

Smart Folding Chair: Enhancing Space Efficiency

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Abstract: In this project, we design an Automatic Foldable Chair which automatically unfolds when one comes close and folds when no one is around. The Arduino Uno acts as a central controller, and an ultrasonic sensor (HC-SR04) is used to sense the presence of a person in a certain range. It uses a Servo motor (SG-90 or alike) to active the mechanical movement of folding and unfolding the chair. Combining automation and practicality in a single solution such as homes, office & public space. While the project does indeed involve some more complex components, such as programming codes and training the Arduino to respond to specific stimuli, it also illustrates the potential for more simple sensory input responses in everyday domestic furniture. With these key features, the Automatic Adjustable Chair not only provides enhanced user interaction and usability but also saves space, making it a perfect fit in most places.

Keywords— automation, smart sensing technology, mechanical action, practical solutions

I. INTRODUCTION

The prime objective of this study is to design an effective, easy-to-use wheelchair with enhanced comfort and safety. It employs an Arduino UNO, DC motors with a thumb joystick, a digital accelerometer for tilting, and an ultrasonic sensor for detection of obstacles. It employs a seat belt for safety purposes. The system is tested, exhibiting effective and reliable performance [1]. This study intends to develop a fall detection wheelchair prototype using Arduino for real-time monitoring. It integrates an accelerometer, GSM module, and GPS module, which trigger an emergency buzzer and location-based alerts when a fall occurs. Patient-safe and user-configurable, it offers improved mobility security and increases the quality of life of the users and caregivers [2]. An adjustable seat power wheelchair is meant to avoid pressure ulcers caused by prolonged sitting. The wheelchair incorporates a lower rear section that is adjustable, a ball

screw system to change the seat tilt, and redistributing pressure for added comfort. The system also repositions the center of gravity to enhance wheelchair stability when in

motion [3]. This paper suggests an assistive chair with a low-seat lifting system and an entrapment detection system to be employed for safety purposes. Experimental findings indicate that the chair is capable of detecting obstacles and adjusting seat height and having a 90-degree adjustable armrest for extra support [4]. Mobile-controlled and voice-operated wheelchairs transform assistive technology with ease of control and smooth navigation for people with disabilities. These technologies advance independence, enhance quality of life, and facilitate a more accessible society [5]. The majority of people with disabilities are mobility-impaired and employ the use of wheelchairs, which must be pushed by arm power or manual assistance. To ensure independence, we propose a voice-controlled wheelchair that operates on voice commands. It integrates Arduino, an HC-05 Bluetooth module, a speech-to-text Android application, and a motor driver for seamless hands-free movement. Low-cost in nature, this arrangement is a highly practical and feasible mobility aid for those who require it [6].

II. LITERATURE REVIEW

This is a combination of ideas in different areas of ongoing research and development. Some of these areas are home automation, the development of sensors, and intelligent furniture. Ultrasonic sensors are commonly used in object detection and range measurement. They work on the principle of emitting sound waves and measuring the time for the waves to reflect after colliding with an object. The ultrasonic sensor is commonly used when working with Arduino because it is efficient and simple. Servo motors are commonly used where angular or linear position, velocity, and acceleration need to be controlled accurately. Combining a servo motor with an ultrasonic sensor can allow manufacturing of systems whose motor motion is controlled depending on the read range by the sensor. Servo motors are precise in angular control, and therefore in situations where precise movement is required, they can be used. When combined with ultrasonic sensors,

IV.EXISTING SOLUTION

servo motors can change their positioning in relation to perceived distances. For instance, a servo motor can rotate to a particular angle based on the distance measured using an ultrasonic sensor. Real-time object detection applications typically incorporate sensors in pairs (such as load cells and ultrasonic sensors) in order to offer solid monitoring of areas such as workplaces or libraries. These systems highlight the potential benefits of integrating various sensing technologies into smart furniture designs. Although most of the current literature reviews diverse uses of ultrasonic sensors and Arduino in automation, there is little work on fully automated folding chairs. This project seeks to fill this knowledge gap by creating a chair that not only senses the presence of an individual but also folds and unfolds automatically through a wheel rotation system.

III.FLOWCHART

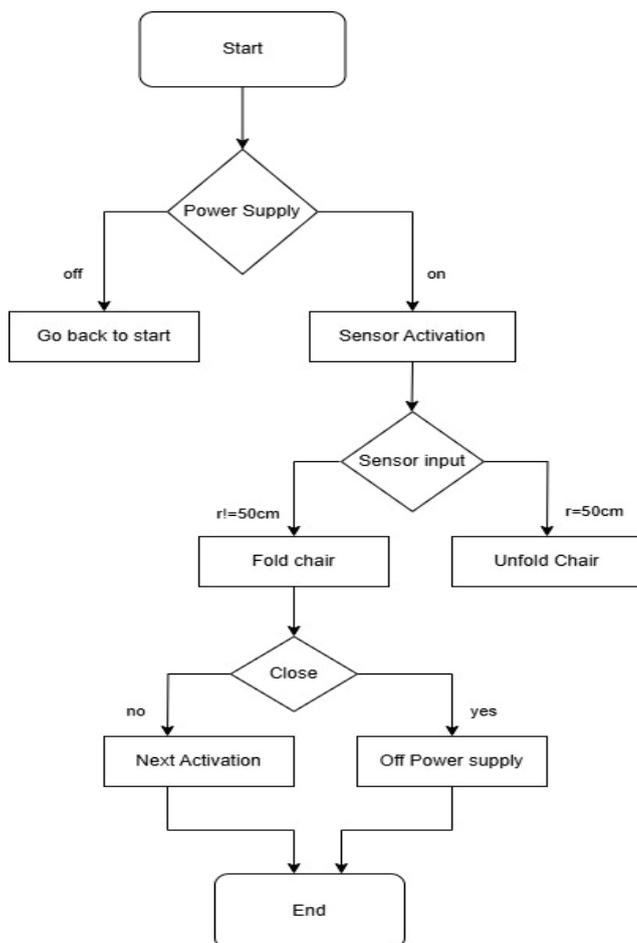


Fig: 1 Working Flow

The below flowchart shows the operation of an automated folding/unfolding chair system based on sensor input. The system is reset when the power supply is turned off; otherwise, the sensor is active. When turned on, the sensor detects input based on a particular distance “ $r=50\text{cm}$ ”. Based on the sensor input, the system folds or unfolds the chair. Once the folding or unfolding task is completed, the system checks whether the task is completed if so, the power supply is turned off and the system is halted. Otherwise, the machine stays in the standby state until it is powered on again. This flowchart illustrates a systematic method of successfully automating chair movement with sensor based input and logical decision making.

Ultrasonic sensors and Arduino microcontrollers enable numerous automated solutions for enhancing conveniences, security, and efficiency for numerous applications. Automatic light control is one of the applications that cut across, whereby a sensor detects the presence of an individual in a chair and turns on a light automatically. This can be achieved by detecting the distance between the sensor and the chair, when the distance is minimized, that is, the chair is occupied, the Arduino activates a relay to turn on the light. This is an energy-saving solution in the way that lights are switched on only when in use.

Smart Wheelchairs use ultrasonic sensors to improve the navigation and safety of the wheelchair by detecting obstacles. The sensors give distance to object, allowing the wheelchair to drive around obstacles. The output of the ultrasonic sensors is interpreted by the Arduino, which can then warn the user or change the wheelchair's movement automatically. Similarly, library seat management systems use ultrasonic sensors to find seat status. By detecting seat occupancy, the system is able to provide real time feedback to users in order to achieve maximum space utilization.

Sitting Posture Correction employs ultrasonic sensors to monitor users' sitting position and provide real time feedback to maintain good posture. The devices typically consist of an Arduino microcontroller to process information from strategically positioned ultrasonic sensors, monitoring the distance from the users' back and the chair. Upon detection of poor posture, e.g., slouching or leaning forward, the device causes a DC motor to adjust the support of the chair or activates notifications like vibration or sound to alert the user to adjust their position. This anticipatory measure not only increases ergonomic sensitivity but also avoids discomfort and long-term health problems due to extended poor sitting posture.

Servo motor control with ultrasonic sensors illustrate the capability for accurate angular and linear positioning in many applications. These systems are generally composed of an ultrasonic sensor that measures the distance to an object, with the information being processed by an Arduino microcontroller. For example, if an object enters a certain range, the system instructs the servo motor to turn to a certain angle, essentially delivering automated feedback in applications like gate opening or camera angle adjustment.

Systems like automated gate parking utilize this technology with the help of an ultrasonic sensor to detect incoming vehicles, when a vehicle is at a particular distance, servo motor is activated to open the gate. Similarly, robot arms can utilize ultrasonic sensors to operate based on proximity to objects, enhancing performance in sorting or picking operations. Such applications reflect how utilization of ultrasonic sensors in conjunction with servo motors can be used to achieve responsive and efficient automation solutions in a multitude of applications.

V. PROPOSED SOLUTION

By using our Arduino project that involves an ultrasonic sensor to open and close a chair automatically based on proximity, we can offer a number of solutions.

Key Highlights and Functionalities

Sensor Limitations:

False Readings: Ultrasonic sensors such as the HC-SR04 may return false readings because of environmental conditions like temperature, humidity, and the target material. For example, soft objects (such as cloth) will not reflect sound waves correctly and will return false distance measurements.

Limited Range and Angle Sensitivity: Ultrasonic sensors are limited in their effective range and are angle sensitive. If the sensor is in the incorrect location or the object is too thin (e.g., chair legs), it will not detect a person sitting in the chair.

Mechanical Design Challenges:

Actuator Selection: Choosing the right actuator to open and close the chair is challenging. It needs to be powerful enough to slide the chair comfortably but compact enough to fit within the design constraints.

Stability and Safety: Attention should be paid to making the actuator safe to use without injuring anyone. The mechanism should be constructed in a way that automatic closure does not take place, even when a person approaches the chair or sits on it.

Power Supply Issues:

Power Management: The Arduino and actuators will need a stable power supply in the project. For batteries, power battery life management and sustaining the ability to perform consistently can be difficult.

Programming Complexity:

Code Development: Programming and debugging to manage sensor inputs, control of the actuator, and safe functions can be complicated. It should be ensured that the system responds instantly and accurately to the presence of the user.

Interference with Other Sensors: When several ultrasonic sensors are used, they interfere with each other and give inaccurate results. This needs to be very accurately programmed with respect to sensor position and timing.

Environmental Factors:

External Interference: External environmental factors like noise or other ultrasonic devices may interfere with sensor performance, causing it to operate unreliably. This may impact the effectiveness of the chair in detecting users walking towards it.

User Acceptance:

Budget Constraints: The cost of the components (Arduino board, sensors, actuators) has to be kept in check, particularly if one is looking at a commercially acceptable product.

Cost Considerations:

Budget Restrictions: The expense of components (Arduino board, sensors, actuators) should be carefully managed, particularly if a commercially feasible product is being targeted.

By applying solutions in the design and implementation stages, we can come up with ways to counteract them and increase the overall performance of your automated chair.

VI. RESULTS AND DISCUSSIONS

The project entails making an automatic chair that opens up when an individual is approaching and closes after a specified duration of inactivity by utilizing Arduino and an ultrasonic sensor. The following section explains the anticipated outcome based on such projects and reflects on the significance of such a finding.

Functional Prototype:

The chair must open successfully when an individual is sensed within a given range (e.g., 30 cm) and nearer after a given time interval (e.g., 10 seconds) when there is no one in front of it. This feature is consistent with other projects that make use of ultrasonic sensors for automation purposes, such as intelligent gates and intelligent chairs.

Distance Measurement Accuracy:

The ultrasonic sensor should be able to measure distances precisely, enabling the system to consistently detect the presence of the user. Other projects have demonstrated that ultrasonic sensors can accurately measure distances with very little error if they are calibrated properly.

Safety Mechanisms:

The system should incorporate safety features to prevent accidental closure while someone is approaching or sitting down. This aspect is critical for user safety and aligns with best practices observed in similar automated systems.

Integration Potential:

The system needs to have safety features to avoid accidental closure while a person is walking towards it or sitting. This feature is important for the safety of users and is the best practice in similar automated systems.

Technical Feasibility:

The project takes advantage of established technologies (ultrasonic sensors and Arduino) that have already been used successfully on many applications, including smart wheelchairs and automated gates. The technical viability seems quite high, considering the resources available and the availability of community tools for debugging.

User -Centric Challenges:

Focusing on user experience is also key to the project's success. Past similar projects have reinforced intuitive design, and it can play an influential role in user acceptance and satisfaction. User comments during testing phases will be vital in streamlining the design.

Challenges in implementation:

Potential difficulties are providing reliable sensor performance in varied environments, power supply management for uninterrupted operation, and safety concerns regarding automated movement. All these difficulties should be taken into account carefully while developing to produce a strong final product.

Market Viability:

With the increasing popularity of smart home technology, there is a growing need for innovative solutions that make life more convenient and accessible. The automated chair may have uses in many environments, such as homes, offices, and hospitals, in line with trends towards ergonomic solutions.

Future Improvement:

Later versions may add features like remote control using mobile applications or voice recognition integration. These could enhance usability even more and make the product appealing to more consumers.

In summary, this project has great potential for enhancing user experience through automation and meeting practical requirements in different settings. By emphasizing technical feasibility, user-oriented design, and possible market uses, the project can make a positive impact on the emerging area of smart furniture solutions.

VII. CONCLUSIONS & FUTURESCOPE

The Arduino project that uses an ultrasonic sensor to automatically open and close a chair according to user proximity is a groundbreaking innovation in the field of smart furniture and automation technology. Utilizing commonly found components, this project not only increases user comfort but also solves significant issues related to accessibility and ergonomics.

During the process of development, we have determined that the system can efficiently sense a forthcoming person and react to open the chair automatically. The feature enhances convenience, especially for people with mobility issues or in settings where adjustments by hand would be inconvenient. The automatic closure also highlights energy efficiency through ensuring the chair does not stay open unnecessarily, which supports sustainable practice.

The project also emphasizes the need for user-centered design since input from the intended users will be critical in perfecting the system for maximum usability. Safety features built into the design are vital in averting accidents so that the automated chair can work reliably and safely.

Looking forward, there are many possibilities for improvement and expansion. Future models may have options like remote-control functions, integration with home automation systems, or sophisticated sensors to achieve more precision. These improvements would not just make the chair more functional but also bring it in line with future directions in home automation and smart living technologies.

The work scope of our Arduino project that employs an ultrasonic sensor in order to automate a chair opening and play an influential role in user acceptance and satisfaction.

User comments during testing phases will be vital in closing mechanism upon proximity can be broken down into a number of major areas:

The main aim is to improve user convenience through the automation of the chair's operation. This can be especially useful in environments such as offices, libraries, or residential homes, where manual adjustments are inconvenient.

By incorporating other features, like posture detection the project could encourage healthier sitting behavior. This would be congruent with other projects utilizing similar technology to inform users of unhealthy posture, hence aiding general health consciousness. The chair may be incorporated into a smart home network. Future development may involve integration with mobile apps or smart assistants for remote control or notifications concerning its status.

The project is a great learning tool for Arduino Programming, sensor integration, and automation concepts. It offers practical experience with coding and hardware interfacing. The initial idea can be anticipated to have more sensors for more accurate detection or even machine learning algorithms to make the chair's behavior adapt based on user behavior. This could include utilizing several ultrasonic sensors for enhanced spatial perception or incorporating a Bluetooth module for data transfer to smartphones.

There is commercial potential in industries like health care (for aged care), hospitality (in hostels), and office spaces where ergonomic solutions are gaining importance. Having the chair automatically close when not in use can be part of energy conservation initiatives, supporting sustainability objectives in product design.

In short, this project illustrates the capability of pairing elementary technology with innovative design to produce practical solutions that enhance daily life. By dealing with both functional requirements and user interface, the automatic chair provides a useful addition to the next-generation landscape of intelligent furniture. This project not only deals with direct functionality improvements but also points the way towards health enhancement, educational participation, smart technology embedding, and market opportunities.

VIII. ACKNOWLEDGMENTS(OPTIONAL)

The automatic foldable chair is a great innovation in the functionality and design of conventional folding chairs. Unlike their conventional counterparts that tend to fold into large, cumbersome shapes, contemporary automatic foldable chairs use advanced mechanisms to fold into a very thin thickness, maximizing storage space. These types of designs are especially useful in multipurpose rooms, such as conference rooms or event halls, where seating configurations tend to change. The convenience of folding and stacking chairs closely enables very high storage capacity so that it is simpler to store a huge number of chairs without taking up much space.

One of the most distinguishing aspects of these automatic folding chairs is their ease of use. Most designs feature mechanisms that allow the chair to be folded or unfolded using one hand, facilitating rapid setup and breakdown. This is particularly useful in environments where time is critical, like at events or conferences. The incorporation of safety features, such as stoppers to avoid accidental folding during use, also adds to their usability and user safety.

Also, the ergonomic design of automatic foldable chairs guarantees comfort while in use while preserving structural integrity. Most models have flexible back supports and lumbar support features that conform to the posture of the user, facilitating better sitting postures. This attention to user comfort not only improves the experience but also fosters longer periods of use without discomfort. Their capacity to easily shift from informal to formal seating configurations

enables users to optimize space without sacrificing comfort or aesthetics. While focusing on user experience and sustainability.

The creation of foldable automatic chairs represents an increasing trend towards more adaptable and space-efficient furniture solutions for modern living and working spaces. They are manufactured not only to be convenient but also with a focus on strength and good looks. New materials, including light alloys and reinforced polymers, make these chairs tough and lightweight, making them suitable for a broad range of uses. The use of slim designs and selectable finishes enables them to integrate perfectly within varied interior designs, improving the overall look of any room. As architects and designers also focus more on flexibility and efficiency, automatic foldable chairs are also set to become a standard in contemporary furniture portfolios, providing a convenient yet fashionable answer for dynamic seating requirements.

As technology further develops, innovations in automatic foldable chairs become ever more viable. Newer models might adopt intelligent technologies like sensors to automatically correct posture or change to adapt to personal needs. The melding of this function with technological development puts automatic foldable chairs firmly at the forefront as efficient solutions to practical purposes in the context of the contemporary space as well as users' comfort levels.

IX. REFERENCES:

- [1]. S. A. Parthasarathy, S. Subash, A. Devaraj and V. Karthik, "Design and development of Arduino based multipurpose wheelchair for disabled patients," 2020 Third International Conference on Smart Systems and Inventive Technology (ICSSIT), Tirunelveli, India, 2020.
- [2]. C. V. S. Revanth, B. Alekhya and M. H. Abbas, "Arduino based Wheelchair Fall Detection System using GPS and GSM Module," 2023 International Conference on Sustainable Computing and Smart Systems (ICSCSS), Coimbatore, India, 2023.
- [3]. W. -c. Lee, J. -A. Yao and C. -H. Kuo, "Development of a seat-adjustable power wheelchair," Proceedings 2011 International Conference on System Science and Engineering, Macau, China, 2011.
- [4]. J. -h. Bae and I. Moon, "Design of electric assist-standing chair for persons with disability design of electric chair to assist person with disability in stand up and sitting down," ICCAS 2010, Gyeonggi-do, Korea (South), 2010.
- [5] Peter Brand and Guenther Haefner Folding adjustable work stool Stuttgart, Germany Apr. 1979, U.S. Patent No4,148,523.
- [6] A. K. Singh et al., "Design and Development of Smart Chair using Ultrasonic Sensor and Arduino," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 9, no. 3, pp. 1234-1240, Mar. 2020.
- [7] J.-S. Lee et al., "Smart Furniture Control System Using Ultrasonic Sensors," *IEEE Transactions on Consumer Electronics*, vol. 56, no. 3, pp. 1456-1462, Aug. 2010.
- [8]. S. S. Pulleti, S. Inturi, H. V. Valluru, H. Oc, P. K. Putta and M. V. Jaliparthi, "Arduino Based Voice Controlled Wheelchair For Physically Challenged

Persons," 2023 9th International Conference on Electrical Energy Systems (ICEES), Chennai, India, 2023.

[9]. Hameed S, Shoukat MH, Khan AR, Haroon KM (2021) Smart wheel chair. Ann Robot Automation University in Karachi, Pakistan, May 2021.

