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Amruta Gesture Controlled Contactless switch

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Abstract
The increasing need for hygienic and touch-free control systems has led to the development of sensor-based automation in homes and industries. This project presents a **Gesture Controlled Contactless Switch** designed using the **Arduino Nano**, **APDS9960 gesture sensor**, and a **relay module** to operate electrical appliances without physical contact. The APDS9960 sensor detects gestures such as swipe-up, swipe-down, left, and right, converting them into digital commands for the Arduino. The microcontroller processes these gestures and triggers the relay to switch the connected load ON or OFF.
The system enhances user convenience by enabling effortless control of devices even from a short distance, making it especially useful in environments where minimizing touch is essential, such as hospitals, laboratories, kitchens, and public spaces. The design is compact, energy- efficient, and low-cost, making it suitable for smart home applications. This project demonstrates how intuitive gesture recognition can be integrated into everyday electrical systems to improve safety, hygiene, and user interaction.

1. Introduction

A **gesture-controlled contactless switch** is an advanced smart switching system designed to operate electrical appliances without requiring any physical touch. In today's world, where automation and hygiene play a major role, touchless technology has become an important innovation. Traditional switches require physical contact, which may lead to wear and tear, electrical hazards, and the spread of germs, especially in public or sensitive environments. To overcome these limitations, gesture-based switching provides a modern and convenient solution by enabling users to control devices using simple hand movements in the air.
This system works using an optical gesture sensor such as the **APDS9960**, which is capable of detecting various hand gestures like up, down, left, right, and wave motions. The sensor contains infrared light emitters and receivers that continuously monitor movement in front of it. When a user performs a gesture, these optical elements sense the change in reflected light. The sensor then generates signals corresponding to the gesture pattern. These signals are sent to a microcontroller, commonly an **Arduino Nano**, which processes the gesture and decides whether to switch the connected device ON or OFF. The final switching operation is carried out by a **relay module**, which acts as the interface between the low-power electronics and the high-power electrical load.
The main aim of a gesture-controlled contactless switch is to create a **safe, hygienic, and highly responsive** method of operating appliances. In environments like hospitals, laboratories, kitchens, offices, and public restrooms, touching

switches repeatedly is not only inconvenient but also unhygienic. Gesture-based switching eliminates this issue by allowing users to activate or control devices without any direct contact. This is especially helpful in preventing the spread of infections, maintaining cleanliness, and ensuring user comfort.

2. Problem Statement and Literature Review

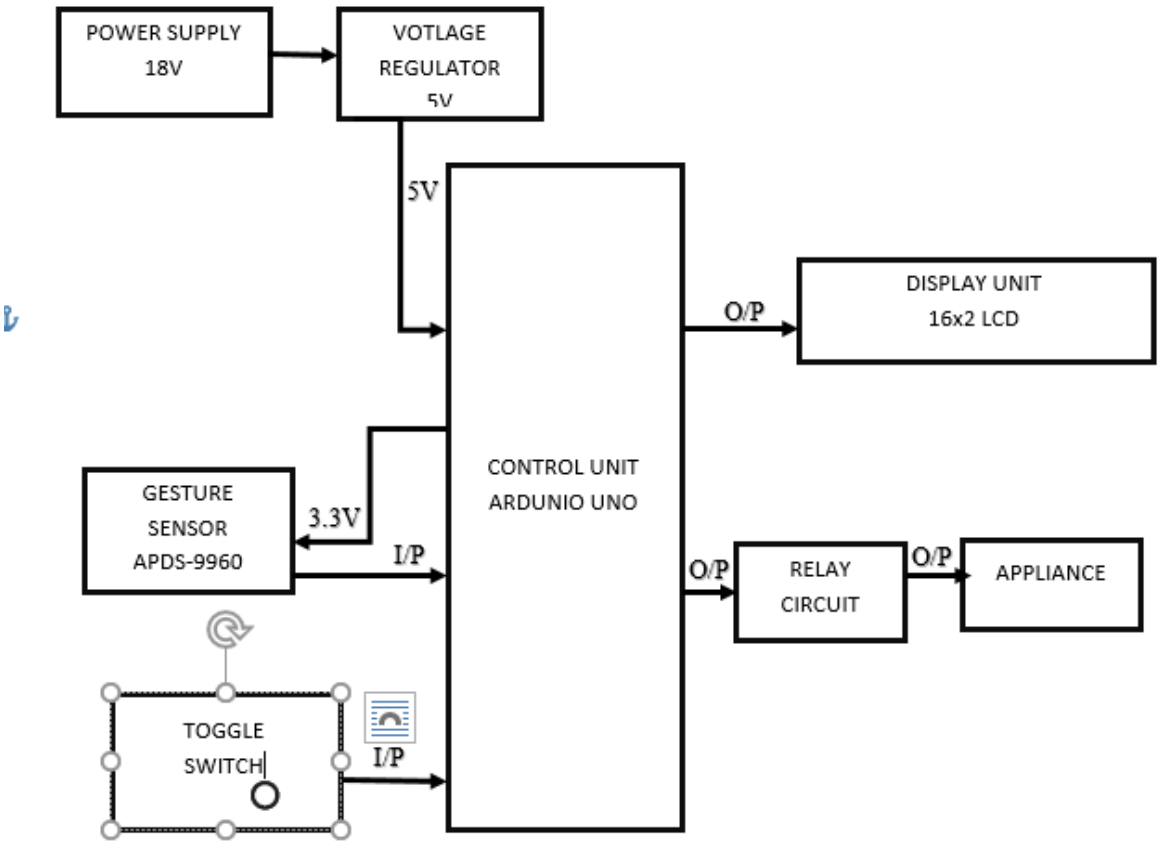
Traditional electrical switches require **direct physical contact** to operate home or industrial appliances. This creates several practical issues in real environments. Users frequently touch switches with wet, dirty, or contaminated hands, leading to **unhygienic conditions**, especially in hospitals, public places, kitchens, and laboratories. Moreover, mechanical switches undergo wear and tear due to continuous pressing, which reduces their lifespan and increases maintenance.

During situations like the **COVID-19 pandemic**, the risk of virus transmission through commonly touched surfaces highlighted the need for **contactless operation**. Existing systems lack intelligent sensing and cannot respond automatically to hand gestures or proximity. There is **no automation, no smart control, and no support for touch-free interaction**.

Additionally, elderly or physically challenged people may find it difficult to reach or press standard wall switches. In dark conditions or when hands are occupied, operating a physical switch becomes inconvenient. These challenges clearly indicate the necessity of a **safe, hygienic, reliable, and user-friendly contactless switching mechanism**.

Thus, the identified problem is the absence of a **smart, gesture-based control system** that can detect hand movements accurately and control electrical loads without physical touch. A solution is required that is **low-cost, easy to install, and efficient**, and that works within a practical distance range using sensors like the APDS9960.

3. Working Principle



- **Arduino Nano:** A small microcontroller board that processes sensor data and controls the relay.
- **APDS-9960 Gesture Sensor:** Detects hand gestures like swipe or wave without physical touch.
- **Relay Module:** Works as an electronic switch to turn appliances ON or OFF safely.

□ **Power Supply (5V):** Provides stable power to the Arduino and sensor.

□ **Jumper Wires:** Used to connect all components in the circuit.

□ **Breadboard/PCB:** Base used to assemble and hold the circuit components.

4. Methodology

□ Identify the problem and requirements for contactless switching.

□ Select components like Arduino Nano, APDS-9960 gesture sensor, and relay module.

□ Interface the sensor with the microcontroller through proper wiring.

□ Write and upload the code to detect gestures and control the relay.

□ Assemble the complete circuit on a breadboard/PCB.

□ Test the system with different gestures, distances, and lighting conditions.

□ Make necessary adjustments to improve accuracy and reliability.

□ Finalize the working model and document the results

5.Results and Discussions

The gesture-controlled contactless switch system was successfully designed and implemented using an Arduino Nano, APDS9960 gesture sensor and a relay module. The prototype accurately recognized hand gestures such as swipe left, right, up, and down without any physical contact, typically within a distance of 5–10 cm. The sensor readings were processed by the Arduino and used to safely energize or de-energize the relay, enabling touchless control of electrical appliances like lights and fans. Throughout testing, the system remained stable, responsive, and reliable, showing minimal delay between gesture detection and switching action. This confirms that gesture-based automation can be implemented in a compact, low-cost and efficient manner, making the project a successful demonstration of modern, contact-free control technology.

6.Conclusion

The gesture-controlled contactless switch proves to be a highly efficient, hygienic and modern solution for electrical appliance control. By combining the APDS9960 gesture sensor, Arduino Nano and relay module, the system enables hands-free switching that enhances safety and convenience, especially in environments where physical contact should be minimized. The project showcases how gesture-based technology can improve automation, reduce contamination risk, and offer an advanced user experience. Although it has limitations related to distance and lighting, its advantages outweigh them, making this switch a practical and scalable approach for smart homes, healthcare environments, and public places. Overall, the project successfully demonstrates the feasibility and effectiveness of gesture-controlled automation.

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Biography

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