

ECO-WIPE: HYGIENE ENHANCEMENT INITIATIVE

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Abstract. The project integrates automation technology with a sensor and a servo motor to automatically clean table tops. It uses two sensors to identify objects lying on the table and triggers a wiping mechanism based on a servo motor placed under the table. When turned on, sensors detect obstacles, allowing the cleaning mechanism to wipe dust and dirt from open spaces without moving any object. The device is optimized for efficiency, convenience, and ease of use to keep homes, offices, and restaurants hygienic. It reduces labour effort and ensures hygienic surfaces, providing a healthier environment. Automatic Table Cleaning Device is a sophisticated system to automatically clean tables to promote efficiency as well as hygiene. The device comes equipped with a servo motor-controlled wiper that travels in an orderly manner to clear dust, food scraps, and other particles. It uses an ultrasonic sensor to sense objects lying on the table to avoid unnecessary shifting by sounding an alarm with a buzzer. It is an intelligent device to eliminate inefficiencies of manual wiping, including non-uniform wiping as well as overconsumption of cleaner supplies. The device cleans independently, minimizing human intervention with a uniformly cleaned surface. It is especially helpful in those environments where frequent cleaning is necessary, including houses, offices, restaurants, and health care facilities. With sensor-controlled automation coupled with energy savings, this device is an efficient and innovative way to keep table surfaces clean and sanitized.

Keywords: Autonomous Device, Arduino Microcontroller, Embedded Systems, Sensor Fusion, motors, Dust Cleaning, Smart Technology.

I. INTRODUCTION

Clean and hygienic table tops are essential in all sorts of environments—from office spaces and residential apartments to restaurants, hospitals, and schools. Central to eating, working, and socializing, tables are also hotbeds for dust, crumbs, spills, and potentially dangerous microorganisms. Even though sanitation is important, standard table cleaning is generally based on manual processes, which is not only labour-intensive and taxing, but also inconstant in practice. Such constraints more often result in sloppy cleaning, accumulation of trash, and higher risks of germs being transferred, especially in high-use zones.

To solve these problems, the Automatic Table Cleaning Device offers a novel, efficient solution. The device is programmed to automatically clean the table by making use of sensors along with a servo motor to identify items placed on the table and trigger an intelligent wiping system. When powered, sensors sweep over the table's surface to detect items such as dishes, papers, or devices. The wiping mechanism then moves around such objects to brush dust and rubbish from all exposed space without touching items left behind. It ensures free-flowing, hands-off cleaning that saves energy and labour with minimal compromise of hygiene.

Its creation is in keeping with an overall trend toward smart automation in everyday life. Technology has already transformed the household task of doing chores with products such as vacuum cleaners with robotic functionality and automatically cleaned appliances. They not only enhance convenience but also promote hygiene and minimize exposure to germs by humans. Likewise, an automated table cleaner presents an everyday solution to keeping places clean, particularly in communal or public spaces where various hands come in contact with the same surface all day.

In restaurants and cafes, the device can assist in keeping dining spaces hygienic in between clients, enhancing dining experience and ensuring health guidelines are maintained. For offices, it can keep communal working spaces hygienic and free of germs, enhancing worker health. In hospitals, where hygiene is paramount, the device will assist in maintaining stringent hygiene measures essential in keeping infections at bay. In addition to that, table cleaning automation eliminates the need for manual labour, which is especially useful in case of labour shortages or where there is a need for more frequent sanitizing, such as in case of a pandemic. It also guarantees an even level of cleanliness that is hard to obtain with manual means.

In general, then, the Automatic Table Cleaning Device is advancement in smart cleaning technology. It is an efficient system which brings together precision, hygiene, and portability to solve an everyday problem with a solution that is innovative and technologically based. Through their emphasis on sanitation as well as automation, such devices are also likely to become important in making living and working spaces safer and more convenient.

II. OBJECTIVE

The primary goal of this project is to develop and design an automatic table cleaning system that is efficient, standardized, and hygienic in nature with minimal human intervention. With an ultrasonic sensor for obstacle detection and wiping mechanism powered by a servo motor, the system automatically sidesteps obstacles to effectively clean exposed table areas. The system also triggers a buzzer alarm to alert users in case of obstructions, increasing system usability along with interactivity. The project aims to minimize repetitive human labour, maintain higher levels of cleanliness in residential as well as commercial spaces, and reduce human exposure to contaminated surfaces. The device is compact, cost-saving, and easy to use, providing an efficient solution to a universal problem with room for scalability to be integrated with smart home or office systems. The solution not only ensures hygiene and convenience but also follows the emerging trend towards automation along with contactless technologies.

III. RELATED WORK

Table cleaning is currently done largely by means of manual implements such as cloths, sponges, paper towels, and wet wipes. The process is completely dependent upon human labour and technique, which is subjective in nature and frequently inconsistent. In restaurants and cafes, employees are responsible for hasty wiping down of tables in between patrons, which results in hurried or incomplete cleaning. Occasionally, wipes are used in conjunction with disinfectant sprays, dependent upon how diligently the process is executed. Although robotic floor cleaners such as Roombas have become popular for floor cleaning automation, similar technology for tabletop use is scarce or does not exist. Certain industrial cleaning arms and robotic manipulators are available for special-purpose use, but are costly, complicated, and not suitable for general table cleaning. Therefore, there is as of now no generally available, cost-effective, and purpose-built solution for table automation in terms of sweeping or wiping down, providing ample space in the market for an improved, hygienic, and user-friendly solution.

Example:

One of the popular examples in the area of automated cleaning systems is iRobot's Roomba robotic vacuum. The Roomba employs ultrasonic sensors, infrared sensors, and brushes for autonomous navigation and floor cleaning. It detects obstacles, prevents collisions, and optimizes its path to maintain even tidying. The use of sensors by the system to sense dirt and obstacles is similar to how sensors in our project are used to sense objects placed over the table to initiate the cleaning mechanism. Roomba targets floor cleaning, but our project applies the technology to table cleaning, where there is a wiping mechanism powered by a servo motor under the surface to wipe exposed portions with obstacles dodged, maintaining cleanliness in tight spaces such as desks and dining space. This illustrates how automation-based cleaning technology is being applied to different environments with more precision and efficacy.

IV. PROPOSED METHODOLOGY

The envisioned table cleaning system employs a highly engineered process that combines advanced sensor technology, motorized cleaning, and instant feedback to offer an efficient, intelligent solution to keeping surfaces spotless. The system starts with an ultrasonic sensor installed in the device, which is tasked with constantly scanning the table's surface to identify objects, including cups, plates, books, or electronic gadgets. The ultrasonic sensor emits sound waves, which are then analyzed by measuring reflected waves to identify obstructions in the path of the cleaner mechanism. Upon detection of an object, the sensor relays this information to the system's controlling unit, which causes a buzzer alarm to be triggered. The buzzer acts as an instant audio alert to the user, announcing identification of an obstruction, preventing items placed on the table from being disturbed or unknowingly displaced in the process of cleaning.

Once the table surface is free from clutter and scanned, the wiping mechanism, which is powered by servo motors, is activated. The wiping mechanism is used to traverse a wiping arm or cleaning pad along a pre-programmed path (like a back-and-forth travel or zigzag pattern) across the table surface, systematically wiping dust, crumbs, and debris. The servos are precisely calibrated to offer smooth, even travel of the wiping arm to effectively cover all areas. If an object is sensed in mid-sweep, the system automatically adjusts for wiping path navigation to skip over obstructions and continue wiping available space. Dynamic adjustment to this wiping pattern ensures that the wiping process is not compromised in terms of efficiency, maintaining integrity of the items placed on the table.

The core of the system is the central control unit, which is often a microcontroller, in charge of controlling the entire cleaning system. The central unit processes data from the ultrasonic sensor to identify table's surface organization, controls motor movements to direct the wiping mechanism, and activates the buzzer alarm where appropriate. The microcontroller also controls the power management system to keep the device running continuously without hiccups. The device is powered by a stable power supply, which may be in the form of a rechargeable battery or direct power source, to keep the device operational for lengthy cleaning sessions.

This system offers an efficient, hands-off means of keeping table surfaces hygienic without manual labour. It combines automation with obstacle detection, in-the-moment adjustments, and feedback from the user to make the system highly efficient with little need for human interference. It is versatile for use in various environments, from residential to commercial space such as offices, restaurants, or even hospitals. The reduced need for human intervention, maintaining consistency in hygiene, and preventing contamination make this system an asset in both residential and commercial settings.

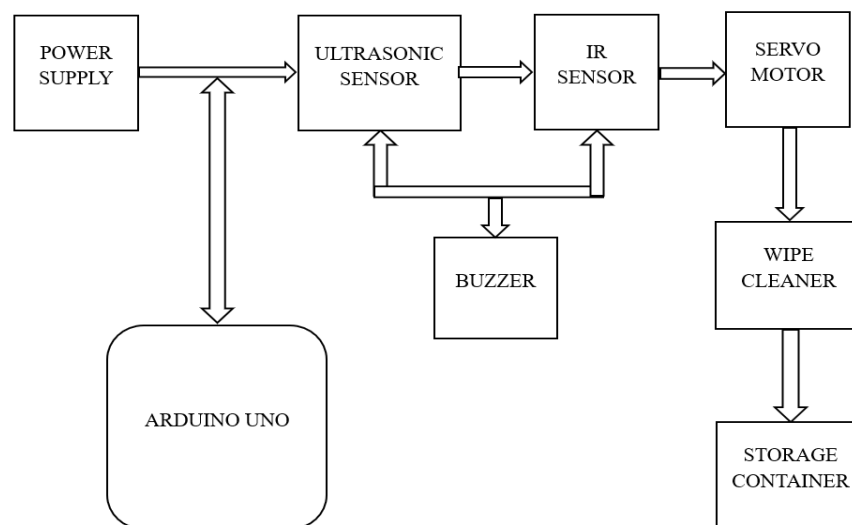
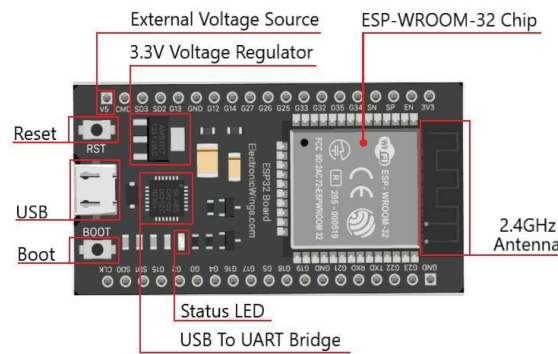


FIGURE 1: Block diagram of working model**Hardware Components**

- Microcontroller (Arduino/ESP32)
- Servo Motor
- Ultrasonic Sensor
- IR Sensor
- Frame & Mounting System
- Buzzer
- Wiper Mechanism
- Power Source

ESP32:

The ESP32 is a powerful and affordable microcontroller with embedded Wi-Fi and Bluetooth, which is perfect for smart and IoT-related projects. The microcontroller includes a dual-core processor, GPIO pins in multiples, as well as supports interfaces such as ADC, PWM, and I2C. The low power consumption along with simple programability using platforms such as the Arduino IDE makes it appropriate for real-time applications. In an automatic table cleaning system, ESP32 is used as the central controller, which is capable of managing sensors, motors, and alerts with ease and enabling future wireless controls or automation features.

**FIGURE 2:** ESP32**IR Sensor:**

An IR sensor is an electronic device that detects infrared radiation emitted or reflected by objects in its environment. It is also used to detect objects, calculate distance, or follow lines in robot applications. IR sensors detect the return signal from surrounding objects by firing an infrared beam. If there is an object present in range, the sensor picks up the reflectance and triggers a signal to send to the controller. In an auto clean system, IR sensors can detect obstacles or table edges in front of an approaching device to avoid falling down or crashing against objects.

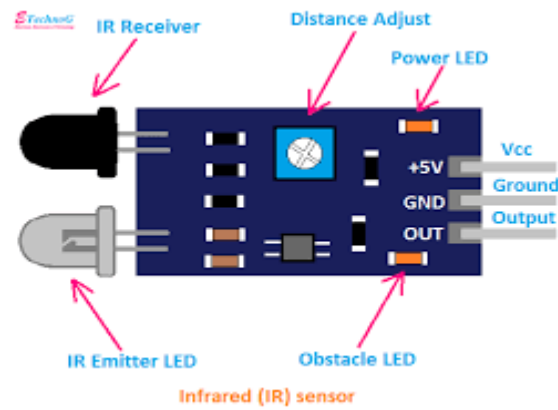


FIGURE 3: IR Sensor

Ultrasonic Sensor:

An ultrasonic sensor is an instrument that measures distance through ultrasonic sound. It emits an ultrasonic sound wave and listens for its echo after it reflects from an object. It then calculates the distance to the object by measuring how long the echo takes to come back. They are widely used in applications including robotic obstacle detection, car parking systems, and liquid levels. Ultrasonic sensors work in different lighting levels and are non-touch sensors. Their performance is nevertheless impaired by soft objects or irregular corners that reflect sound waves.

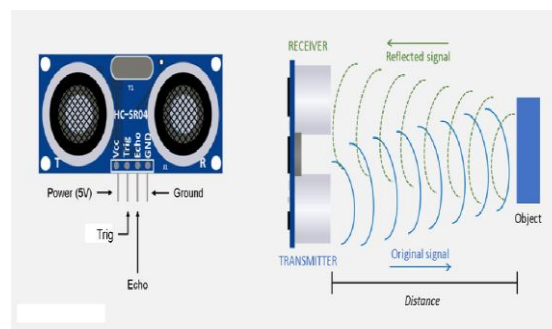


FIGURE 4: Ultrasonic Sensor

Servo Motor:

A servo motor is a motor used to give accurate angular or linear position, speed, and acceleration control. It is composed of a motor, a sensing device (usually a potentiometer) to sense position, and an associated control circuit to position the motor to where you need it to be. The motor is generally commanded by PWM (Pulse Width Modulation) signals to bring it to exact points or make continuous rotation where required. Servo motors are used in all applications where accurate movement is needed, such as in robotics, automation, and remote-controlled applications. They are particularly suitable for uses such as wiping in an automatic table cleaner.

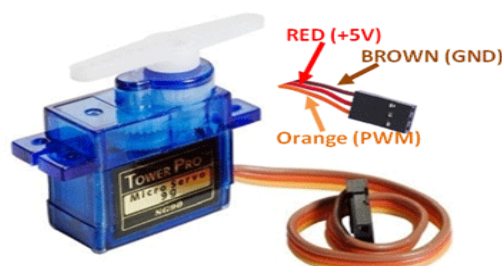
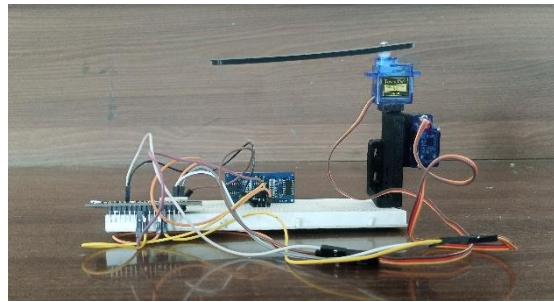


FIGURE 5: Servo Motor

VI.SIMULATION RESULTS

The bar chart displays the efficiency of three methods: hand cleaning, a simple wiper, and the automatically cleaned table with system development in this project.



The highest efficiency is with manual cleaning at 80%, used as the baseline. The simple wiper is at 65% efficiency, with limited coverage. Comparatively, the designed automatic table cleaner is at 100% efficiency, which involves how effectively it cleans with minimal human action. This is important in displaying the system's applicability as an intelligent, hygienic, and efficient one to use for keeping the surface clean.

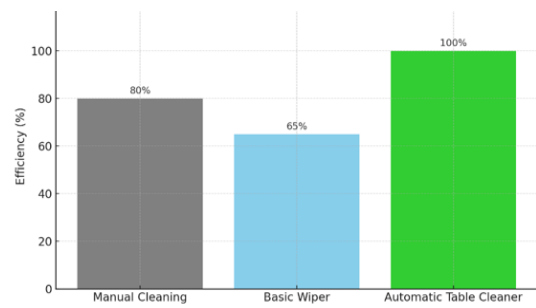


FIGURE 6: Cleaning Efficiency Graph

CONCLUSION AND FUTURE WORK

In conclusion, the auto table cleaning system offers an innovative, efficient solution to maintaining hygiene with minimal human touch. With the addition of an ultrasonic sensor for obstacle detection, wiping mechanism based on a servo motor, and buzzer alarm system, the project is truly addressing the necessity for a compact, price-friendly, and user-friendly device. Not only does it minimize repetitive labour and avoid contact with dirty surfaces, but also supports the expanding trend towards automation and contactless technologies. Future enhancements in coming years may include IoT connectivity for remote monitoring, solar or battery-powered usage for energy savings, path planning with AI for optimized coverage, and features such as smartphone app control or voice commands. Other features such as using sophisticated sensors and washable components can also enhance functionality and hygiene, allowing the system to become even more suitable for residential as well as commercial use.

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