

## Design and Modelling of Coin Sorting Machine

 A.Paramasivam<sup>1</sup>  P.Vidhushini<sup>2</sup>  N Arunprakash<sup>3</sup>  S.P.Srinivasan<sup>4</sup>  S Paneerselvan<sup>5</sup> and  
 Vijayalakshmi Kakulapati<sup>6</sup>

<sup>1,2,3,4,5</sup>Department of Mechanical Engineering, Rajalakshmi Engineering College, Thandalam, 602 105, Tamilnadu, India

<sup>6</sup>Department of Information Technology, Sreenidhi Institute of Science and Technology, Hyderabad, 501 301, India

\*Corresponding author. Email: paramasivam.a@rajalakshmi.edu.in

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### Abstract

In this dynamic era of new evolution of technology, the systems are moving towards smart way to improve the utilization and effectiveness of the system. In this work, an attempt is made to design and develop the coin sorting machine, which can be extended to variety of similar applications. Coins are circulated enormously in public and private transportation sectors, temples and in Retail shops, where sorting and counting done by manually, which increases the monotony of the work, less precision and effectiveness. The objective in this work is to reduce the fatigue faced by human, improving the effectiveness and utilization of the sorting and counting process. The first step is to develop the framework of the coin sorting mechanism using the Lining mechanism, which will separate the coins, followed by measurement of the coin specification such as diameter, thickness and weight to identify the value of the coin. A programmed coin checking and arranging machine model is created by utilizing ARDUINO as the primary regulator. This work included the structure of the basic showcase board to show the absolute amount of each coin. The coin acceptor has been utilized as it goes about as a coin selector to decide the division of coin and restrict any invalid or undesirable coins. Through the task, this coordinated structure has superior for coin including and arranging as far as easy to use and engaging quality.

**Keywords:** coin, sorting mechanism, lining mechanism, solid works, Arduino.

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### Introduction

In the coin sorting and valuing process, initially the coins are checked for various parameters such as dimensions, based on this coin arranged by the machine exists for the reason to assist individuals with recording down the amount and complete estimation of coin and partition the coin to compare opening consequently. The idea of the coin counter is generally founded on the recognition of the measurement, weight, edge of credit beats by utilizing sensors. The coin arranging plate is intended to sort a diverse kind of coin dependent on the size of coin in various divisions. For the old plan of the gadget, it is only a basic mechanical development that just has the fundamental capacity of tallying and arranging the coin and it has numerous restrictions, for example, the constraint of the amount of coins and neglects to distinguish various coins precisely. These days, the high innovation has indicated the improvement to the considering and arranging machine the cutting-edge gadget turns out to be further developed to running the tallying and arranging measure. Presently, the gadget has the quality of straightforwardness, accommodation and high productivity as the tallying and arranging machine can be mechanized and it carries speed and exactness to us. The coin tallying and arranging framework can be found in different gadgets like candy machine, clothes washer, drinking machine, message seat to enable the machine to deal with crafted by coin checking and arranging

### Literature Review

The advancement of the coin worked machine from its initial innovation until the most recent present day today. This part has likewise examined the idea and hypotheses of the coin worked machine to do the coin checking and arranging measure. Dissecting and comprehending from the writing audit is significant in light of the fact that it goes about as the direction for the task. In the early creation, the mechanical gadget of the coin machine is fit to do the tallying and wrapping a wide range of coin – gold, silver, nickel, and copper in

the USA. It comprises an including board, a different tallying tube for every division and size of coin, and separate metal cylinders for assaulting and wrapping [1].

Sorting and valuing is the cyclic process followed in various sectors in regularly periodic intervals. A modest bunch of coins of any section are put in an including container of the correct size. The cylinder is then run quickly over the scored tracks of the tallying board, where they are kept. Each track holds just ten coins. At the point when the coins are completely positioned on the track, the board is somewhat inclined, in this way tossing the coins into the spaces between the tracks. One finish of the board is then raised, and the coins immediately run down the passageways into the stacking-cylinder to the furthest limit of the plate. This cylinder contains a paper covering, which can undoubtedly be shut when the cylinder is opened. Some time ago coin tallying was an occupation for a specialist, yet this machine approaches in speed and precision the best of the bygone era cash handlers known to banking notoriety [1]. Coin discriminators or ordinarily known as coin selector normally can be found in a coin-worked machine-like candy machine, washing machine, drinking machine, or gaming machine. The capacity of the coin selector is to decide the division of coin just as to restrict any phony or invalid coin. The activity time to identify each coin is quick as conceivable the purchaser won't understand the deferral between every addition of the coin during the activity [2].

### **Coin Discrimination**

In the structure of coin discriminators, it contains the structure and part like a sensor for distinguishing coin, coin entrance, anvil, coin tubes and electronic circuit. For the method of activity, the coin is supplemented to the coin opening and through the coin way at that point goes through the sensor which is situated along the coin way to quantify the coin's physical properties. The properties of coins like measurements, weight, elasticity, conductivity, and dropping time are estimated dependent on the sensor utilized in the coin discriminator. For most of the part, sensors are used to improve the utilization, which are electromagnetic sensor, attractive sensor, acoustic sensor, and optical sensor [2][3].

The most ordinarily sensor that can be found in the regular coin discriminator is the Electromagnetic sensor. This sensor is normally the inductive sensor or Hall Effect sensor. The lasting magnet is typically placed on the coin way and the area of the attractive sensor is straightforwardly inverse to the perpetual magnet. A consistent attractive transition and attractive field quality is produced over the coin way. At the point, when the coin goes and experiences the way, the coin will differ the attractive motion thickness so that the first type of the attractive motion thickness in the space is changed. This subsequent determined difference in the attractive sensor and immediately instigated the electromotive power (emf). The incited emf's greatness is impacted dependent on the metallurgical property like thickness and breadth of the coin. To distinguish the pinnacle estimation of actuated emf, the attractive sensor is associated with an electronic sensor. Since various sorts of coin will deliver explicit pinnacle voltage, it very well may be utilized to check the legitimacy of coin division [3]

### **Coin Detection and Recognition**

In general different sorts of activity of attractive sensors in coin discriminators that actualize the coin separation dependent on attractive properties with the oscillator circuit. Inductors and capacitors are typically used to construct the oscillator circuit for this setup of the attractive sensor. At the point when the coin isn't exist, the oscillator circuit is at the foreordained recurrence as indicated by the estimation of parts and setup. The change in swaying is happening and the outcome will be changed when the coin is recognized depending on the material and thickness of the coin [4].

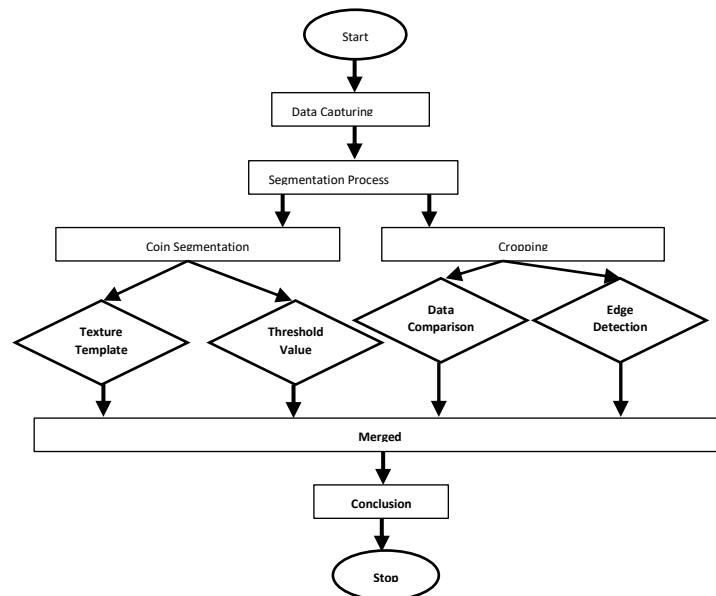


Figure 1 Flow Chart to represent the Recognition

## Coin Counting and Programming

In coin counting and programming process checking the sum and amount of the coin, the coin tallying programming framework can view, print and spare all tallying outcomes to the Personal Computer (PC). A total information base can be worked as the coin checking came about can be spared. The case of the element of utilizing coin checking framework are: transfer coin tallying results to PC, store checking results on PC, printing the checking results, have a diagram of checking history(transaction history) and so on. The development of this coin sorter has the goal to furnish a coin arranging framework with work at fast and high precision in a size-decreased machine [5].

The coin sorter is including a rotatable plate which has a tough top surface and furthermore a fixed arranging head with the lower surface is situated corresponding to the upper surface of the circle. The arranging head from the lower surface makes a quantity of coin leave entryways for the reason to sort and release distinctive sort and estimation of coins. For the reason to accomplish one of the points which is a high number of coins in a little and size-decreased territory, the coins are lined in a short checking of length around 2 inches. So that, this short measuring district comes about the littler width of the arranging head [6][7]

The coin sorter is including a unitary base part. This unitary base part is break in which the arranging head is embedded as it naturally lines up with the rotatable plate shown in figure 2. The unitary base part incorporates various basic coin chutes which every one of the chutes will gets a specific coins leave entryways and the coins are guided for every section [7].

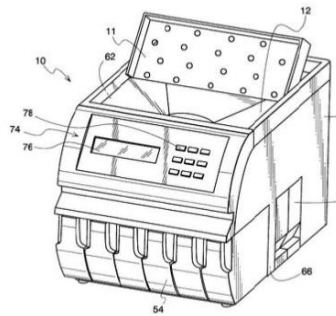


Figure 2 The design of the high speed coin sorter with reduced size(Source: Joseph J. Geib, Scott D. Casanova, Bogdan Kowalczyk, Glenn C. Gray, Steven S. Kuhlin 2000) [7]

### Sensor Based Coin Tallying Machine

The sensor-based coin tallying machine is made with the ability to acknowledge various coins, check the coins and furthermore shows the worth and result to the end client. The coin tallying machine is comprises of a coin discriminator sensor, a coin container with a holder for get quantities of coins, and a feed for acknowledge the coins in the compartment to the coin discriminator sensor, and a regulator for compute the absolute estimation of the coins which is responsive from the coin discriminator sensor. The regulator is controlling the holder with the goal that the coins have been removed from the compartment by the feed. The feed is developed and works with a moveable back-plate one-sided toward the compartment. The roundabout plate rotating option is additionally mounted to the moveable back-plate, and the regulator can administer the coin by moving the back-plate away from the holder [7].

### Methodology

The methodology followed in the design and modeling of coin sorting machine using lining mechanism and sorting mechanism. The coins are set on the pivoting table which is kept on the fixed edge with the assistance of metal rollers. A guide way is fitted to the top surface of the table. So when the table is turned with the manual driving component the coins will go in a specific confined way through the guide way which adjusts the coins in a steady progression in a direct way. Sorting Mechanism - A sheet metal of measurement 3 mm thickness, 350 mm long, 30 mm width is utilized to process utilizing vertical processing machines to require measurements relating to coin distance across. The slider is kept at an ideal edge with the goal that the coin's erosion diminishes and begins to slide. At that point as per its measurements the coins fall in its suitable spaces. For this model Arduino program is developed to automate the process.

### Modelling of Coin Sorting Machine

Coin sorting machine design and modelling carried out using solid works is shown in figure 3. The components of coin sorting machine are guide way, ball bearing, collecting chamber, counting sensor, base fixture, rolling table. The guide way is design with the specification of length of 400mm, breadth of 400 mm and height of 300mm. The slider specification is length of 350mm, breadth of 35mm and thickness of 2mm. The rotating is carried out

Section headings should be left justified, bold, with the first letter capitalized and numbered consecutively, starting with the Introduction. Sub-section headings should be in capital and lower-case italic letters, numbered 1.1, 1.2, etc., and left justified, with second and subsequent lines indented.

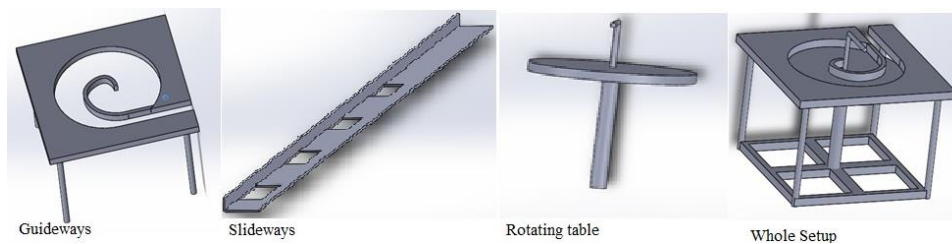


Figure 3 Design of Coin Sorting Machine Components Using Solid Works

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### Design of Coin Sorting Machine

The design of Coin of sorting machine done based on the coins going to be used for counting and sorting purpose. The coin is to be inserted into the slot of the machine, the coin falls with free wall with the centre of gravity, i.e. free falling velocity. The dimensions of one rupee coin, two rupee coin and ten rupee coins are measured using the digital Vernier calliper(Figure 4). The sliding velocity and acceleration of coins are determined using the Equation (3) and (4).



Measurement of One Rupee Coin



Measurement Value of One Rupee Coin



Measurement of Two Rupee Coin



Measurement Value of Two Rupee Coin



Measurement of Ten Rupee Coin



Measurement Value of Ten Rupee Coin

Figure 4 Measurement of Coin and Guide Way Slots

Table 1: Measurement of Dimensions of Coin Using Vernier Calliper

| Coin | Dimensions (mm) | Slot Dimension(mm) | Clearance(mm) |
|------|-----------------|--------------------|---------------|
| 10   | 27.14           | 27.67              | 0.53          |
| 5    | 23.21           | 23.27              | 0.06          |
| 2    | 24.96           | 25.06              | 0.10          |
| 1    | 21.85           | 22.07              | 0.22          |

## Determination of Sliding Velocity and free Falling Velocity of Coins

The free falling velocity of coin is expressed as  $V^2 = 2as$  (1)

Where V is the free falling velocity in m/s, a is the acceleration in  $m/s^2$ , s vertical distance travelled by the coin in mm.

The sliding velocity is determined using the following equations

$$F = \mu mg \sin \theta \quad (2)$$

From the Newton second law of motion  $F = ma$  (3)

Equation 1 states the force exerted by an object over a sliding surface having a coefficient of friction ( $\mu$ ) for mild steel is 0.6. The angle of the slider is  $\theta = 20^\circ$ .

From equation (2) and (3) the acceleration is derived as  $a = \mu g \sin \theta$  (4)

Since the relationship between acceleration and velocity is expressed as

Acceleration = (Final velocity – Initial velocity)/Time.

When the coin falls, its initial velocity is zero, acceleration = final velocity / time

Therefore the final velocity = acceleration \* time.

The sliding velocity and free falling velocity is determined for the coins taken into the study is given in the Table 2.

Table 2: Free Falling and Sliding velocity of Coins

| Coin | Distance travelled (mm) | Free falling Velocity (m/s) | Sliding Velocity(m/s) | Acceleration ( $m/s^2$ ) |
|------|-------------------------|-----------------------------|-----------------------|--------------------------|
| 10   | 12.5                    | 0.49                        | 0.8                   | 2.013                    |
| 2    | 15.5                    | 0.55                        | 0.664                 |                          |
| 1    | 17.5                    | 0.58                        | 0.56                  |                          |

## Results and Discussion

The coins are tested with the coin sorting machine for various trials. Since the machine is automated. From the study its reveals that the one rupee coin efficiency is higher than the ten rupee coin and 2 rupee coins. The variation is due to the coefficient of friction, geometric shape of the coin and weight of the coin for the given slider angle of ( $\theta$ )  $20^\circ$ . This is calculated using the 10 trials of inserting the coins in the slots and number of times the coins was accepted and rejected was noted

## Conclusion

The coin sorter objective is to save the time where huge collections of coins are stored and periodically valued. The proposed model can be extended to any type and size of coin to value the time value of the individual. The proposed system improves the accuracy and effectiveness. The proposed coin sorting methodology and model results with exactness in determining the value of the coin and sorting the same. The fundamental challenging issues are in identifying and sorting various small size coins universally. This can be addressed with the help of picture sensor in the start of the slide and having servo engines that are constrained by Arduino so the coins don't blend out and out. Further this work can be expanded by developing automated system by

using huge data of the coins at various position to improve the sorting efficiency and effectiveness using machine learning algorithm to make the coin sorting system smart enough.

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