# Home Automation Using Tilt Switch for Physically Challenged People

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***Abstract* – Home automation using a tilt switch for physically challenged people presents an innovative solution to enhance the independence and quality of life for people with limited mobility. This system utilizes tilt sensors integrated into various household devices, allowing users to control home appliances such as lights, fans, doors, and windows with simple movements or gestures. The tilt switch detects the angle of inclination and sends signals to a control unit that activates or deactivates devices accordingly. This paper makes use of tilt switch, LED, fan and ESP32 and shows the automation of light and fan using tilt switch. This paper proposes an idea for physically challenged people to make use of home automation which makes their life easy and comfortable, enabling them to control their environment without the need to depend on any other individual.**

***Keywords— ESP32, tilt switch, home automation***

## I. INTRODUCTION

In the recent years, home automation has emerged as a vital and powerful tool in improving the quality of life for humans. Home automation has evolved through the years, the way in which we interact with our physical environment. With the advancement in technologies, use of these technologies to control light, fan, doors, etc. is home automation. In this paper we present the idea of home automation for physically challenged people using tilt switch. By this way it reduces the dependency of these people on other individuals for their basic needs like turning on and off a light or fan. For individuals with limited mobility, using traditional switches and controls can be a challenge, which is where tilt switches offer a better solution.

A tilt switch is a device that detects the orientation or tilt of an object and triggers a response based on the angle of movement. By integrating tilt switches into home automation systems, physically challenged individuals can interact with their environment more easily. It is cost effective and user-friendly. It also provides as a better alternative when compared to other wearables which might be inconvenient for them to wear it for a longer period of time.

## II. LITERATURE SURVEY

The necessity for effective automation solutions tailored to the needs of the elderly and disabled has prompted extensive research into diverse technologies. This research aims to address specific challenges encountered by these individuals and to develop practical solutions suited to their unique circumstances.

Kshirsagar et al. [2] offered an IoT-based home automation system which had an addition of gesture recognition capability to manage various domestic appliances. While this system is convenient in the use of a wearable glove and mobile application, its dependence on constant internet connectivity, high implementation costs, and complexity make it less feasible for elderly users who may face technological barriers.

Khan et al. [3] presented a low-cost alternative to the development of assistive automation for the elderly and disabled population without robotic operating system. The proposed solution is economical but relies on gesture-based input, which is difficult to implement for users who have limited mobility and/or dexterity. This is a drawback to the need for simpler systems that don't pose physical strain on users.

Matsuda et al. [4] proposed a tilt sensor-based system using conductive liquid material that measures tilt directly as a digital signal without requiring external complex computation. The system can readily be recommended because of its simplicity and cost-effectiveness and drift-free working. The fact that it measures tilt in two dimensions makes it more ideal for wearable devices and automation systems addressed towards an elderly market, posing less complicated and reliable alternatives in place of gesture- or IoT-based solutions.

Nithya Priya et al. [1] demonstrated the practical application of tilt sensors using a hand-gesture-controlled robot. The system uses a mercury tilt switch for gesture detection and an RF transmitter-receiver module to drive the motor of a robot. The study highlights the reliability and cost-effectiveness of tilt sensors for automation tasks and demonstrates their ability to be adapted for real-world applications.

Sergiusz Łuczak et al. [5] provide an overview of the properties and applications of electric-contact tilt sensors, especially concerning their reliability in various domains, including the field of automotive systems, as well as structural health monitoring. The simplicity and cost-effectiveness of tilt sensors make them even more suitable for the automation systems for the elderly.

This comparative analysis shows that though IoT and gesture-based systems exhibit advanced functionalities, the complexity and cost associated with them are not so perfect for elderly clients. In lieu of this, tilt sensors are quite practical and affordable as they are simple, reliable, and effective. The evidence presented by Matsuda et al. [4] and Nithya Priya et al. [1] particularly supports the conclusion that tilt sensor-based systems are the most feasible solution for assistive automation for the elderly and disabled, ensuring accessibility without imposing financial or technological burdens.

## III. MATERIALS AND METHODS

This section describes the hardware components, software implementation, and operational principles of the proposed system, designed for automated control of devices based on tilt inputs. The system employs an ESP32 microcontroller, tilt sensors, a relay module, an LED light, and a fan. These components are interconnected using jumper wires, assembled on a breadboard, and powered by a regulated 5V supply. Each aspect of the system is outlined in detail below.

### A. Hardware Components

#### 1. ESP32 Microcontroller

The ESP32 microcontroller serves as the system's central processing unit. It monitors the tilt sensors for input signals and controls the relay module based on these inputs. The ESP32's features, including low power consumption, integrated wireless capabilities, and advanced processing power, make it an ideal choice for home automation applications.

Figure 1. ESP 32 Microcontroller

#### 2. Tilt Sensors

The system incorporates two tilt sensors that operate in a complementary manner. Tilt Sensor 1 acts as the activation trigger, while Tilt Sensor 2 serves as the deactivation trigger. Their mutually exclusive operation ensures a binary system state, minimizing ambiguity in the control of connected devices.

Figure 2. Tilt Sensor

#### 3. Relay Module

The relay module acts as an intermediary between the ESP32 and the output devices, switching the power supply to the LED light and fan based on ESP32 commands. Its robust design ensures safe and efficient handling of the power requirements for the connected appliances.

Figure 3. Relay Module

4. Output Devices

The LED light and fan serve as the system's output components, providing visual and functional feedback. They are powered on when Tilt Sensor 1 is triggered and powered off when Tilt Sensor 2 is triggered, reflecting the system's operational state.

5. Power Supply

A regulated 5V power supply ensures the system's stable operation, protecting components from voltage fluctuations that might compromise performance or longevity.

B. System Operation

The ESP32 continuously monitors the tilt sensors to determine the system's state. When Tilt Sensor 1 detects a tilt while Tilt Sensor 2 remains inactive, the ESP32 activates the relay module, powering the LED light and fan. Conversely, when Tilt Sensor 2 is triggered and Tilt Sensor 1 is inactive, the ESP32 deactivates the relay, cutting power to the appliances. This dual-sensor mechanism ensures precise and reliable toggling between the system's on and off states.

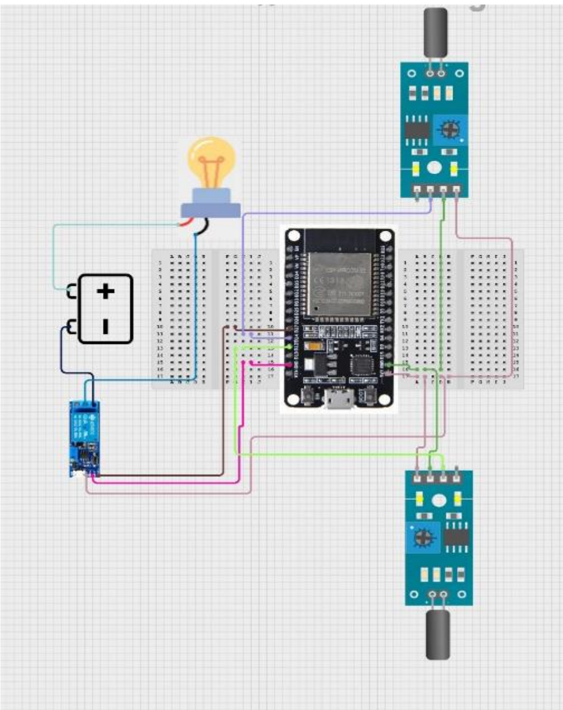

Figure 4. Circuit Diagram

C. Software Implementation

The ESP32 is programmed using the Arduino IDE. The software monitors sensor inputs and executes corresponding actions based on predefined conditions. A debounce mechanism is implemented to filter out noise and prevent false triggers caused by mechanical vibrations or sensor inconsistencies. This mechanism introduces a brief delay between sensor readings, ensuring that only consistent signals trigger state changes. The inclusion of this feature enhances the system's reliability in noisy environments.

D. Design and Installation

The system is designed for ease of assembly and operation. The tilt sensors are strategically positioned to optimize tilt detection while minimizing false positives. Initially assembled on a breadboard for prototyping, the system allows for future transition to a printed circuit board (PCB) for enhanced durability. The modular nature of the relay module ensures compatibility with various appliances, adding versatility to the design.

The system's energy-efficient design, driven by the ESP32 and other low-power components, makes it suitable for long-term use in home automation scenarios without incurring significant energy costs.

## IV. RESULTS

The testing assessment showed that the system was reliable and performed consistently, largely due to the use of tilt sensors. These sensors ensured the circuit engaged or disengaged correctly based on their orientation. For example, the LED light and fan turned on when Tilt Sensor 1 was active and Tilt Sensor 2 was inactive. Similarly, they turned off when Tilt Sensor 1 was inactive and Tilt Sensor 2 was active.

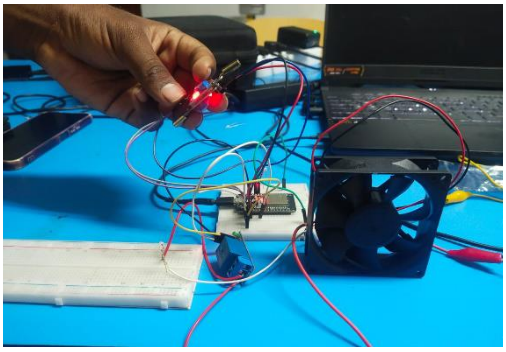

Figure 5. 'Off' Position

Using tilt sensors improved reliability by accurately detecting the system's tilt angles, reducing errors and ensuring smooth operation. Their simple and sturdy design also added to the system's durability and consistent performance. Users with limited mobility found the system easy to use, highlighting its practical design. Additionally, the system's low power consumption made it an efficient and user-friendly solution.

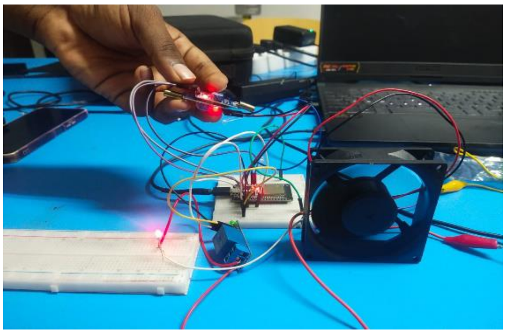

Figure 6. 'On' Position

## V. CONCLUSION

The proposed tilt sensor-based home automation control system would be a more practical and friendly solution to provide elderly people or physically disabled patients with a feasible control system because traditional mechanical switches often create barriers for these individuals, requiring skills or physical work that may be difficult for the user. The system significantly improves by enabling the control of electrical devices using simple hand tilts or minor movements through the replacement of such switches with a tilt-sensor mechanism, thereby making the system highly accessible and reducing physical strain.

The inclusion of the ESP32 microcontroller provides a substantial value addition to the system. Its processing power and built-in support for wireless communication ensure smooth, reliable, and near-delay-free system operation. The device is versatile enough to be used with other smart devices and systems, which adds more functionality to the home automation setup. The most important aspect is that the tilt-sensor mechanism, coupled with the ESP32, makes the system user-friendly, even for those who may not be well-versed in modern technology.

This is an efficient and cost-effective solution. Its components, such as tilt sensors and the ESP32, are cheaper and highly accessible so that the system can be more widely adopted with minimal costs involved. Plus, it's simple enough to be fast to install and easy to maintain, which reduces ongoing costs and complexity.

This system gives the elderly the ability to independently manage their environment and, thus improve their quality of life. It also meets the increasing need for smart home automation systems with emphasis on accessibility, user-friendliness, and economic feasibility.

## VI. FUTURE WORK

Future developments in the tilt-sensor-based home automation system might include miniaturized components. It would be much easier to integrate and carry around the system for household use, making it simpler to install the system in the most confined areas, using the miniaturized sensors and optimizing the ESP32 design.

Miniaturization also allows for the inclusion of portables or wearables, with carrying the control appliance by a member of this very age group from one location throughout the dwelling-again allowing further mobility and the convenience associated. Energy-efficient technology would help in the design of compact power supply sources like the rechargeable kind of battery within the system.

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