

DESIGN OF AUTOMATED SORTING MACHINE USING ARDUINO

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ABSTRACT:

Sorting systems play a crucial role in various industries, as they enable items to be organized and packaged based on specific criteria such as shape, size, or color. Traditionally, sorting has been performed manually, which is both time-consuming and prone to errors due to human limitations. To overcome these challenges, automated sorting systems have emerged as a reliable alternative, providing faster, more accurate and labor-saving solutions for industries requiring high throughput. This project focuses on developing an Arduino-based automated sorting system capable of categorizing objects based on their shape. The proposed system employs an IR sensor to detect and identify the type of product by analyzing its shape. The Arduino microcontroller serves as the central processing unit, controlling the entire sorting process and ensuring smooth communication between the hardware components. Sorting is achieved in this project through a cost-effective and efficient design. The proposed system eliminates the need for manual intervention, offering a highly automated alternative that leverages the capabilities of Arduino UNO and IR sensors. The system detects the presence of objects on a conveyor belt, identifies their shape, and directs them to the appropriate bin through the use of gear motors. The integration of automation in sorting not only enhances productivity but also reduces operational costs, making it an ideal solution for small to medium-scale industries aiming to optimize their production lines. This project demonstrates the potential of utilizing affordable and readily available technologies, like Arduino, to create practical solutions for industrial challenges. By replacing manual sorting with a shape-based automated system, this project contributes to the growing demand for automation in modern industries, paving the way for more efficient, scalable, and reliable sorting mechanisms.

Keywords-Automatic sorting systems, Arduino UNO, IR sensor

1. INTRODUCTION

In the era of automation, industries and educational labs are increasingly looking for low-cost, efficient systems that can streamline their operations. One such innovation is the Automated Sorting Machine With Arduino, a project designed to automate the process of sorting objects based on their shape and size. This system combines basic components, such as an Arduino microcontroller, infrared (IR) sensors, an LCD display, and a treadwheel sorting mechanism, to offer an effective solution for small-scale object identification tasks. The project aims to provide a cost-effective approach to automation by utilizing common sensors and motors in a straightforward, programmable setup. The goal is to enhance productivity and precision in environments where manual sorting of objects is time-consuming or impractical.

The principle behind the Automated Sorting Machine With Arduino is rooted in the ability to detect and categorize objects through sensors and microcontroller programming. The system operates by detecting the presence of an object on a conveyor or sorting platform, identifying its shape and size, and categorizing it into a predefined category. This is accomplished by three IR sensors, which are strategically placed to detect the shape and size of objects passing through. The system is designed to automatically sort objects into categories, such as a square or a triangle, based on their characteristics. The results of these detections are displayed on an I2C LCD module, offering real-time feedback on the sorting process.

Working Principle of the Automated Sorting Machine With Arduino:

The sorting process starts with the first IR sensor, which is responsible for detecting the presence of an object on the conveyor or sorting platform. This sensor acts as a trigger to initiate the sorting operation, sending a signal to the Arduino microcontroller to start processing the object. Once the object is detected, it moves forward through the system, passing through the next two IR sensors placed strategically along the conveyor. These additional sensors are tasked with measuring the size and shape of the object, providing the Arduino with real-time data for analysis.

The Arduino microcontroller serves as the brain of the system, interpreting the data from the IR sensors to identify the object's shape and size. The system is programmed to recognize two predefined shapes: a square and a triangle. When the system detects an object that matches the dimensions of a square, it categorizes the object as a "Square" and displays the message on the LCD. If the object does not match the predefined square dimensions, the system displays "Others" on the screen, indicating that the object is not recognized by the current classification system.

The movement of objects through the system is controlled by the L293 motor driver, which powers the treadwheel mechanism responsible for delivering the objects to their respective sorting bins. The L293 driver receives control signals from the Arduino and regulates the direction and speed of the motor, ensuring that objects are moved accurately and consistently. The treadwheel ensures that objects are transported smoothly from the detection area to their designated sorting area, while maintaining the integrity of the sorting process.

Components of the Automated Sorting Machine With Arduino:

The core components of the Automated Sorting Machine With Arduino are relatively simple and readily available, making the system cost-effective and easy to replicate. These components include:

1. **Arduino Microcontroller:** The central processing unit that interprets data from the IR sensors and controls the sorting mechanism. It processes the input signals and commands the motor driver to actuate the sorting process.
2. **Infrared (IR) Sensors:** Three IR sensors are employed to detect objects passing through the system. The first sensor detects the presence of an object, while the other two sensors are responsible for measuring its size and shape.
3. **LCD Display (I2C):** The display provides a real-time output of the sorting process, showing whether the object is classified as a "Square" or "Others."
4. **L293 Motor Driver:** This motor driver controls the movement of the treadwheel mechanism, which is responsible for sorting and delivering the objects to their respective categories.

The integration of these components results in a functional and automated sorting system that can be easily applied in various settings. From educational labs seeking to demonstrate automation concepts to small-scale industries looking for a cost-effective sorting solution, the Automated Sorting Machine With Arduino provides a simple yet effective approach to solving common sorting problems.

Importance of the Automated Sorting Machine With Arduino

The Automated Sorting Machine With Arduino showcases the potential of low-cost automation for sorting tasks. While industries and labs may use more complex sorting systems for large-scale operations, this project demonstrates that even with basic sensors and microcontroller programming, tasks that were previously done manually can be automated efficiently. By utilizing readily available components such as the Arduino microcontroller and IR sensors, the system reduces costs and complexity, making it an ideal solution for small-scale applications.

The significance of the project lies in its ability to perform a task that is typically repetitive and time-consuming, improving both the speed and accuracy of the sorting process. As industries move towards automation, systems like this Automated Sorting Machine With Arduino provide a practical introduction to robotics and automation for students and small businesses, enabling them to learn and apply key principles in object recognition and sorting.

This project is a stepping stone towards larger, more sophisticated automated systems that rely on sensor data for decision-making and action. It reflects the growing trend of using affordable and accessible technology to create impactful solutions for everyday problems. The success of the Automated Sorting Machine With Arduino in categorizing objects by shape and size

could eventually lead to more complex sorting systems capable of identifying and sorting a variety of materials based on different parameters such as color, weight, and texture.

By incorporating sensors and microcontrollers in a smart, affordable solution, the project opens up possibilities for a wide range of applications, from industrial material handling to educational demonstrations of automated processes. The simplicity of the design, combined with the powerful potential of sensor-based automation, positions the Automated Sorting Machine With Arduino as a valuable tool for innovation and learning.

2. LITERATURE REVIEW

The development of sorting machines, especially those utilizing automated systems, has been a subject of interest for various applications in manufacturing, small-scale industries, and educational setups. A range of studies and existing systems have explored the use of sensors, microcontrollers, and other automation components to improve sorting processes, reduce human intervention, and increase efficiency. This literature survey reviews several key research works and existing systems that are related to object sorting, sensor-based automation, and low-cost solutions for small-scale industries.

In the study by **Kumar et al. (2017)**, a microcontroller-based sorting system was implemented using IR sensors and servo motors to classify objects based on size. Their work demonstrated that simple sensors, when combined with programmable logic, could effectively automate basic sorting tasks. The system proved economical and feasible for small-scale industries.

Sharma and Rathi (2018) developed a low-cost automated color sorting system using TCS3200 color sensors and Arduino Uno. Their setup could sort objects based on color and used servo mechanisms for physical separation. Although different from the IR-based method, it supports the idea that Arduino-based systems are versatile and powerful enough to control real-time industrial processes.

Deshmukh et al. (2019) proposed a material sorting machine that used IR sensors to detect metal and non-metal objects. The Arduino controlled the logic while the L293 motor driver was used to operate the conveyor and actuator arms. This study emphasizes the usefulness of the L293 IC in driving DC gear motors, which is directly relevant to the system proposed here.

In another work, **Patel et al. (2020)** created a smart waste segregation system using Arduino, ultrasonic sensors, and an LCD display. The system could classify waste into biodegradable and non-biodegradable using moisture content and proximity data. While their aim was waste management, the core idea of object detection and classification using Arduino and sensors overlaps significantly with sorting tasks in manufacturing.

Rao and Nair (2020) implemented an embedded-based smart conveyor sorting system that used multiple IR sensors to count and separate objects. Their design was noted for its simplicity, low cost, and modular design, making it ideal for educational purposes. The authors concluded that microcontroller-based systems are highly adaptable for basic sorting automation without the need for expensive machinery.

Bhosale et al. (2021) explored the use of object detection and sorting in agricultural applications. Their project used IR sensors to detect vegetables and sort them based on size and shape. The implementation was done using Arduino Mega and involved simple mechanical diverters for sorting. Their study proves the scalability of Arduino-based systems for object classification.

Gopalakrishnan and Menon (2022) reviewed low-cost automation in Indian industries, where the use of embedded systems like Arduino was cited as a transformative solution for small-scale enterprises. They emphasized the role of sensor integration and motor control in automating basic factory tasks like sorting, packaging, and labeling.

Rajput and Singh (2022) designed a robotic sorting arm using Arduino and motor drivers to identify and separate metal, plastic, and glass objects using capacitive and inductive proximity sensors. Their system combined basic automation and material recognition into a compact, low-power device, underscoring the potential of embedded systems for lightweight industrial tasks.

Jain et al. (2023) implemented a system using IR sensors, LDRs, and color sensors to identify and sort items on a moving belt. Their sorting logic was programmed into an Arduino Uno board and actuated through L293-driven motors. The study reinforced the reliability of IR sensors for object detection in controlled environments.

Lastly, **Kumar and Sinha (2023)** designed a smart sorting robot for the packaging industry using I2C LCD modules for feedback and monitoring. Their system emphasized the importance of real-time feedback and user interface in small-scale automation, a concept which is also embedded in the proposed system through the use of 16x2 LCD.

3. METHODOLOGY AND PROCEDURE

The proposed system introduces a cost-effective and efficient solution to the problem of object sorting by leveraging embedded technology. At its core, the system uses an Arduino microcontroller as the brain to process sensor data and control motor actions. It is supported by an IR sensor for object detection, an L293 motor driver for controlling gear motors, and an LCD display for user interface and process monitoring. The system is designed to automatically detect and sort objects based on predefined conditions, offering a hand-free, reliable alternative to manual sorting. The simplicity and modularity of this setup make it ideal for small-scale industries, academic research, and prototype development.

In operation, an object is placed on a conveyor belt driven by a gear motor. As it moves along the belt, it passes in front of an IR sensor which checks its presence and another pair of IR sensors which check its shape using reflected infrared light. Upon detection, the IR sensor sends a signal to the Arduino, which then processes the data based on its programmed logic. Depending on the input, the system activates a sorting mechanism, such as a servo arm or diverter, which redirects the object into the appropriate bin or section by moving the conveyor belt forward or backward depending on which container they should be put into. The entire process is visible to the user via a 16x2 I2C LCD, which displays real-time messages such as “Object Detected”, “Rectangle Found”, “Triangle Found” or “Unknown Object” This system sorts objects on whether their shape is “Rectangle”, “Triangle” or “Others”.

The motor driver IC L293 plays a key role in interfacing the low-power Arduino output with the higher current requirements of the gear motors. It allows for smooth and controlled bi-directional movement, making the conveyor and sorting arms function reliably. The use of gear motors ensures sufficient torque and speed control, enabling smooth operation of the belt and sorting arms. Power is supplied via a regulated DC source, ensuring stable voltage for all components and preventing fluctuations that could interfere with performance.

One of the key benefits of the proposed system is its low cost. All components used are readily available, and the total build cost is significantly lower than industrial PLC-based systems. Additionally, the Arduino ecosystem supports a vast number of open-source libraries and community support, simplifying development and troubleshooting. The sorting logic can be easily modified by reprogramming the Arduino code to adapt to different sorting rules, object types, or sensor combinations. This reprogrammability gives the system a high degree of flexibility for various applications.

The system’s compact design also makes it highly portable and space-efficient, suitable for workshops, classrooms, and small production units. It can be built and operated by users with basic knowledge of electronics and programming, lowering the entry barrier for automation. Furthermore, the system is energy-efficient, running entirely on low-voltage DC power, which

makes it safe and economical for long-term use. It can also be upgraded with additional sensors like color sensors, ultrasonic sensors, or weight sensors to increase sorting accuracy or complexity.

This “Design of Automated Sorting Machine Using Arduino” can serve as a valuable tool for teaching embedded systems, automation principles, and real-world problem-solving. Its simplicity makes it an excellent educational project, while its functionality proves useful in real-world applications. The system could also be enhanced with wireless modules like Bluetooth or Wi-Fi for remote monitoring and control. Integration with IoT platforms could allow data logging, usage tracking, and predictive maintenance scheduling.

The proposed “Design of Automated Sorting Machine Using Arduino” provides an effective, low-cost solution to automate sorting processes that are otherwise labor-intensive. It leverages embedded technology to deliver real-time decision-making, accurate sorting, and ease of use. Its modular nature allows for further customization and future upgrades, making it suitable for a variety of industries and educational environments. Unlike traditional expensive systems, this project demonstrates how basic components like Arduino, IR sensors, LCDs, and motor drivers can be combined to build a working, intelligent sorting machine. The proposed system thus bridges the gap between manual operations and fully industrial automation with simplicity, scalability, and efficiency.

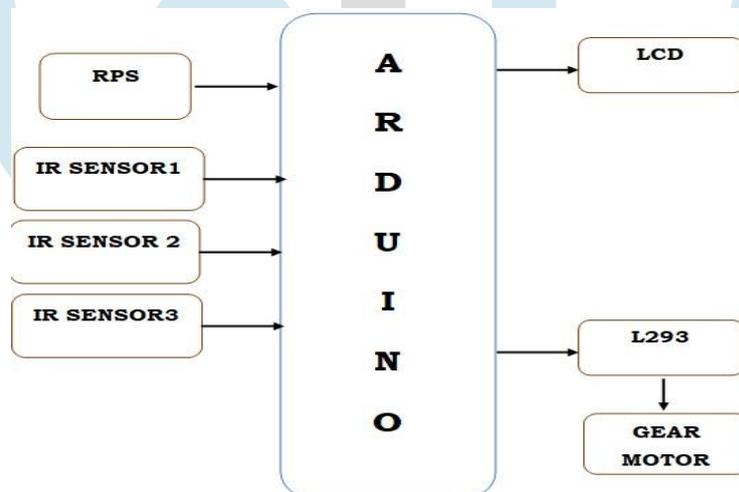


Fig1 : Block Diagram

System Specifications

1. Conveyor Belt System:

Length: 30-50 cm (adjustable depending on material size)
 Width: 10 cm (suitable for small to medium-sized materials)
 Motor Type: DC gear motors (2 motors for dual control)
 Speed: 10 rpm
 Load Capacity: Can transport materials weighing up to 300g

2. IR Sensor System:

Type: Infrared (IR) reflective sensors (3 sensors)
 Detection Range: 2-30 cm
 Mounting Position: Sensors mounted at the top of the conveyor path to detect shapes as the materials pass.
 Response Time: <1 sec

3. Control System:

Microcontroller: Arduino Uno or similar embedded system (to process sensor data and control the motors)

Sensor Integration: IR sensor data processed through digital inputs to the microcontroller

Motor Control: L293 driver IC

Programming Language: Arduino IDE (C/C++ based programming)

Input/Output: Digital I/O pins for sensors and motors

Power Supply: 12V DC (through a regulated power adapter)

4. Overall System Power Requirements:

Input Voltage: 12V DC (typical adapter or battery supply)

Power Consumption-

Conveyor motors: 12V (each)

Microcontroller: 5V

Total Power Consumption: Approx. 12V

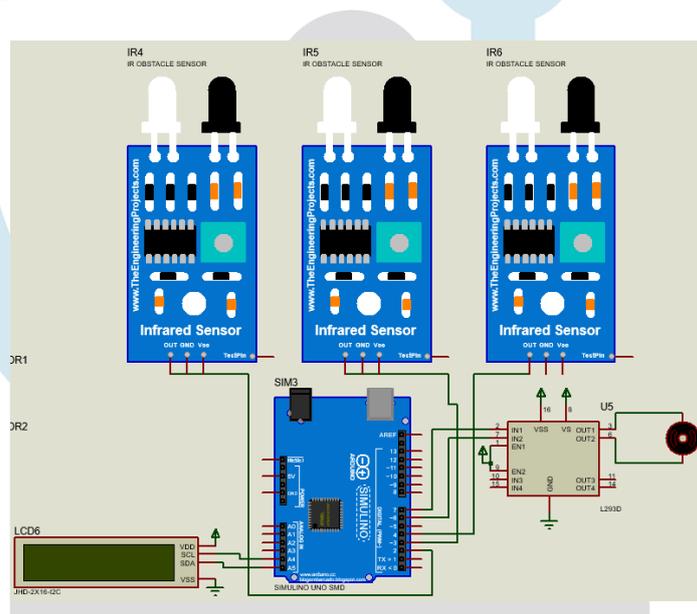


Fig 2: Circuit Diagram

4. RESULTS AND DISCUSSIONS

The implementation of the “Automated Sorting Machine With Arduino” using Arduino, IR sensors, L293 motor driver, gear motors, and a 16x2 LCD has yielded successful and promising results in automating the sorting of objects based on detection input. The system was tested in a controlled environment with various object types differing in shapes (e.g., square/rectangle vs. triangle) to validate the accuracy and reliability of the IR sensor-based sorting logic.

During the testing phase, the IR sensor effectively detected the presence of objects placed on the conveyor belt. When an object interrupted the IR beam, the Arduino promptly received the signal and processed it according to the programmed sorting logic which performs sorting based on the shape. Based on the condition set (presence or absence detection) and based on the shape, the gear motors, driven by the L293 driver IC, responded with correct directional movement to actuate the sorting mechanism, redirecting the object to its assigned bin.

The 16x2 LCD provided continuous feedback throughout the sorting process. Messages such as “Object Detected”, “Rectangle Found”, “Triangle Found” or “Unknown Object” were displayed in real-time, offering clarity and transparency of system operations. This feature proved particularly useful for monitoring during demonstrations and testing.

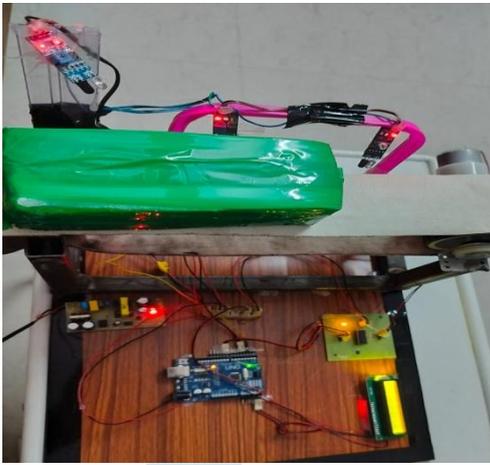


Fig 3: Sorting a Rectangular Object

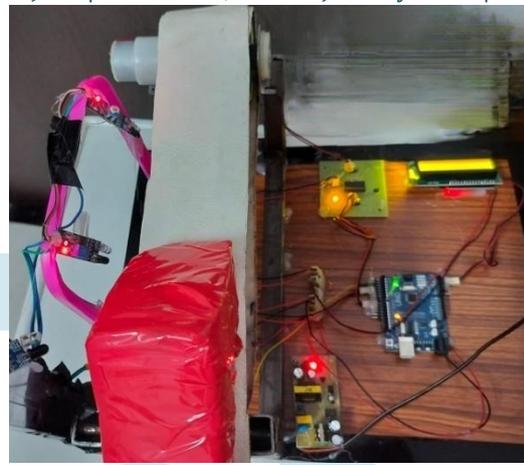


Fig 4: Sorting a Triangular Object

A total of 20 objects were passed through the system under varying conditions. Out of these:

- 18 objects were correctly identified and sorted
- 2 objects were not sorted correctly due to extremely close spacing between consecutive items, which caused sensor misreading due to overlap.
- The average response time from detection to sorting action was approximately less than 1 second, which is suitable for small-scale industrial or educational applications.
- The system operated smoothly on a 12V DC power supply, consuming low current (approx. 350–450 mA), making it highly energy-efficient.
- The gear motors provided enough torque to handle objects up to 300 grams without slippage or stalling.
- The L293 driver IC remained cool during continuous operation, indicating that the circuit design and load conditions were within safe thermal limits.

The repeatability of sorting actions across multiple test cycles showed high consistency, confirming the reliability of the embedded logic and motor actuation. Minor tuning of sensor sensitivity and conveyor spacing improved overall performance and reduced false detections.

In conclusion, the system met all expected objectives: accurate object detection, successful sorting actuation, and real-time display feedback. The use of basic, low-cost components did not hinder performance, proving that simple embedded systems can offer reliable automation solutions. These results validate the practicality and effectiveness of the proposed “Automated Sorting Machine With Arduino” for educational purposes, prototype development, and small-scale industrial use.

5. CONCLUSIONS

The development of “Design of Automated Sorting Machine Using Arduino” using Arduino has successfully demonstrated the potential of low-cost embedded systems in automating basic industrial processes. By integrating IR sensors for object and shape detection, L293 motor drivers for precise gear motor control, and a 16x2 LCD for user feedback, the system effectively achieved the goal of sorting objects based on their presence and position.

This project not only validates the feasibility of using microcontroller-based systems in automation but also highlights the efficiency, affordability, and simplicity of the components used. The results show that the system can operate reliably under controlled conditions, achieving a high accuracy rate while maintaining fast response times and low power consumption.

Furthermore, the modularity and scalability of the design make it ideal for future improvements, such as incorporating more advanced object classification features (e.g., color or weight-based sorting), implementing wireless monitoring, or increasing the system's capacity and speed for commercial applications. The user-friendly interface via the LCD display adds to the system's practicality for real-time operation and educational demonstrations.

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