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Microcontroller-Based Automated Cloth Folding Machine for Domestic and Industrial Textile Applications

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Manual cloth folding is a repetitive and time-consuming process that limits productivity and efficiency in both domestic and industrial contexts. This work presents the design and implementation of a microcontroller-based automatic T-shirt folding machine aimed at achieving a fully autonomous operation without manual intervention. The proposed system employs lightweight acrylic boards for structural strength and portability. It integrates sensors to ensure precise garment detection and controlled folding operations. Experimental evaluation demonstrates a folding time of 9.2 seconds per shirt, ensuring operational efficiency and precision. The system effectively addresses the limitations of previous designs, particularly in terms of automation, sensing capability, and user safety, and provides a scalable foundation for future advancements in automated garment handling.

Keywords: Cloth Folding; Lithiumion; Textile; Servo and Arduino

Introduction:

In an era driven by technological progress, electronic devices play a vital role in everyday life. At the same time, Pakistan's textile industry continues to serve as a cornerstone of the nation's economic development. Pakistan's manufacturing sector is largely driven by the textile industry, which provides employment to approximately 25 million people [1][2]. According to data from the Board of Investment of Pakistan, the country ranks as the eighth-largest textile exporter in Asia. The textile sector accounts for about 46% of Pakistan's total manufacturing and employs nearly 40% of its workforce [3]. Even though advanced technologies and digitalization have been introduced globally, the bulk of operations in the textile industry are still carried out manually in Pakistan.

This limitation primarily stems from the financial and technical constraints faced by local factories. Most textile industries in Pakistan still rely on manual cloth folding, a process that typically takes around 20–25 seconds per fold due to the lack of automation. The textile industries usually pay hundreds of workers to do this repetitive task. Furthermore, the manual process of folding can cause errors in folding and is time-consuming [4][5]. As a result of the lack of automation, the whole textile sector supply chain is adversely affected by inefficiencies.

Moreover, today's fast-paced lifestyle has made household chores increasingly time-consuming and tedious [6]. Among these tasks, folding laundry is often considered the most challenging. Students, office workers, and homemakers alike frequently struggle to find the time or energy to complete this chore [6][7][8]. Automation can act as an effective solution in this case, reducing time and physical effort. The use of automation has become essential because it can improve productivity in current textile and apparel organizations, as well as in a household setup. A cloth-folding machine can serve as an important advancement towards automating tasks in textile industries or at home. The automatic cloth-folding process will save both cost and time. It will be a source of comfort in a household setup.

Objective:

To overcome the cons of the previously proposed versions of cloth folding machines, this research presents a detailed design, implementation, and testing of a fully automatic machine that can perform cloth folding automatically. It uses lightweight acrylic boards, which provide precise folds due to their rigidity. The machine's status in different states is visible to the user through the LED (Light Emitting Diode) indicator. The machine utilizes servo motors for flipping the boards as they offer accurate position, speed, and torque control. The proposed machine can be used in conjunction with other automatic fabric machines in textile industries for improving work efficiency. Moreover, it can also be used in different applications, including homes, hospitals, hotels, etc., as it is lightweight, portable, cost-effective, and user-friendly.

Novelty:

Unlike previous designs, where the material used for cloth folding is either heavy or the status of the machine is not demonstrated, or the testing of individual blocks is not presented, this research uses lightweight acrylic boards for the cloth folding process. The machine is fully automatic in initiating the sensing and folding process. The status of the machine is indicated with the help of an LED indicator. Moreover, detailed testing of individual blocks used in the system has been presented, making the work more robust and easier to understand. In addition, user safety is another novel feature of the proposed design.

Literature Review:

Several cloth-folding machines are documented in the literature. A comprehensive survey of various designs is presented in [8][9]. In February 2015, N. Gomesh et al. proposed and developed a cloth-folding machine equipped with four DC motors and an AT89C51 microcontroller. The overall machine is powered by a photovoltaic system, and a push button is used to initiate the folding process. The operation depends on sunlight, as the system derives its power from solar energy [10]. Consequently, the performance may be affected in low-light or rainy conditions unless supported by battery backup. A similar study by Mukesh P. Mahajan et al. in March 2017 utilizes a push-button mechanism to initiate the folding process. The design employs an AT89S52 microcontroller along with DC motors to control the movement of the folding boards [8]. Prajwal A. Wankhede et al. proposed the design of an automatic motor-controlled T-shirt folding machine in July 2022. Their model serves as a valuable solution for industries such as laundry services, hospitals, and apparel manufacturing. The design also employs DC motors to facilitate the movement of the folding boards [11]. Although a DC motor is simple and cost-effective, it lacks precision, feedback, and efficiency. Its speed tends to drop or fluctuate under varying load conditions. Additionally, DC motors cannot precisely control position or angle on their own. Praful Randive et al. also utilize DC motors in the design of their cloth-folding machine [9]. However, their paper provides only limited technical details regarding the system's design and operation. Another work by Nogar Silitonga et al. presents the design of cloth folders made of plywood. The disadvantage is that plywood, even at 3 mm thickness, can be relatively heavy and bulky compared to lighter materials (like acrylic or plastic), making the model less portable and harder to handle [12]. Md. Shahnauze Ahsan et al. report the design of an Android app-based, Bluetooth-controlled, low-cost cloth-folding machine in [13]. Their design utilizes PVC wood sheets for the folding boards, which are cost-effective; however, these materials are prone to scratching and fading over time, reducing their long-term durability and value. Another work by Yuda I. et al utilizes wooden frames and boards for folding, which also seems to be an impractical solution due to weight and portability issues. They indicate the folding time to be 2 seconds per shirt, which seems to be an unrealistic value [14]. This design does not incorporate any indicator to indicate the state of the machine. The FoldiMate is another example of an advanced yet costly and complex cloth-folding machine. Its size, being larger than a typical washing machine, poses challenges in terms of portability and space efficiency [15].

Table1. Summary of limitations in previous designs

Author	Year	Material Used	Control System	Limitation
N. Gomesh et al [10]	2015	Polystyrene	AT89C51 microcontroller + DC motors	Push button start Needs solar energy Low precision DC motors Material prone to cracking Lacks state indication
M. P. Mahajan et al [8]	2017	Polystyrene	AT89S52 microcontroller +DC gear motors	Push button start Low precision DC motors Material prone to cracking Lacks state indication
N. Silitonga et al. [12]	2019	Plywood	ARDUINO ATMega328 + servo motors	Push button start Heavy Non-portable Lacks state indication (buzzer only on completion)
B. Vinitha [7]	2020	Plywood	ATMEGA8 microcontroller + servo motors	Push button start Heavy Non-portable AN RGB LED is used, but details are unavailable
Md. Shahnauze et al. [13]	2020	PVC wood sheets	Arduino Uno + servo motors	Starts through app control Heavy

				Non-portable Lacks state indication
Y. Irawan et al [14]	2021	Wooden boards	Arduino Uno + servo motors	No start-up information given Heavy Non-portable Lacks state indication
P. Randive et al [9]	2022	NA	Arduino + DC motors	Push button start Low precision DC motors Lacks state indication Theory work only

A summary of the literature review of existing cloth folding systems is presented in Table 1. The table outlines the material used, the control mechanism adopted, and the key limitations observed in previous designs. It can be observed that almost all previous designs required manual intervention to start the folding process and lacked safety control. While some of the designs utilized servo motors, they employed heavier materials, which reduced portability and relied on DC motors that offered limited precision. Thus, none of the designs had all the features in one unit. The proposed system addresses all the shortcomings of previous versions and combines all features in one unit. It employs dual sensors for automatic sensing and safety control. It uses strong, lightweight acrylic boards to enhance portability and high-torque metal gear servo motors to achieve precise folding. This combination ensures improved reliability, safety, and operational accuracy compared to earlier models.

Methodology:

System Design:

The proposed cloth folding machine was initially modelled in the ROS (Robot Operating System) simulation environment, as shown in Fig. 1, followed by the fabrication of the corresponding hardware. ROS, an open-source framework, provides libraries and tools to develop robotics systems [16].

The machine consists of five acrylic boards selected for their durability and smooth surface. All acrylic boards are mounted on a main baseboard measuring 39 x 30 inches. Board 1 measures 9 x 28 inches; boards 02 and 03 measure 28.5 x 8 inches; and boards 04 and 05 measure 12.5 x 12 inches.

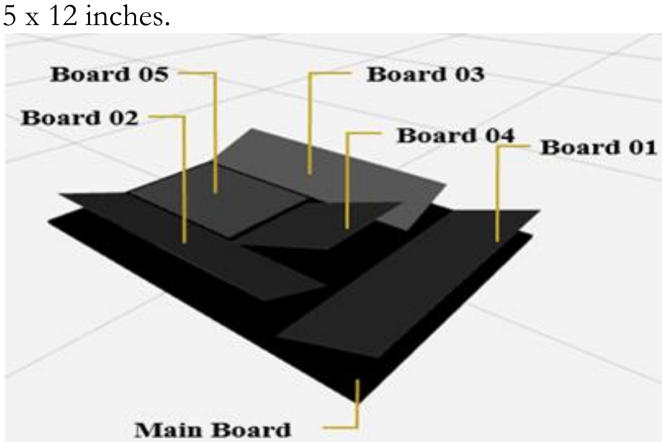


Figure 1. Physical Design of the Cloth Folding System

The system architecture, presented in Fig. 2, comprises five major units: power supply, mechanical assembly, control, user interface, and sensing. The power supply provides regulated voltages for all subsystems. The mechanical and the user interface units establish bi-directional communication with the control unit, whereas the sensing unit provides unidirectional data input to the controller.

The power subsystem includes four 3.7 V rechargeable Li-ion cells (ICR18650), connected in series to deliver 14.8 V, which is regulated through LM317 circuits to 7.5 V for the mechanical unit and 5 V for the control and sensing modules. A protection circuit board (HX-4S-A01) safeguards against overcharging and deep discharge.

The mechanical unit employs four TD-8120MG metal gear digital servo motors (torque 21.8 kg-cm @ 6.0V, torque 18.5 kg-cm @ 4.8V) to actuate the folding boards. These motors provide precise positional feedback, eliminating the need for additional encoder circuitry [17]. The servo-based actuation ensures synchronized and repeatable folding motion compared to the conventional DC gear mechanisms.

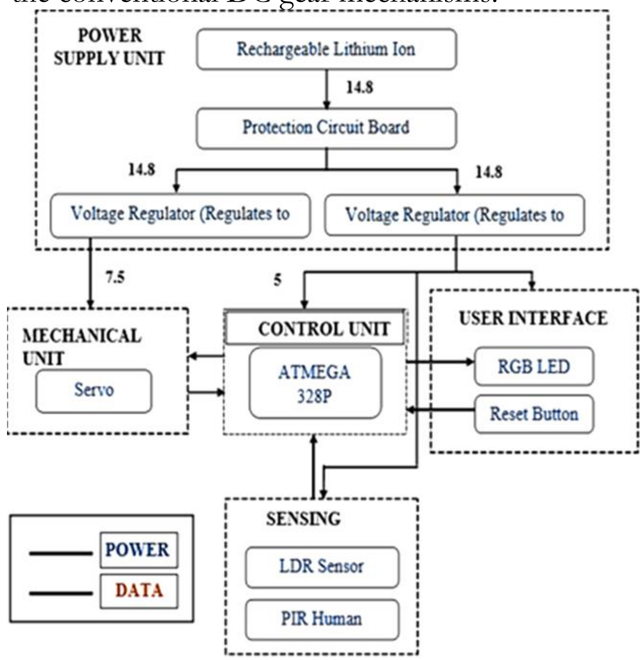


Figure 2. Block Diagram of the Cloth-Folding System

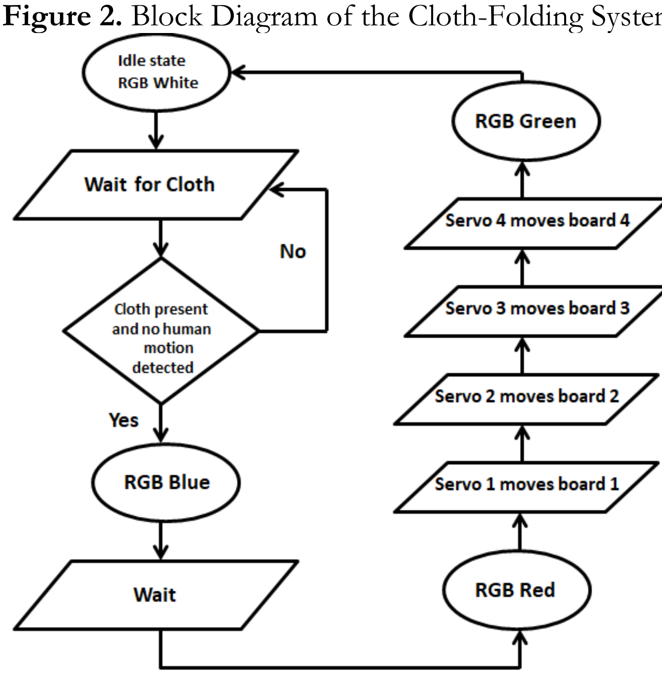


Figure 3. Workflow of the Automated Cloth-Folding System

The sensing module integrates an LDR (Light Dependent Resistor) sensor for cloth detection and an HC-SR501 PIR (Passive Infra-Red) sensor for human presence detection. The system initiates the folding process only when fabric is detected and no human hand is in proximity. The control unit, based on the ATmega328P microcontroller (ARDUINO UNO), processes sensor data and governs servo motion.

The user interface unit features an RGB (Red Green Blue) LED for operational status indication, a reset button for error handling, and a battery monitoring module (BMS 4S 1A) that displays the state of charge across four levels. The coding developed in the Arduino programming environment (C++ based) coordinates sensing, actuation, and safety control functions.

The interconnections among all modules are designed to ensure proper signal flow between the control and sensing units. The LDR module is interfaced through digital input pin 12 of the Arduino to detect the presence or absence of cloth. The PIR sensor's digital output is similarly connected to digital input pin 7 of the Arduino. As the Arduino UNO provides six PWM-capable digital pins, and four of them are to be utilized by servo motors, the remaining two pins are assigned to the RGB LED. The RGB LED's green and blue terminals are connected to two available digital PWM pins, 3 and 5, respectively, while the red terminal is connected to digital pin 4. These connections are enough to generate the required colors red, green, blue, and white in our system. The servo motors' signal wires are connected to digital PWM output pins 6, 9, 10, and 11 for precise control. All components share a common ground, and regulated 5 V and 7.5 V supplies are distributed through LM317 outputs. This configuration enables coordinated operation across all subsystems.

The detailed operational logic of the system, including the sequence of sensing, control, and actuation events, is explained in the workflow section below.

Workflow:

The workflow of the proposed cloth-folding machine is illustrated in Fig. 3. When the switch is turned ON, the machine enters an idle state. At this stage, the Arduino UNO sends a signal to the RGB LED to emit white light, indicating that the machine is ready and waiting for a cloth to be placed. Once the cloth is detected by the KY-018 LDR sensor, it sends a signal to Arduino that the cloth has been detected, causing the RGB LED to turn blue. Simultaneously, the PIR sensor looks for any human movement on the boards. If the PIR sensor detects the presence of a user, the machine remains inactive. If no human movement is detected within the defined range, the machine automatically initiates the cloth-folding process. At this point, the RGB LED switches to red, signaling that the machine is in operation and the folding process is underway.

The Arduino then controls the servo motors to operate in the predefined sequence while simultaneously receiving feedback. Once the folding process is completed, the RGB LED changes to green, indicating successful operation. The entire sequence of actions is repeated in a continuous loop, ensuring the repetitive functioning of the cloth-folding machine.

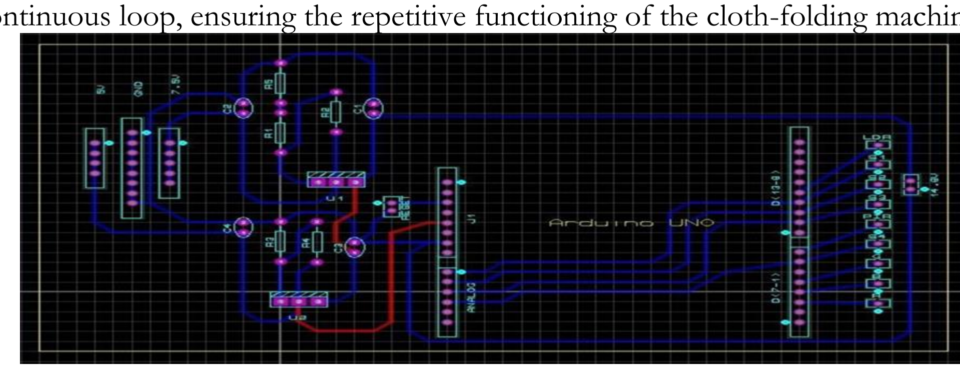


Figure 4. PCB Layout

PCB Implementation:

The complete circuit of the cloth folding machine was implemented on a self-designed PCB (Printed Circuit Board). Proteus Professional 8 version 8.13 was used to design the circuit schematic and PCB layout. The PCB was a single-layer, meaning it was a single-sided board with one side consisting of a conducting layer and the other side used for the integration of electronic components. Connector footprints were utilized for the RGB LEDS, servo motors, LDRs, PIR sensor, reset buttons, and the Arduino UNO board. Single-row vertical pin connector footprints were employed for the GND (ground), 7.5V, and 5V connections. This configuration was selected to ensure a clean and comprehensible layout of the PCB. As shown in Fig. 4 of the PCB layout, the bottom copper layer was primarily used for routing. Furthermore, two wires were incorporated on the bottom layer specifically to address the Design Rule Check (DRC) constraints. Figure. 5 illustrates the practical implementation of the PCB with soldered components.

Results and Discussion:

Testing:

Before integration, all units of the proposed machine were tested individually to ensure proper functioning.

Testing of Protection Circuit:

To verify the functionality of the protection circuit, it was connected to the DC power supply, and the output was examined using an oscilloscope. By gradually adjusting the input voltage from 0V to 18V in increments of 0.3V, the corresponding changes were observed, as illustrated in Fig. 6. The protection circuit was designed to shut off the output voltage when the input voltage went beyond 16V to protect the components from overvoltage damage. The overcharge voltage ranged from 4.25V to 4.35V, while the over-discharge voltage varied between 2.3V and 3.0V.

These results validate the circuit protective response against voltage fluctuations, confirming its effectiveness in preventing component damage and ensuring system reliability during power variations.

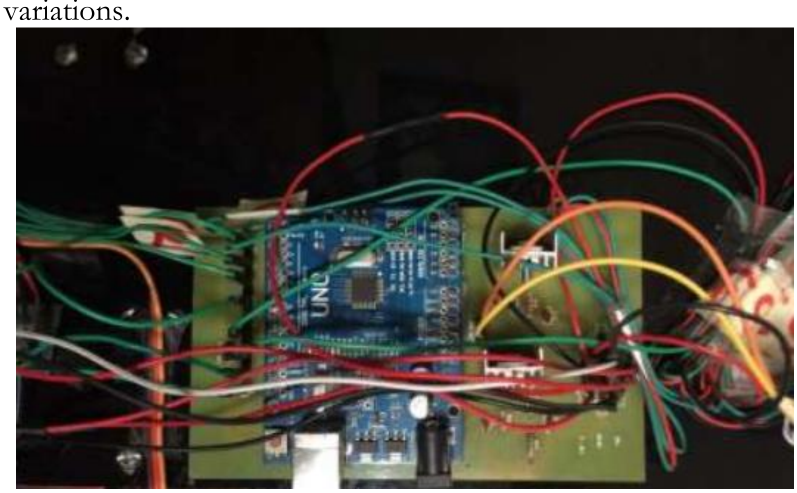


Figure 5. Fabricated PCB with soldered components

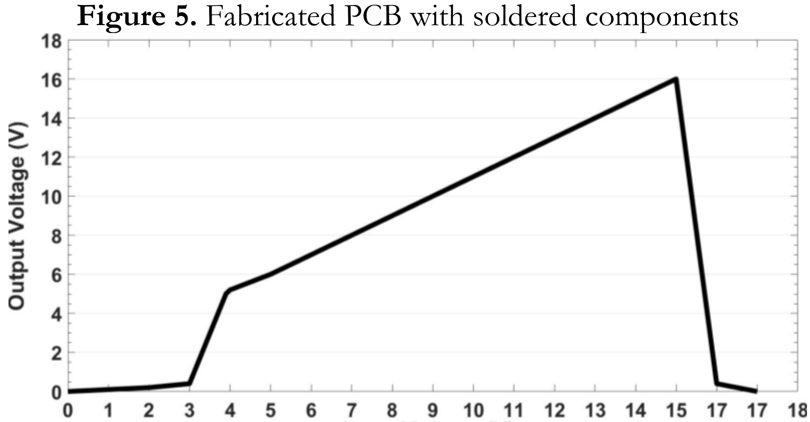


Figure 6. Protection Circuit Board Input Vs Output Voltage

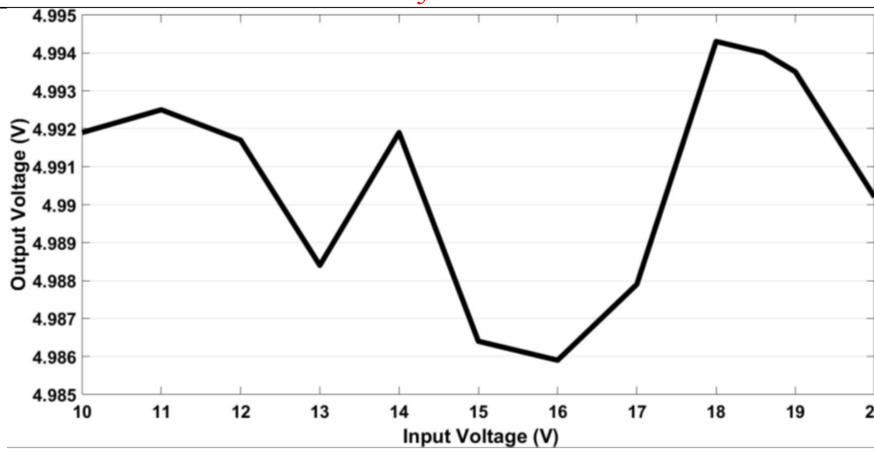


Figure 7. Output Voltage vs Input Voltage for 5V Voltage Regulator

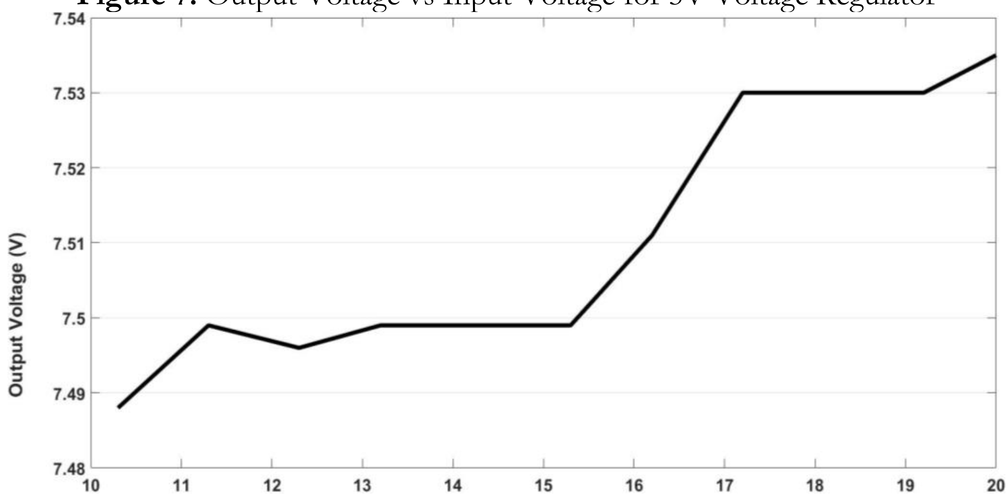


Figure 8. Output Voltage vs Input Voltage for 7.5V Voltage Regulator

Testing of Voltage Regulators:

As previously discussed, the two voltage regulators converted the 14.8V input supplied by the lithium-ion batteries into distinct output voltages of 5V and 7.5V, respectively. To evaluate their performance, tests were conducted in which the DC power supply was connected at the input of each regulator and systematically varied. By keeping the input voltage within the range of 10V to 20V, the outputs observed were well-regulated. The results presented in Fig. 7 and Fig. 8 clearly demonstrated that the output voltages from the regulators remained approximately at the desired levels of 5V and 7.5V. This confirmed the proper functioning of the voltage regulation system.

The steady voltage levels under variable input conditions confirm the regulator's efficiency and stability, ensuring consistent operation of all connected electronic components.

Testing of LDR Sensor:

Since the LDR was employed to detect the presence of cloth, its individual operation was tested by covering it with a cloth and keeping the input voltage constant. It was expected that this action would cause the output voltage to drop below 3.0V, showing an increase in resistance and indicating the presence of cloth. Specifically, the photo sensor was first tested uncovered and then covered with black, grey, and white cloth. The input voltage (VIN) was maintained at a constant value of 5V. The obtained quantitative results are presented in Table 2.

The observed voltage drop upon cloth coverage verifies the sensor's accuracy and sensitivity, confirming its suitability for reliable cloth detection under varying fabric shades.

Table 2. Test results of the LDR Sensor

Type of cloth	Voltage (V)	Current (A)
Uncovered	4	0.64
Covered with black	0.7	0.08
Covered with grey	2.4	0.4
Covered with white	2.83	0.482

Testing of the PIR Sensor:

The proposed machine was equipped with a PIR sensor that was capable of detecting human motion. Its functionality was tested during a full test of the machine. The PIR sensor was powered by the Arduino Uno, and its output pin was connected to pin D7. The machine logic high state indicated the detection of a human motion, while the logic low state produced a signal indicating the absence of a human. The data obtained are compiled and presented in Table 3.

The clear distinction between high and low logic states demonstrates precise motion sensing, ensuring safe and automated system activation, only in the presence of a user.

Table 3. Test results of the PIR Sensor

Output Status	Current (μA)
Output high	138
Output low	38

Testing of the RGB LED:

The RGB LED was tested by measuring the current flowing through each of its legs. This was done by placing an ammeter in series with the RGB LED. Upon testing, the current values of different colors were recorded, and the results are summarized in Table 4. The measured current values verify that each LED channel responds correctly, confirming proper indication functionality for different machine states (idle, active, or complete).

Table4. Test results of the RGB LED

Color	Current (mA)
Red	12.05
White	29.13
Blue	9.54
Green	8.53

Testing of the Reset Button:

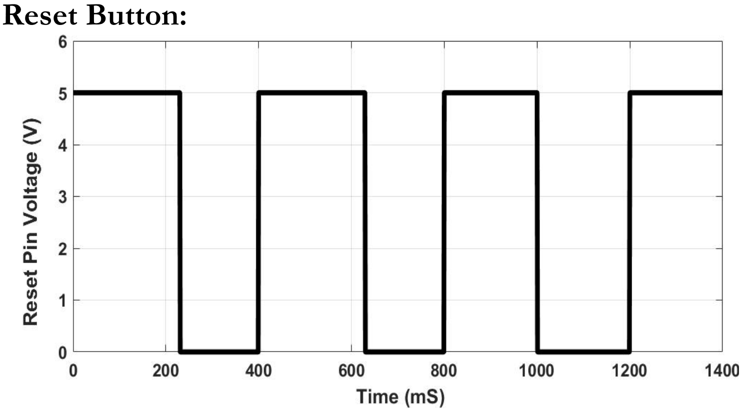


Figure 9. Test results of the reset button indicating reset pin output voltage

An oscilloscope was used to test the working of the reset button. The reset button was connected to a 5 V supply, with the other pin connected to ground. The probe of the oscilloscope was connected to the reset pin of the reset button. Fig. 9 shows the voltages (with respect to system ground) across the reset button when it was pressed and released multiple times. The results shown in Fig. 9 clearly demonstrate that pressing the component reduced the voltage to zero, thereby resetting the intended connection.

The consistent voltage transition from 5V to 0V confirms reliable hardware reset functionality, ensuring system stability and quick recovery during faults or malfunctions.

Testing of battery level indicator:

To assess the operation of the Battery State Indicator, various voltages were applied across its terminals using a voltage supply, and subsequently, the battery level was observed. Table 5 shows the battery levels at different voltages.

The accurate indication of different battery states confirms the circuit's ability to provide real-time feedback on power availability, which is critical for autonomous machine operation.

Table5. Test results of Battery Sensor

Battery level	Voltage (V)
100%	16.8
75%	16.5-15.8
50%	15.2-14.8
25%	14.6-13.7
Below 25%	13.9

Testing of the Servo Motors:

The efficiency of servo motors was tested in terms of their ability to reach the assigned angle. The testing method employed was straightforward and utilized a basic geometric tool—a protractor. To measure the servo angles, the center of the protractor was aligned with the servo's pivot point, and the angles were read directly from the protractor where the servo arm intersected the scale. This test was repeated for all servo motors. The results are compiled and organized as shown in Table 6.

The close correspondence between assigned and measured angles confirms accurate servo response and repeatability, ensuring reliable and synchronized cloth-folding movements.

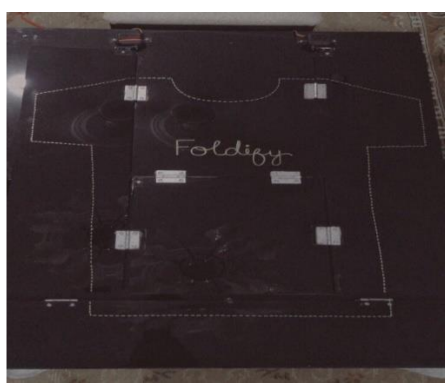


Figure 10. Complete cloth-folding machine setup

Table6. Test results of Servo Motors

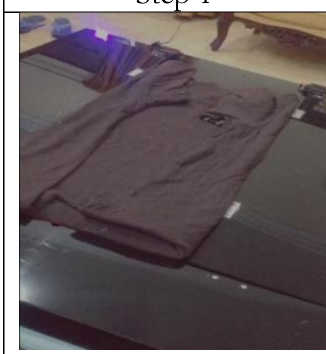
Servo Motor Number	Assigned Value	Achieved value
1	160°	155°
2	160°	153°
3	30°	33°
4	160°	157°

Testing of the Complete System:

The complete setup of the system is shown in Fig. 10. After testing the individual components, the proposed machine was tested with a T-shirt to assess its complete operation. It was powered on and brought to the idle state. During this time, the RGB LED remained white in color. The T-shirt was then loaded onto the machine, which caused the RGB LED to turn blue. Once the human hand was removed from the vicinity, the machine waited for two seconds and started the folding process, during which the RGB LED remained red. First board 1 folded the lowest bottom of the cloth, and then board 2 folded the left side. Board 3 folded the right side of the cloth, and finally, board 4 folded the cloth in half, completing the folding process. The successful folding of the T-shirt was completed in almost eight seconds. The completion of the process was indicated by the RGB LED turning green. The machine returned to the idle state after 20 seconds, indicated by the white color of the RGB LED. The different steps of the cloth folding process are shown in Figure 11.

Step 1

Step 2



Step 3

Step 4

Step 5

Figure 11. Complete Cloth Folding Process

The synchronized motion of sensors, actuators, and control logic demonstrates the successful integration of all subsystems. The efficient and error-free folding sequence verifies the machine's capability for fully automatic cloth folding with minimal human involvement, safety, and thus meets the design objectives.

Table7. Comparison of the proposed cloth folding machine with the existing design

System	Sensing Mechanism	Average folding time in seconds	Automation level	Manual Intervention
This work	LDR and PIR sensor	9.2	Fully automatic	Not required
[7] B. Vinitha	NA (Push	2*	Semi-auto	Required

	button)			
[14] Yuda Irawan et al	Use an ultrasonic sensor to identify something in the vicinity not detect humans	2*	Semi-auto	Data unavailable
[10] Gomesh	NA (Push button)	2*	Semi-auto	Required
[8] Mahajan	NA (Push button)	2*	Semi-auto	Required
[11] P. Randive et al	NA	8 (predicted outcome, design is not fabricated)	Semi-auto	Required
[12] N. Silitonga et al.	Ultrasonic sensor	4*	Semi-auto	Required
[13] Md. S. Ahsan et al.	App controlled	12	Semi-auto	Required

Discussion: A comparative analysis of the existing cloth folding machines and our system is presented in Table 7. As evident from the detailed evaluation of existing designs, the system operates with minimal human intervention. The machine automatically initiates both the sensing and folding processes. In contrast, most previous designs require either a push button or app-based activation to initiate the folding process, while some do not clearly describe their starting or sensing mechanisms. Furthermore, none of the reviewed designs incorporates a sensor to detect human presence, posing a potential risk to users. Hence, safety is a key distinguishing feature of the proposed design.

Additionally, in Table 7, several studies report a folding time of approximately two seconds, which appears unrealistic from a technical standpoint. In comparison, the proposed system achieves a verified and practical folding time of around 9.2 seconds, highlighting its reliability and authenticity among existing designs.

Conclusion: The paper presents the design and implementation of a proposed Automatic cloth-folding machine. The machine offers an innovative solution for both textile industry applications and household chores by folding clothes in less time and with minimal human attention and monitoring. The presence of cloth and initiation of the folding process are fully automatic, ensuring seamless operation. The machine is equipped with sensors to ensure user safety, and the entire process is controlled through an Arduino UNO ATMEGA328p microcontroller. Detailed testing of each individual block of the system has been presented, making the system robust and understandable.

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Author's Contribution: The project was conceptualized by Sana Arshad, who supervised the execution of the entire project with a focus on the microcontroller section, assisted in troubleshooting of the system, and also prepared the final manuscript. Hamna Sajjad purchased acrylic boards and other hardware parts, performed hardware designing using ROS, and hardware, and worked on software implementation of the circuit. She also participated in system integration. Sadia Muniza provided technical guidance for hardware interfacing and also assisted in troubleshooting the complete system. Hafsa Qureshi worked on the software implementation of the circuit. She was also involved in the system integration process. Habiba Fayyaz purchased the electronic components, worked on the software part of the circuit, and also contributed to system integration. Syeda Insia Nusrat handled the PCB design and software operation of the circuit and assisted in system integration.

Conflict of Interest: The authors declare no conflict of interest.

References:

[1] S. Abbas and A. Halog, "Analysis of Pakistani Textile Industry: Recommendations Towards Circular and Sustainable Production," *Environ. Footprints Eco-Design Prod. Process.*, pp. 77–111, 2021, doi: 10.1007/978-981-16-3698-1_3.

[2] "Statistics on textile industry in Pakistan." Accessed: Nov. 13, 2025. [Online]. Available: https://web.archive.org/web/20231007201143/https://tribune.com.pk/story/522292/statistics-on-textile-industry-in-pakistan/

[3] "Regionally Competitive Energy Tariffs and Textile Sector'sCompetitiveness," 2021, [Online]. Available: https://www.pide.org.pk/Research/Regionally-Competitive-Energy-Tariffs.pdf

[4] S. Shah, R. Pillai, U. Mahajan, K. Engineer, and P. S. Mahatre, "AUTOMATIC CLOTH FOLDING AND COLOR BASED SORTING MECHANISM," *Semant. Sch.*, 2015.

[5] R. Mouleeshuwarapprabu, T. Kalavathi Devi, B. Kousika, A. Hariprasath, and S. Giritaran, "Arduino UNO based Automated Folding System for Textiles," *7th Int. Conf. Trends Electron. Informatics, ICOEI 2023 - Proc.*, pp. 221–226, 2023, doi: 10.1109/ICOEI56765.2023.10126033.

[6] N. S. M. S. Sahazati binti Md Rozali, "Development of Automatic Cloth Folding System by Using Arduino Uno Microcontroller and Servo Gears," *Int. J. Electr. Eng. Appl. Sci.*, vol. 7, no. 2, 2024, [Online]. Available: https://ijeeas.utem.edu.my/ijeeas/article/view/6219

[7] B. Vinitha*, S. Amritha, M. Sinduja, M. Sonia, P. Abinaya, and D. M. Ravindran*, "Cloth Folding Machine," *Int. J. Recent Technol. Eng.*, vol. 8, no. 6, pp. 4492–4495, Mar. 2020, doi: 10.35940/IJRTE.F9441.038620.

[8] Mukesh P. Mahajan, Srishti Prasad, Tejal Binnar, Monika Tambe, "Automatic T-shirt Folding Machine," *Int. J. Comput. Appl.*, vol. 162, no. 10, 2017, [Online]. Available: https://www.ijcaonline.org/archives/volume162/number10/mahajan-2017-ijca-913344.pdf

[9] Vijay Talodhikar, "Design and Fabrication of Automatic T-shirt Folding Machine," International Journal of Engineering Research and Applications. Accessed: Nov. 01, 2025. [Online]. Available: https://www.researchgate.net/publication/361207914_Design_and_Fabrication_of_Automatic_T-shirt_Folding_Machine

[10] M. F. N. Gomesh, I. Daut, V. Kumaran, M. Irwanto, Y.M. Irwan, "Photovoltaic Powered T-Shirt Folding Machine," *Energy Procedia*, vol. 36, pp. 313–322, 2013, doi: https://doi.org/10.1016/j.egypro.2013.07.036.

[11] K. M. Kamta Dixit, "Survey on Automatic Cloth Folding Machine," *Int. J. Res. Appl. Sci. Eng. Technol.*, vol. 11, no. 4, 2023, [Online]. Available: https://www.ijraset.com/best-journal/survey-on-automatic-cloth-folding-machine

[12] N. Silitonga, J. M. Hutapea, I. S. Dumayanti, A. N. N. Sianipar, and S. Sitepu, "Design and Simulation of Automatic Folders," *2019 Int. Conf. Comput. Sci. Inf. Technol. ICoSNIKOM 2019*, Nov. 2019, doi: 10.1109/ICOSNIKOM48755.2019.9111491.

[13] M. S. Ahsan, S. Das, and H. Mobarak, "Android App based Bluetooth controlled

Low-cost Cloth Folding Machine," *2020 IEEE Reg. 10 Symp. TENSYMP 2020*, pp. 170–173, Jun. 2020, doi: 10.1109/TENSYMP50017.2020.9231012.
[14] R. W. Yuda Irawan, "Folding Clothes Tool Using Arduino Uno Microcontroller And Gear Servo," *J. Robot. Control*, vol. 2, no. 3, pp. 170–174, 2021, [Online]. Available: https://journal.umy.ac.id/index.php/jrc/article/view/10002
[15] "FOLDIMATE - OFFICIAL WEBSITE - Foldimate." Accessed: Nov. 01, 2025. [Online]. Available: https://e-foldimate.com/en
[16] R. A. El-Laithy, J. Huang, and M. Yeh, "Study on the use of Microsoft Kinect for robotics applications," *Rec. - IEEE PLANS, Position Locat. Navig. Symp.*, pp. 1280–1288, 2012, doi: 10.1109/PLANS.2012.6236985.
[17] B. S. B. S.Arivazhagan, Degu Menna, Sirak G/hiyot, Melese Yonas Dana, "Performance Characteristics of Servo and Stepper Motors," *Int. J. Innov. Sci. Res. Technol.*, vol. 5, no. 1, 2020, [Online]. Available: https://ijisrt.com/assets/upload/files/IJISRT20JAN194.pdf