumers and businesses. From improved energy efficiency to advanced AI and machine learning, smart plugs are set to become an essential component of the smart homes and cities of the future.