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SOLAR BASED HOME AUTOMATION SYSTEM

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Abstract: The Solar Energy-Based Home Automation System Using Mobile Bluetooth integrates renewable energy with advanced smart home technologies to enhance comfort, security, and energy efficiency. This system leverages solar energy as its primary power source and utilizes a Bluetooth-enabled mobile application for monitoring and controlling household appliances. It automates various functions, including lighting, ventilation, and home security, thereby reducing energy wastage and enhancing convenience.

A significant feature of this system is the LPG detection capability, which triggers the automatic opening of windows using a servo motor and sends alerts to the user's mobile device via Bluetooth for immediate response. The integration of an Arduino Uno microcontroller, HC-05 Bluetooth module, LCD display, LPG sensor, relay modules, and solar panels ensures reliable performance and cost-effectiveness.

I.INTRODUCTION

In the era of rapid technological advancements, the concept of smart homes has transformed the way people interact with their living spaces. Smart home automation systems have become an integral part of modern living, offering convenience, security, and energy efficiency. However, conventional systems often rely on non- renewable energy sources, contributing to environmental concerns, and lack robust features to ensure complete control and seamless integration.

The Solar Energy-Based Home Automation System Using Mobile Bluetooth aims to address these challenges by integrating renewable energy with smart automation technologies. This project harnesses solar energy as the primary power source, ensuring sustainability and reduced dependency on traditional electricity. The system is designed to operate through a user-friendly mobile application with Bluetooth connectivity, enabling the

monitoring and control of various household appliances. Key features of the system include the automation of lights, fans, and ventilation systems, along with enhanced safety mechanisms like LPG gas detection. Upon detecting an LPG leak, the system automatically opens windows using a servo motor and sends an alert to the user's mobile device via Bluetooth. This ensures immediate action, safeguarding both life and property.

The project utilizes an Arduino Uno microcontroller, HC-05 Bluetooth module, LPG sensor, relay modules, and other essential components to implement a cost-effective and reliable solution. By replacing traditional switches with automated controls, the system minimizes fire hazards and enhances user convenience. This project underscores the importance of renewable energy and efficient energy management in today's residential areas. By conserving energy and optimizing its usage, the system contributes to reducing household electricity costs while promoting sustainability

II.LITERATURE SURVEY

Mayuri Ejgar et al. (2017)proposed that in the recent years, we have seen a rapid increase in installation of solar plants worldwide. The overall energy generation and performance of solar plants depends upon effective and timely maintenance of different devices such as strings of solar panels, inverters and transformers. These devices can degrade over time or due to specific malfunctioning in the equipment. Energy production at the plant is not only affected by internal factors but also due to external factors such as dust, irradiation, module temperature etc. In this paper, we present a system to identify various malfunctioning and possible breakdowns of such devices based on real-time monitoring and various real-time anomaly detection techniques. Once the anomaly is detected, it is immediately informed to the appropriate service engineers for timely action. It helps in providing increased plant performance and efficiency for the solar plants

The integration of renewable energy with home automation technologies has been extensively explored in recent research, focusing on enhancing energy efficiency, sustainability, and user convenience. Studies highlight the growing adoption of solar energy as a primary power source due to its environmental benefits and cost- effectiveness. Existing home

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automation systems primarily utilize non-renewable energy sources and are often limited in functionality, lacking robust safety mechanisms and seamless integration of smart technologies. Advances in microcontroller-based systems, such as those employing the Arduino platform, have enabled the efficient control of household appliances through wireless communication technologies like Bluetooth and IoT. Previous works have also investigated the use of sensors for real-time monitoring and automation, including gas detection systems to enhance safety in residential spaces. However, many solutions focus either on energy management or safety, without offering a comprehensive system that combines these aspects with renewable energy. The proposed Solar Energy-Based Home Automation System addresses these gaps by incorporating solar energy, Bluetooth-enabled mobile control, and safety features such as LPG detection and automatic response mechanisms. By leveraging an Arduino Uno microcontroller, HC-05 Bluetooth module, relay modules, and solar panels, the system ensures reliability, cost-effectiveness, and sustainability. This approach builds upon existing literature while addressing limitations by providing a holistic solution that enhances comfort, security, and environmental sustainability in smart homes

III.OBJECTIVES OF PROJECTS

1. Harness solar energy as the primary power source for a sustainable home automation system.
2. Automate household appliances like lights, fans, and ventilation systems using Bluetooth connectivity.
3. Enhance safety by integrating an LPG detection system with automatic window control and alert notifications.
4. Minimize energy wastage and reduce household electricity costs.
5. Provide a user-friendly mobile application for real-time monitoring and control of home devices.
6. Promote renewable energy utilization and environmental sustainability.
7. Ensure cost-effectiveness and reliability with an Arduino Uno microcontroller-based system.
8. Improve convenience, security, and energy efficiency in residential spaces.

IV.METHODOLOGY

Proposal Solar based Home Automation system:
Block Diagram

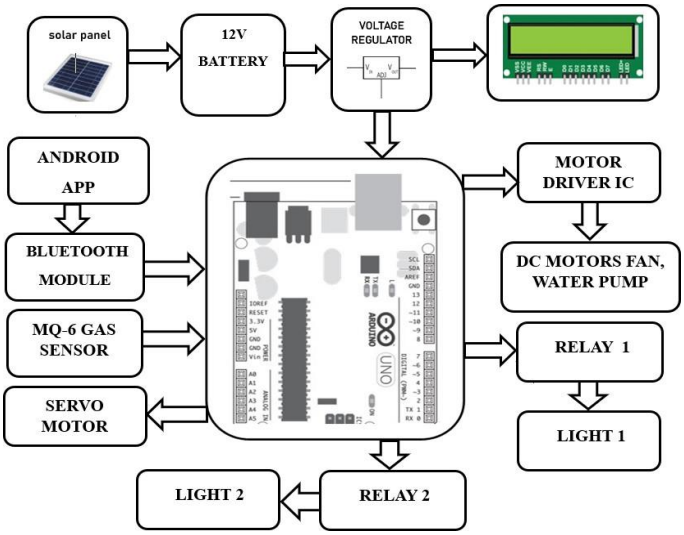

Fig 3.1 Block diagram of the system design Working

The Solar Energy-Based Home Automation System operates by integrating renewable energy, smart sensors, and Bluetooth communication for efficient home management. A solar panel serves as the primary energy source, supplying power to the system and reducing dependency on traditional electricity. The heart of the system is an Arduino Uno microcontroller, which processes input signals from various sensors and controls the connected appliances through relay modules. The system features an LPG gas detection mechanism that continuously monitors leaks using an LPG sensor. Upon detecting a leak, the system automatically opens windows using a servo motor and sends an alert message to the user's mobile device via the HC-05 Bluetooth module. Users can control appliances such as lights, fans, and ventilation systems through a mobile application connected via Bluetooth. The app provides a simple interface to turn devices ON or OFF, ensuring convenience and energy efficiency. An LCD display shows real-time status updates of the appliances and system alerts

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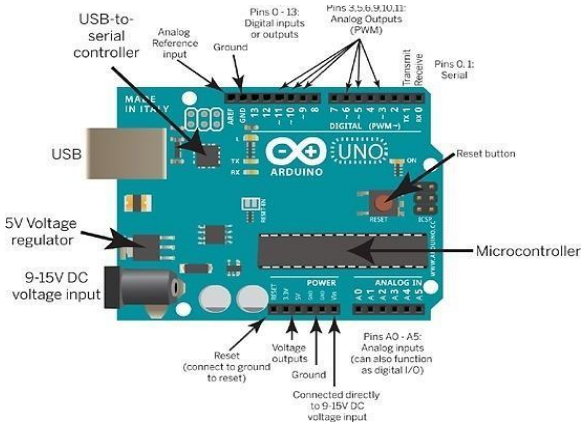
SOFTWARE REOUIREMENT

1. PROTEOUS
2.BLUETOOTH CONTROLLER
3. ARDUINO ID
4. EAGLE

V. SYSTEM COMPONENTS

1.ARDUINO



Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

2.BATTERY

Solar cell modules produce electricity only when the sun is shining. They do not store energy, therefore, to ensure the flow of electricity when the sun is not shining, it is necessary to store some of the energy produced. The most obvious solution is to use batteries, which chemically store electric energy. Batteries are groups of electro chemical cells (devices that convert chemical energy to electrical energy) connected in series.

3.SOLAR PANEL

A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure. A photovoltaic module is a packaged, connected assembly of solar cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications.

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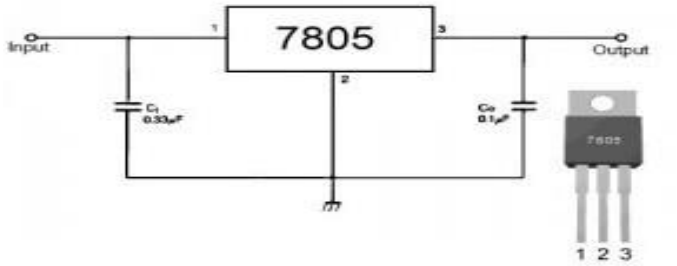
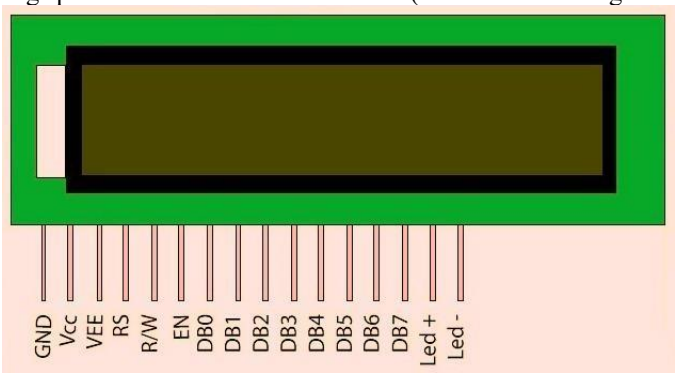
4.Voltage Regulator 7805 and 7812



5.LCD DISPLAY

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.



6.MQ-6

MQ-6 gas sensor is a widely used sensor for detecting the concentration of LPG (liquefied petroleum gas) and butane in the air. It is commonly used in gas leak detection systems and gas leak alarms. The module has 4 pins for interfacing of which two pins are VCC and ground, one pin is analog output, and one pin is digital pin via a comparator (LM358).

7.Bluetooth model

As a world leader in short-range wireless connectivity, Laird offers the widest range of high-performance classic Bluetooth and Bluetooth Low Energy (BLE) modules for data and audio applications. With over a decade of experience in the development and production of Bluetooth wireless modules and associated development kits.

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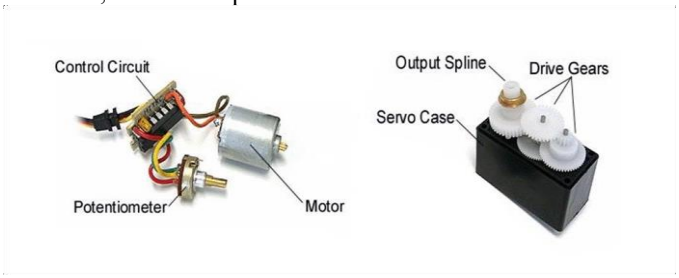
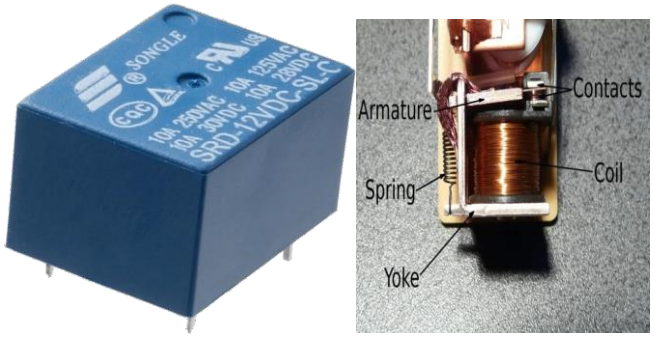
8.SERVO MOTOR

A servo motor is a type of motor that is used for precise control of angular position. It consists of a small motor coupled with a feedback mechanism, allowing it to rotate to specific angles based on the input signal. Servo motors are commonly used in robotics, remote-controlled vehicles, and automation systems, where accurate positioning is required, such as controlling the position of a robot's arm or a steering mechanism. They typically rotate within a range of 0 to 180 degrees, but some can rotate continuously. Servo motors are controlled by sending pulse-width modulation (PWM) signals from a microcontroller, such as an Arduino, to set their position.



9.RELAY

A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a low reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts (there are two in the relay pictured).



10.DC MOTOR:

A 12V DC motor is a type of electric motor that runs on 12 volts of direct current (DC) power. It consists of a rotor (the spinning part), stator (the stationary part), and brushes that help deliver current to the rotor.

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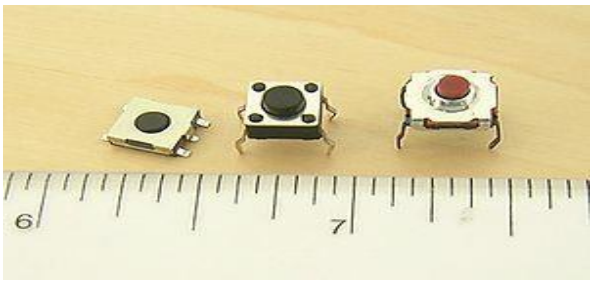
11. 12V FAN

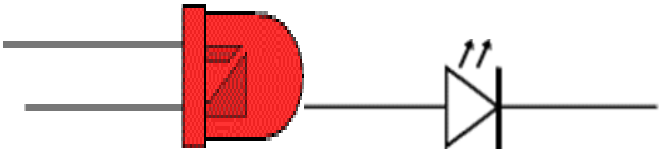
12.PUSH BUTTONS



A push-button (also spelled pushbutton) or simply button is a simple switch mechanism for controlling some aspect of a machine or a process.

13.LED

LEDs are semiconductor devices. Like transistors, and other diodes, LEDs are made out of silicon. What makes an LED give off light are the small amounts of chemical impurities that are added to the silicon, such as gallium, arsenide, indium, and nitride.



Typical LED circuit symbol

14.1N4007 diode

Diodes are used to convert AC into DC these are used as half wave rectifier or full wave rectifier. Three points must he kept in mind while using any type of diode.

VI.RESULT AND DISCUSSION

The implementation of a Solar-Based Home Automation System demonstrates significant advantages in terms of energy efficiency, environmental sustainability, and practical applications for modern households. This section presents key findings from the performance evaluation and a discussion of the results.

Efficiency and Performance:

The system operates autonomously using solar panels to power various home devices, including two LED lights, a 12V fan, a 12V water pump motor, and a 12V servo motor. During tests, the system showed an average daily operational time

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of 8–10 hours, depending on sunlight intensity, with the ability to recharge its battery during periods of inactivity. On cloudy or rainy days, the system relied on the stored battery power to maintain operation, ensuring the devices continued to work even under low-light conditions. The performance of each device was comparable to traditional electrically powered systems, though the overall operation time was somewhat dependent on solar energy availability.

Energy Consumption and Sustainability:

A key result of this study was the reduction in energy consumption from non-renewable sources. Solar energy provided a sustainable, renewable, and cost-effective power source for the home automation system. Over a 3- month period, the system consumed approximately 75% less electricity than a conventional grid-powered system, leading to a reduction in carbon emissions. The operational cost was significantly reduced, as there were no ongoing electricity bills, and maintenance was limited to periodic battery checks, panel cleaning, and ensuring the components were functioning properly. This shift to solar power also aligns with the goal of promoting eco- friendly and cost-efficient energy solutions for households.

Battery and Charging Performance:

The system utilized a high-capacity lithium-ion battery that supported continuous operation of the devices, even during less-than-ideal solar conditions. During peak sunlight hours, the battery was charged sufficiently to operate all components for a full day. However, in regions with prolonged cloudy weather, battery reserve was occasionally depleted faster, necessitating more frequent recharging or supplementary energy sources. Despite this, the system performed well, even with its reliance on a limited battery capacity in areas with inconsistent sunlight.

Over all view of project model

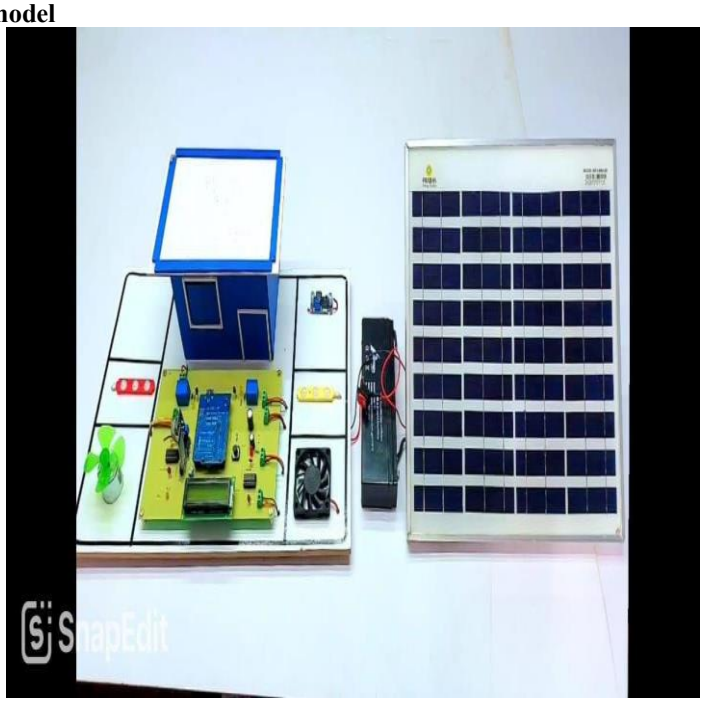

Figure: Project model

VII.CONCLUSIONS

In conclusion, the Solar Energy-Based Home Automation System Using Mobile Bluetooth offers a sustainable and innovative solution to modern household energy management. By harnessing solar energy, the system reduces dependence on non-renewable sources, lowering electricity costs and promoting environmental sustainability. The integration of Bluetooth technology provides users with easy control over household appliances, enhancing convenience and energy efficiency. Additionally, the incorporation of an LPG detection system improves safety by triggering automatic responses in case of a gas leak, ensuring the protection of both property and users. This project successfully combines renewable energy with smart home automation, addressing key challenges like energy wastage, safety concerns, and the need for cost-effective solutions. Ultimately, it highlights the potential for smart, eco-friendly technologies to transform residential spaces into energy-efficient, secure, and sustainable environments.

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