Research Article *Open Access*

Journal of Scientific Engineering Advances

ISSN: 3071-0723

DOI: *doi.org/10.63721/25JSEA0114*

Size and Color Sorting of Solid Products Using a Conveyor Belt & Swipe Arm

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Citation: Abdullah Al Fuad (2025) Size and Color Sorting of Solid Products Using a Conveyor Belt & Swipe Arm. J. of Sci Eng Advances 1(3) 1-09. WMJ/JSEA-114

Abstract

The project's main goal is to split the objects along a line based on their size and colour. In this project, a database of objects that are categorized by colour and size is coded into the swipe arm. In every industry, sorting solid products is absolutely vital. Effective sorting techniques shorten sorting times and affect production rates. Human inaccuracy, a lack of consistency, and manual sorting's imperfections are the justifications for utilizing sensors in conjunction with manual sorting. It may be possible to complete the task economically by using a pneumatic or intelligent robotic arm. The suggested arm can perform the task more effectively over time than manual labour can.

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Submitted: 03.12.2025 **Accepted:** 11.12.2025 **Published:** 20.12.2025

Keywords: Conveyor Belt, Swipe Arm, Robotic Arm, Size Sorting, Color Sorting, Sensor

Introduction

Assembly lines typically replace artisans, and individual human work is routinely substituted by computerized industrial manufacturing. Industrialization is distinct from relying on natural phenomena since it promotes economic growth, a more productive division of labour, and the use of cutting-edge technology to address problems [1]. For a developing country to develop economically, industrialization is essential. The efficiency and adaptability of industrial operations are today greatly boosted by automation. Industrial automation refers to the use of information technology and control systems, including computers, robots, and other devices, to replace people in an industry's many processes and machinery. It is the following stage in the industrialization process after mechanization [2]. Maximum production rates, increased productivity, improved worker safety, shorter manufacturing times, and high-quality products are the outcomes of automation.

Time and space are used while moving solid objects.

In manufacturing and distribution, material handling is a crucial but ineffective and expensive activity [3,4]. A modern manufacturing company's specialized activity is processing solid products efficiently. According to estimates, material handling operations account for between 60 and 70 percent of the cost of production. Two key factors—idle time and labor cost for increased costs associated with inadequate product handling [5]. Costs associated with production or distribution can be drastically decreased with efficient solid product handling solutions. The two parameters that are most important for effectively categorizing and sorting any type of solid product are colour code and size. At various crucial points throughout the process, grading is heavily utilized in the automation sector. The field of automatic inspection comes into play as a key component of quality control for products when considered in this perspective. Accurate product size estimates can aid in the better planning of the packaging, shipping, and marketing processes [6,7]. The product stays mostly static during the transport process as it travels horizontally on the belt, and the color sorters of the belt-type break a lesser percentage of the material. Gravity causes the material to fall down when using a conveyor, which causes collisions, friction, and larger particles [8].

Literature Review

The Automatic Color Sorting Machine on Belt Conveyor, developed and utilizing an RGB color sensor to categorize things according to color, has been upgraded [9]. The DC motor, TCS230 color sensor, and Arduino Uno were utilized to operate the various mechanisms. Two groups have made significant strides in this area: used TCS230 to enhance an automatic color sorting machine, while made progress on a material handling system. In the past, the robotic arm has been used to pick and place items onto moving conveyor belts [10,11]. With the help of the color sensor, the robotic arm can pick up and arrange objects where they belong before returning to its starting position. Using a TCS3200 color sensor, an Arduino UNO, and a servo motor, wrote about a system that could classify things based on color [12]. In order to classify objects according to color and shape, developed a robotic arm system [13]. The system records colour that converted to the hexadecimal color space (hue, saturation, and value). The method then uses a technique known as "contour detection" to determine the form of the object. In order to identify and categorize ten distinct hues, created a novel color detection and classification system [14]. All aspects, including construction, theory of operation, relations, measurements, outcomes, and mistakes, will be discussed in detail. The technology can recognize and differentiate between ten different hues. Created an automated design sorting system based on an object's outside edges. This study covers how to use an arm robot to sort detecting items according to their color, shape, volume, size, and type [15].

Methodology

The working methodology of the project involves using Arduino to control the sorting process based on color and size. The system utilizes two servo motors—one for color sorting and another for size sorting—as well as three HCSR04 sensors—one on top and two on both sides—to detect the height and width of the objects. At the start, the Arduino is initialized, and the necessary pins for the color sensor and distance sensors are set as inputs or outputs. The servo motors are also initialized and set to their initial positions. The system then enters the main loop, where it continuously reads the color sensor values and the distance sensor values. The color sensor, TCS3200, is used to detect the color of the objects passing through the sorting mechanism. By comparing the color sensor readings with predefined thresholds for red, green, and blue, the system determines the color of the object. Simultaneously, the three HCSR04 sensors measure the distances to the object from the top and both sides. These readings are used to determine the size of the object. By comparing the distance values with predefined thresholds for small, medium, and large objects, the system categorizes the size of the object. Based on the color and size information, the system controls the servo motors to perform the sorting operation. Each servo motor has predefined positions for small, medium, and large objects. The appropriate servo motor position is selected according to the color and size of the object detected. For example, if a small red object is detected, the color servo motor moves to the position assigned for small objects, and the size servo motor moves to the position assigned for red objects. The system can be further enhanced by integrating additional actions or outputs, such as activating conveyor belts or triggering indicators, depending on the specific requirements

of the project. By combining the color sensor, HCSR04 sensors, and servo motors with the Arduino's control capabilities, the project achieves an automated sorting mechanism that efficiently sorts objects based on their color and size.

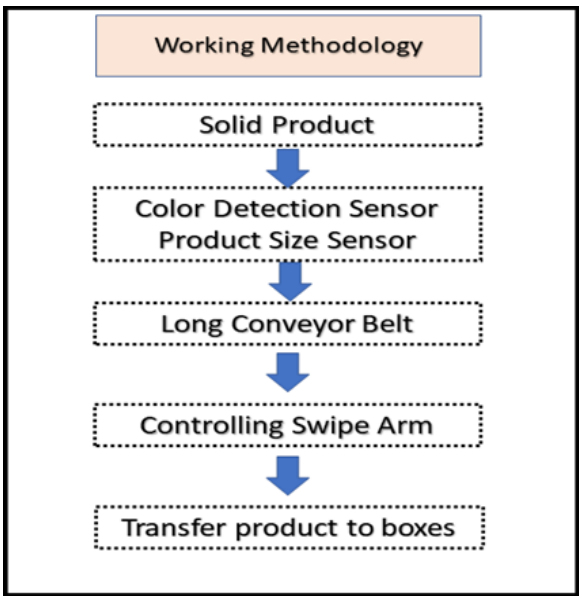

Figure 1: Diagrammatic Representation of the Research Process

Schematic Diagram of the System

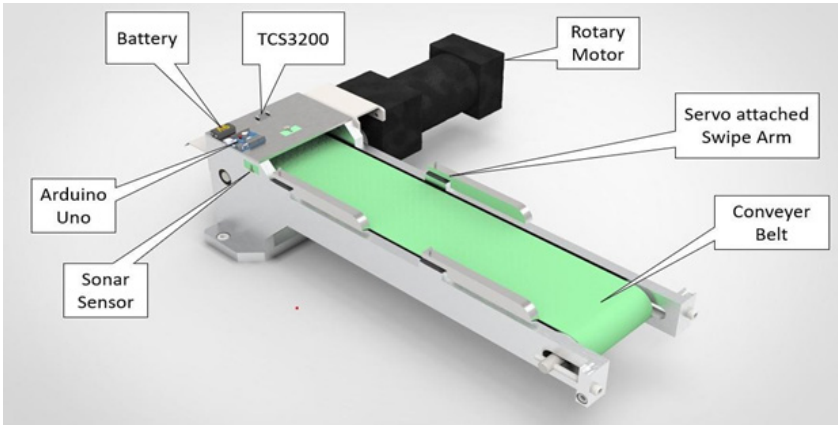

Figure 2: Rendered Version of the Whole System

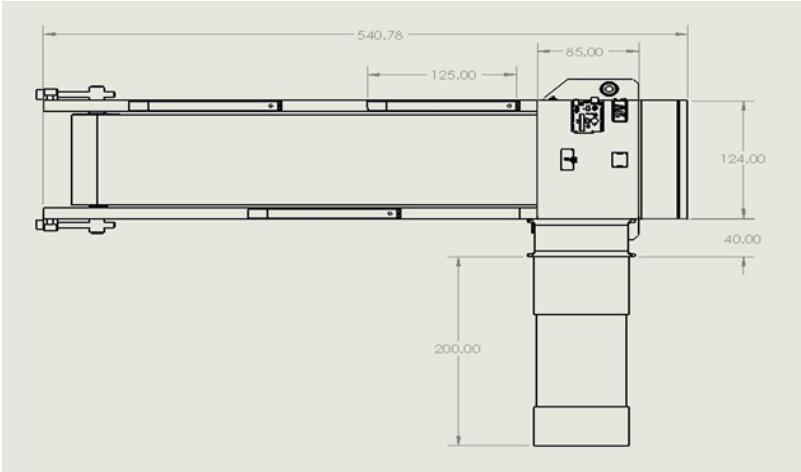

Figure 3: Drawing of the Whole System

Flow Chart of the Algorithm

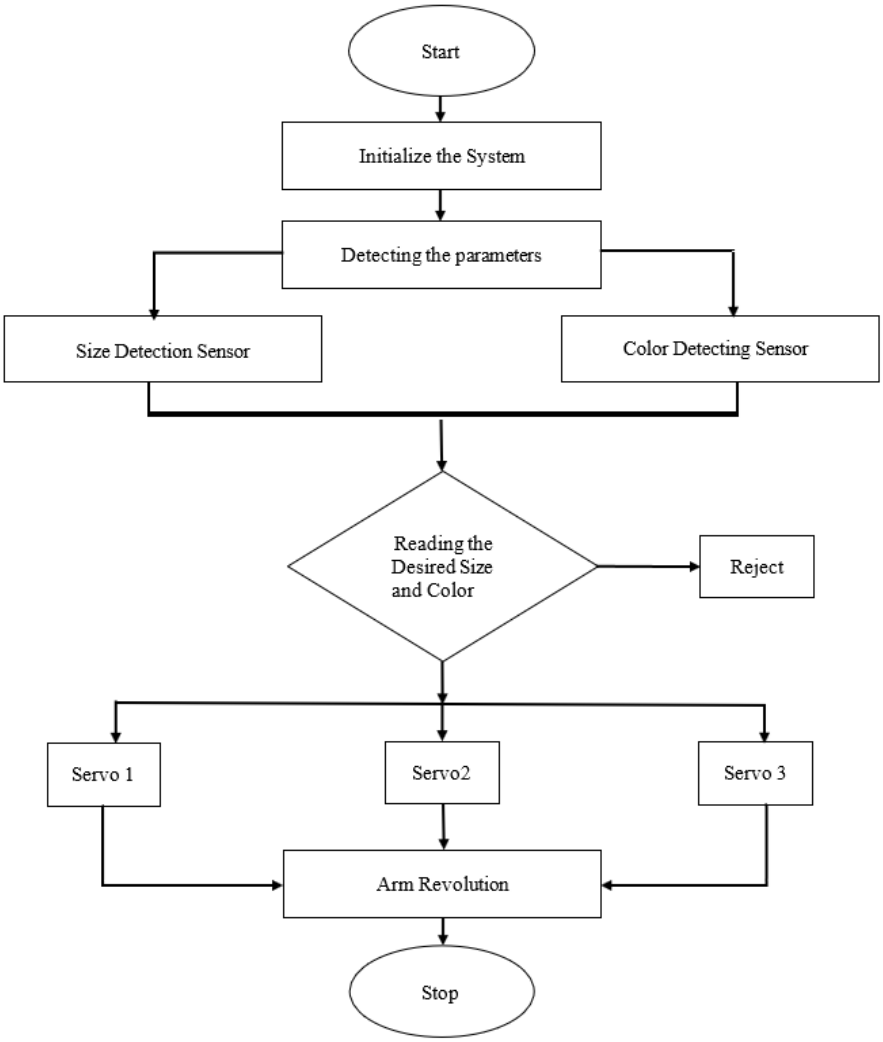

Figure 4: Flowchart of the Algorithm

Fabrication of the Setup

The fabrication process of an automated color sorting and size sorting machine using Arduino, HCSR04 sonar sensor, TCS3200 color sensor, servo motor, and a conveyor belt involves gathering the required components, setting up the Arduino environment, and connecting the components as mentioned before. Additionally, a conveyor belt system is designed and incorporated into the machine. The conveyor belt is assembled and integrated with the sorting mechanism, allowing objects to pass through the sorting area smoothly. The Arduino code is modified to account for the movement of objects on the conveyor belt, synchronizing the sorting actions with the object's position. Thorough testing is conducted to ensure the proper functioning of the combined conveyor and sorting mechanism, including testing with different objects of varying colors and sizes. Safety measures, such as installing safety guards or emergency stop buttons, are implemented to protect operators during operation.

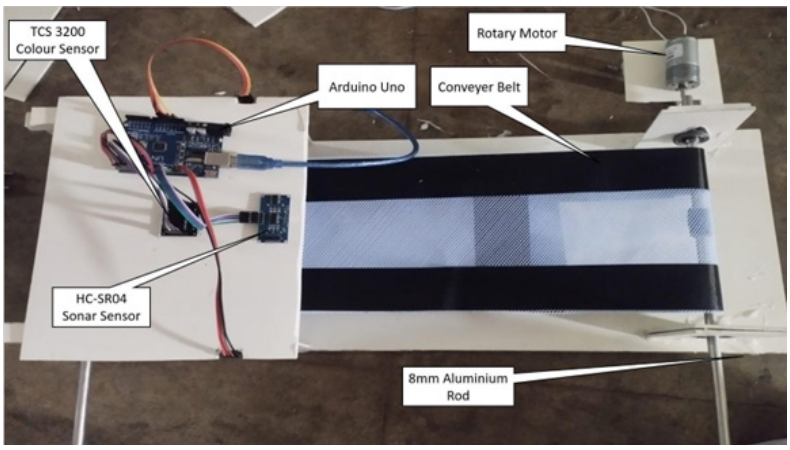

Figure 5: Fabricated Model

Fabrication of the Structure

The fabrication of the structure for the automated color sorting and size sorting project involves designing and constructing a physical framework to house the components and enable the sorting process. First, a sturdy base or frame is created to provide stability and support for the entire system. This can be made using materials such as metal or strong plastic. Next, the conveyor belt mechanism is integrated into the structure. This involves mounting the conveyor belt onto rollers or pulleys, ensuring proper alignment and tension. The conveyor belt should be positioned at an appropriate height and length to allow objects to move smoothly through the sorting area. The TCS3200 color sensor and HCSR04 sonar sensor are securely mounted at strategic locations along the conveyor belt system. The color sensor should be positioned to accurately detect the colors of passing objects, while the sonar sensor is placed to measure the distance of the objects. The servo motor, responsible for the sorting mechanism, is mounted in a way that allows it to move objects to their respective destinations based on color and size. This can be achieved using mechanical arms, gates, or other mechanisms designed to divert the objects into specific bins or containers. Throughout the fabrication process, it is important to ensure proper alignment, stability, and smooth movement of the components. Care should be taken to secure all connections and fastenings to prevent any loose parts or potential hazards. Additionally, safety measures such as installing safety guards, emergency stop buttons, or enclosures should be implemented to protect operators and prevent accidents. Overall, the fabrication of the structure involves creating a robust framework, integrating the conveyor belt system, mounting the sensors and servo motor, and incorporating necessary safety measures to ensure the efficient and safe operation of the automated color sorting and size sorting machine.

Fabrication of the Swipe Arm Mechanism

The fabrication of the swipe arm mechanism for sorting using a servo motor involves designing the swipe arm and mounting the servo motor securely. A linkage or attachment mechanism is created to connect the swipe arm to the servo motor's output shaft, enabling the conversion of rotational motion into linear motion. The swipe arm's movement is calibrated and optimized using Arduino code to achieve precise sorting. Safety measures are implemented, and thorough testing is conducted to ensure reliable and accurate sorting performance.

Fabrication of the Conveyer Belt

The fabrication of the conveyor belt for the automated color sorting and size sorting machine is a crucial aspect that ensures the smooth and efficient movement of objects through the sorting area. To begin, careful consideration is given to selecting the appropriate materials for the conveyor belt. Factors such as durability, flexibility, and grip are taken into account. Common materials used include rubber, PVC, or fabric belts, depending on the specific requirements of the project. Once the material is chosen, the conveyor belt is cut to the desired length and width. Precision is important to ensure that the belt fits perfectly within the sorting machine's structure and allows for unhindered movement of the objects. The next step involves attaching the belt to a series of rollers or pulleys. These rollers are carefully positioned to ensure proper alignment

and tension of the belt. It is crucial to maintain a consistent tension throughout the conveyor system to prevent slipping or misalignment. To achieve the desired movement, a suitable drive mechanism is integrated into the conveyor system. This can be achieved using a motor and pulley system, chain drive, or other mechanisms. The drive mechanism provides the necessary power to move the conveyor belt at the desired speed, ensuring the smooth flow of objects through the sorting area. During the fabrication process, attention is given to the proper alignment of the conveyor belt system. The rollers or pulleys are securely mounted, and the tension is adjusted to maintain proper tracking and prevent any deviation or lateral movement of the belt. Additionally, safety considerations play a vital role in conveyor belt fabrication. Safety guards or enclosures are often added to prevent operators from accidental contact with moving parts and to protect against any potential hazards associated with the operation of the conveyor system. Once the fabrication is complete, thorough testing is conducted to ensure the conveyor belt operates smoothly and efficiently. Objects of various sizes and weights are tested to verify that the belt can handle the load and transport the objects without any disruptions or damage. Overall, the fabrication of the conveyor belt involves careful selection of materials, precise cutting and attachment, integration of a suitable drive mechanism, proper alignment, and adherence to safety measures. The goal is to create a reliable and effective conveyor system that facilitates the seamless movement of objects throughout the sorting process.

Figure 6: Conveyer belt

Fabrication of the Circuit

The circuit diagram of the automated color sorting and size sorting system consists of an Arduino board as the central control unit. The HCSR04 sonar sensor is connected to the Arduino to measure the distance of the objects on the conveyor belt. The TCS3200 color sensor is also connected to the Arduino to detect and analyze the color of the objects. The servo motor is linked to the Arduino to control the sorting mechanism. Power supply connections are made to provide the necessary voltage to the components. Additionally, appropriate resistors, capacitors, and jumper wires are used for proper signal conditioning and connections. The circuit diagram depicts the interconnections between these components, ensuring that the sensors, motor, and Arduino communicate effectively to sort objects based on color and size.

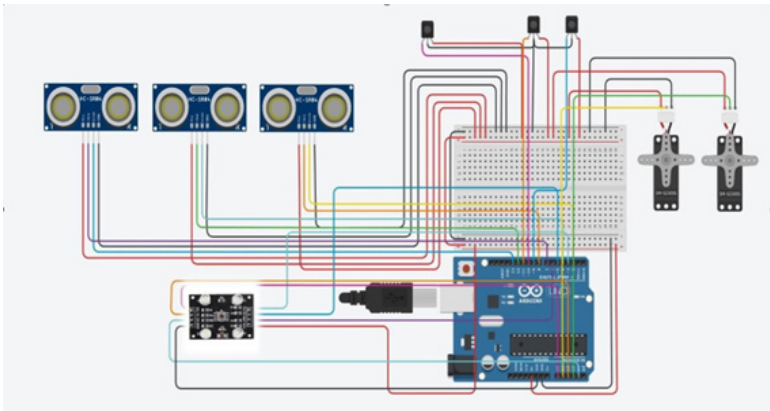

Figure 7: Circuit Diagram

Result and Discussion

Result

A sizable number of objects were successfully sorted using automated color and size sorting equipment. The swipe arm quickly moved across the conveyor belt to quickly classify the articles into several categories as they were continuously transported there by the conveyor belt. Based on their preset color and size parameters, the system correctly detected and classified objects. When compared to hand sorting, the use of automation considerably increases efficiency. The machine can sort items quickly and efficiently while handling a big amount of material. Efficiency gains like these can result in lower labor expenses and higher output. Automating the sorting procedure lowers the chance of human error. The system is capable of precisely detecting and classifying things according to their size and color by using sensors and sophisticated algorithms. This accuracy guarantees proper item sorting, reducing the likelihood of misclassification. Automated sorting equipment can be programmed to handle a variety of objects in various sizes and colors. To meet different sorting needs, the color and size parameters can be changed. Due to its adaptability, the machine may change to meet evolving sorting requirements without requiring extensive reconfiguration. To accommodate the needs of various production or sorting environments, the automated sorting system may be readily scaled up or down. To boost throughput, extra conveyor belts and swipe arms can be added, and the entire system can be connected into bigger manufacturing lines or sorting facilities. Regular maintenance and calibration are necessary to maintain the sorting machine's accuracy and dependability. To avoid problems and downtime, routine inspections and maintenance should be performed on the conveyor belts, swipe arm mechanisms, and sensors. The sorting process can be kept as uninterrupted as possible with proper maintenance planning and an inventory of spare parts. Although an automated sorting system may require a sizable initial investment, the system's long-term advantages, such as higher productivity and lower labor expenses, may outweigh those disadvantages. The machine's exact sorting abilities can reduce waste and maximize resource use, further increasing cost savings. Automated sorting devices can be connected with other systems, such data management and inventory control systems, to improve the efficiency of the entire operational workflow. Real-time tracking of sorted objects, inventory control, and data analysis for process improvement are all made possible by this interaction.

The result of the automated color sorting and size sorting project would be the successful implementation of the sorting mechanism, effectively sorting objects based on their color and size with a high degree of accuracy. This would be evident through the proper functioning of the swipe arm mechanism, precise detection of colors using the TCS3200 color sensor, and accurate measurement of object distances using the HCSR04 sonar sensor. The conveyor belt system would smoothly transport objects through the sorting area, and the servo motor would efficiently control the movement of the swipe arm to direct objects to their appropriate destinations.

In the discussion of this project, several key points can be highlighted. Firstly, the automated sorting system brings efficiency and accuracy to the sorting process, reducing the need for manual labor and potential human errors. The integration of advanced technologies, such as Arduino, servo motors, and sensors, demonstrates the potential of automation in industrial processes. The use of the TCS3200 color sensor allows for reliable color detection, enabling objects to be sorted based on their specific colors. This can have significant applications in industries where color-based categorization is critical, such as in food processing or manufacturing. The inclusion of the HCSR04 sonar sensor adds an additional dimension to the sorting process by measuring object distances. This feature allows for more precise sorting based on object size, contributing to a more accurate and efficient sorting outcome. Furthermore, the swipe arm mechanism controlled by the servo motor provides a reliable and customizable sorting solution. The servo motor's precise control allows for consistent and repeatable movements of the swipe arm, ensuring objects are sorted with high precision and reliability. Overall, the successful implementation of the automated color sorting and size sorting project offers numerous benefits, including increased productivity, reduced labor costs, improved accuracy, and enhanced operational efficiency. It showcases the potential of integrating automation and advanced technologies to optimize sorting processes in various industries.

In summary, the automated color and size sorting machine with a conveyor belt and swipe arm has a lot of benefits, such as increased efficiency, accuracy, adaptability, scalability, and cost-effectiveness. If it is implemented effectively, sorting procedures can be optimized across a range of industries, which will ultimately result in higher production and lower costs.

Conclusion

In conclusion, the automated color sorting and size sorting project has successfully demonstrated the effective integration of advanced technologies, such as Arduino, servo motors, and sensors, to create an efficient and accurate sorting system. The project has showcased the potential of automation in industrial processes, offering benefits such as increased productivity, reduced labor costs, improved accuracy, and enhanced operational efficiency. Through the fabrication of the swipe arm mechanism, utilizing a servo motor as a sorter, objects were precisely sorted based on their color and size. The TCS3200 color sensor enabled reliable color detection, while the HCSR04 sonar sensor provided accurate measurements of object distances. The conveyor belt system efficiently transported objects through the sorting area, ensuring a smooth workflow. The successful implementation of the project highlights the importance of careful design, precise assembly, calibration, and thorough testing. It also underscores the significance of safety measures in the fabrication process to ensure the well-being of operators and prevent accidents. Overall, the automated color sorting and size sorting project demonstrates the potential for automation to revolutionize sorting processes in various industries. It serves as a testament to the effectiveness of integrating advanced technologies and automation techniques to optimize productivity and accuracy. With further development and refinement, such systems have the potential to greatly enhance sorting processes and contribute to increased efficiency in industrial settings.

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