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Design of a Low Cost Coin Acceptor for Vending Machine

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Abstract: Coin acceptor is a device that receive and identifies the validity of the coin. It works by analyzing the coin it received based on its mass, size, diameter, thickness, metal composition, and then sends an appropriate signal through the output connection. However, the cost of purchasing the device is rather high compare to self-fabricate where the current surveys on online shows that the device will cost around RM150-300. This cost is consider high for SME who just planning to start their vending machine business. Therefore, the alternative to come out with a design for a low cost coin acceptor for the vending machine had been done. To make sure the cost will not be high the scope of the project has been determine where the device is designed to only accept the second series version of RM0.50 which is 27 mm in diameter. In this project, the design is produced by using Solidworks software and the coin identification mechanism was designed by integrating the like of sensors, actuators and microcontroller which is the basic component of a coin acceptor. To further reduce the cost a new mechanism of a rejection hole were introduced to replace and eliminate number of sensor used. The expected cost to fabricate the design was expected to be around RM138 and further cost reduction can be done with further research on reducing the product component.

Keywords: Coin Acceptor, Design Coin Acceptor , Vending Machine

1. Introduction

Despite the popularity of cashless transactions, coin acceptors are still widely used in applications such as parking, laundry services and vending machines[1]. The coin acceptor mechanism is one of the essential components in the vending control system. The objective of a coin acceptor is to receive coin and identifies the validity of the coin. Coin acceptor work by analyzing the coin it received based on its mass, size, diameter, thickness, metal composition, and then sends an appropriate signal through the output connection. For today's vending machines, many general forms of coin acceptors are in use. There are many moving parts in the very complex acceptors commonly used in soft drink vending machines, but they work quite well in the clean dry environment where these machines are normally

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located. The coin acceptor consists of mechanical parts and system security in a small box that accepts the "correct coin". Furthermore, there are many newer versions of coin acceptors at the market nowadays that offer many additional features, and for sure the cost is also increasing at the same time with the features. The value of sensors in the coin acceptor itself is also very pricey. Those sensors can integrate with a high-security system to detect counterfeit money and avoid scam that can make the business loss of profit and money.

However, the setup for a vending machine is quite expensive. There will be a high initial setup cost to buy the machine itself before the vending machine business can be started. One of the costs that contribute to the high setup cost of this vending machine is the coin acceptor where the net price can be in the range of RM150-300 and reach the price of above RM1000. Therefore, there are requirements to find practical methods to accept coin at a lower price.

The objectives of this project are to come out with a design of a low cost coin acceptor for vending machine and to develop a new mechanism of coin acceptor. The cost of purchasing the device is consider high for SME who just planning to start their vending machine business compare to self-fabricate. Therefore, the alternative to come out with a design for a low cost coin acceptor for the vending machine had been done.acceptor that can reduce the hardware and maintenance cost. To make sure the cost will not be high the scope of the project has been determine where the device is designed to only accept the older version of RM0.50 which is 27 mm in diameter. The design of this project is done by using the Solidworks software. This project produced a design for coin acceptor that are installed in a vending machine that can also be sell or rent for a low price. The low cost of producing the coin acceptor allow people to own and rent the vending machines and start their own business. Plus, the coin acceptor help to gain profit earlier and reduce the overall setup cost of the vending machine due to the low setup cost of the coin acceptor.

2. Materials and Methods

2.1 Conceptual design

The coin acceptor requires a coin introduction chute that accepts coins or tokens and guides the coins to the bottom of the coin introduction chute in the vertical registry by the help of gravity feed. For authentication purposes, the coin sensing gate is fitted with various sensors to detect different parameters of the coin as the coin drops through the coin sensing gate [2]. When the coin acceptor accepts a coin, this is when the coin validation begins. The coin passes by the metal and proximity sensors. After the coin validation process, a decision gates actuated by solenoids will control the route of the coin to decide whether the coin is genuine or else and accepted or rejected [3]. Solenoids are widely used within coin acceptor to control the plastic gate systems. They are used for coin acceptance, rejection, sorting and pay-out [4]. Metal sensor can detect the coin and work as a system for distinguishing coins with regard to their metal or ferrous material. Coins are inserted into the acceptor and transported by a rotary mechanism that stops when a coin is precisely located in relation to an adjacent metal sensor. The metal sensor is then activated in order to have a measurement and justification toward the coin material in the repeatable stationary position [5]. A coin that is inserted in a coin acceptor will run down a path through the sensors station where the validation toward the inserted coin will happen. The validation process will test and indicate the coin material and metallic content. The signals that come from the coin parameter are then digitised and the data will be compared with the stored data by the microcontroller to evaluate and make decision whether the coin is accepted or rejected. If the coin is accepted then the microcontroller will operate a gate to accept the coin and direct it to an accept path or else the gate will remains static where the coin will be directed to reject path [6].

The method or workflow of the project from the start until the end is shown in the flowchart in Figure 1. The workflow start by identifying the problem statement, objective and scope of the project. After that is overview of existing design in the commercial market and collect information on the basic

mechanism of a coin acceptor. Next, is to design own working mechanism that helped to achieve the objective. The final design selection process were made by applying the pugh matrix method to select the best design for the project. After the design is completed, the simulation test were done to test the design working mechanism to check whether the design can function, accept and reject coin as planned.

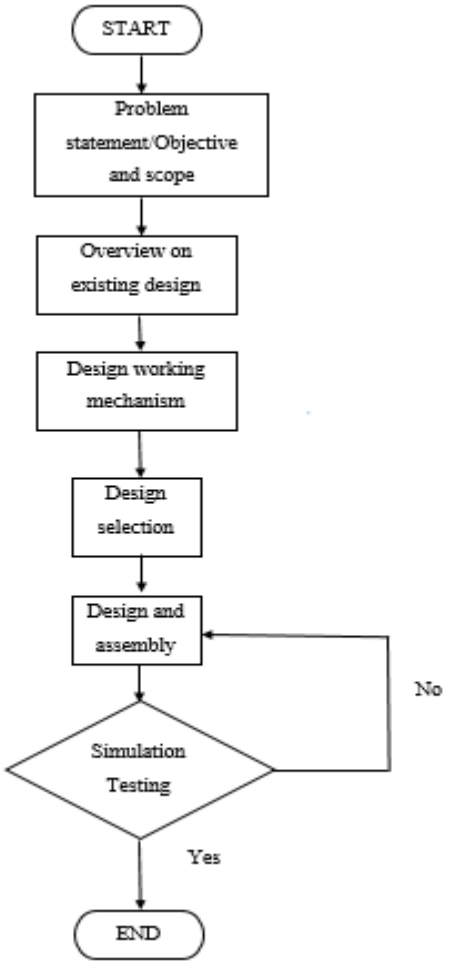

Figure 1: Workflow of the project

2.2 Design working mechanism

Material used for the design of the coin acceptor for this project is metal sensor. A metal detecting sensor is a device that detect the presence of any metallic object. This sensor can be used to detect the presence of coin when inserted in the acceptor and at the same time to check whether the inserted piece is a valid coin or otherwise. This sensor help the decision of whether the inserted coin get accepted or rejected. After the coin is done validated and passing through the metal sensor, it then reach the flipper that work with a solenoid to either accept or reject the coin. The flipper stay in its original position if the coin is deemed genuine and create a path for the coin to pass by it to get to the counter. If the coin is not genuine then the solenoid pulls the flipper to flipped it downward to create an opening so that the rejected coin can then return to the hand of the customer through the rejection outlet. Solenoid is the generic term that used an electromagnet for a coil of wire. It also refers to any device that uses a solenoid to convert electrical energy to mechanical energy. The device creates an electrical current magnetic field and creates linear motion using the magnetic field.

The coin acceptor also used the proximity sensor. This sensor are typically used to detect the presence of nearby objects without any physical contact. A proximity sensor is a non-contact sensor

which detects an object's presence once the target enters the field of the sensor. Sound, light, infrared radiation (IR) or electromagnetic fields is used by the sensor to identify a target, depending on the type of proximity sensor[7]. The coin that passed by the metal sensor for validation then passed by the proximity sensor that calculated how many coin that has been accepted. The coin acceptor is controlled by arduino. Arduino is an open-source forum for electronics development and programming. It can receive and send information to most devices, even through and to the internet to command the specific electronic device. It uses a hardware called arduino uno circuit board and software to programme the board. The device introduced a new mechanism used by this design of coin acceptor with a rejection hole that automatically reject coin that are smaller than 25 mm in diameter. It is a mechanism that are introduced to match the scope of the project where the coin acceptor can only the second series of RM0.50. Figure 2 shows the flowchart of the design project working mechanism where the device can only accept coin that are 25 mm in diameter and automatically reject coin that are smaller than 25 mm through the rejection hole.

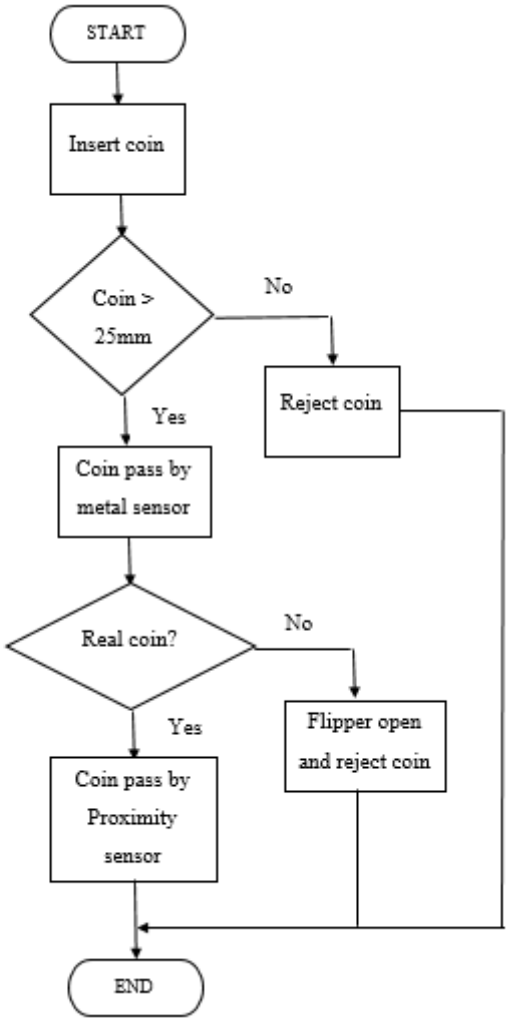

Figure 2: The flowchart of the design project working mechanism

The design is completed by using Solidworks and is ready to be tested with simulation test. Figure 3 shows the completed design for the low cost coin acceptor that are equipped together with the metal sensor, proximity sensor, solenoid and arduino. Figure 4 shows the (a) internal part and (b) side view of the completed design for the coin acceptor.

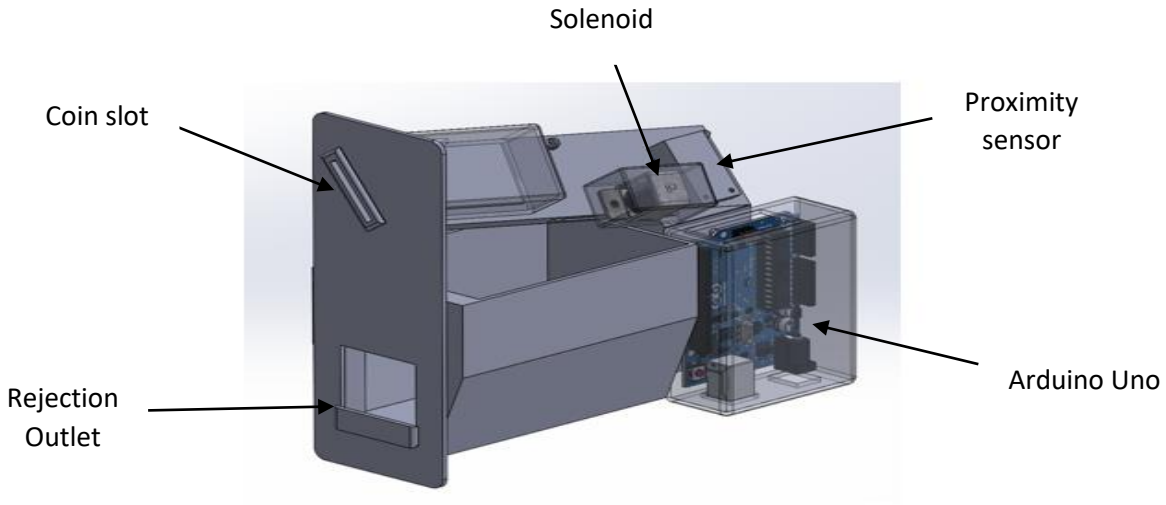

Figure 3: The completed design for the low cost coin acceptor

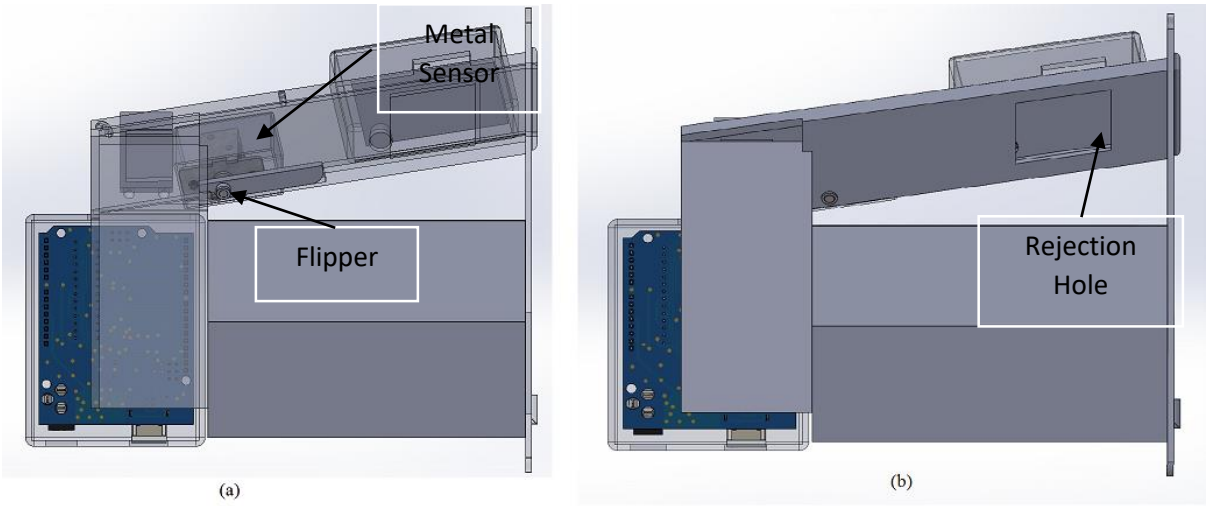

Figure 4: (a) The internal part (b) Side view of the completed design for the coin acceptor

The design was completed and the design working mechanism work as shown in the flowchart in Figure 2. At first the coin is inserted into the acceptor through the coin slot and directly pass through a rejection hole that work to accept and reject coin by their sizes. For coin that are smaller size than 25 mm, it directly drop by the hole into the rejection outlet where the coin will be return to the one who inserted it. While for coin that are bigger than 25mm will pass through the rejection hole and then pass by the metal sensor to be validate if the coin inserted has the material characteristic of a genuine coin. If the coin is deem to be a fake one then the flipper that positioned after the metal sensor will flip to open up a hole for the coin to be rejected and return to the one inserted the coin. This flipper is actuated by a solenoid. As oppose to the case that just been mentioned, the flipper remain at its original position if the coin is a real one and being accepted. The solenoid will not flip the flipper so that the coin can be directed to the proximity sensor. The proximity sensor act as the counter in this design where the coin that are accepted pass by it where one coin is counted as RM0.50 and if two coin it is counted as RM1.

The rejection hole that work to reject coin that is smaller than 25 mm in size is the new mechanism that work to replace sensor and to reduce the hardware cost and maintenance cost. This hole work by using the same application of coin sorting system to bring the coin down and reject the coin back to the

user. This rejection hole help to achieve the project objective and scope which is to come out with a low cost coin acceptor that accept only older version of RM 0.50 cent that are bigger than 25 mm in size.

If the design is to be fabricated, the coin acceptor then be fabricated by using the 3D printing process which uses PLA filament as the printing material. The PLA filament is one of the most common used 3D printing filaments. It is the default recommended material because it is more eco friendly material compare to others and it produces good surface finish and reasonable accuracy of the final product[8].

3. Results and Discussion

3.1 Simulation test

The design is tested by using the Solidworks simulation motion to make sure the design is able to accept and reject coin and works as explained in the design working mechanism. The device working mechanism is tested to see whether it can accept a genuine coin, reject coin through the rejection hole and rejection of fake coin that have the size that are larger than the rejection hole.

At first, the device were tested to check whether it can receive a genuine second series of Malaysia RM0.50 cent. A genuine 27 mm coin were inserted to the coin acceptor to run the test. Figure 5 shows the (a) genuine coin accepting test and (b) the coin passed by the rejection hole. The 27 mm genuine coin were inserted into the device that passed by the rejection hole due to the dimension of the genuine coin is larger than the hole which allowed it to passed by it.

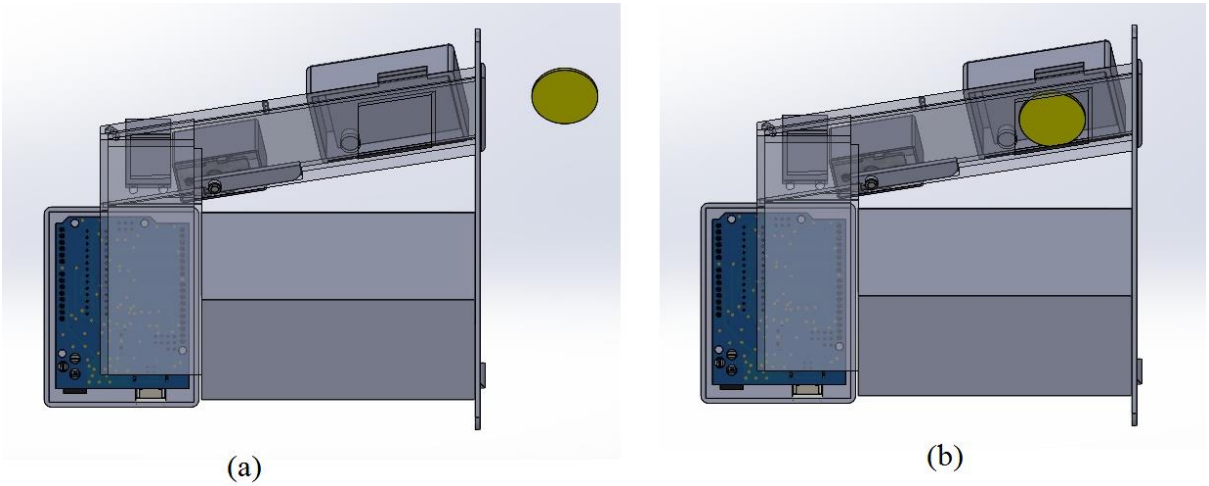

Figure 5: (a) Genuine coin accepting test (b) Coin passed by rejection hole

The genuine coin then passed by the metal sensor to be tested for its material characteristic whether it is metal and when it is tested to be genuine, the coin then passed by the flipper that stay at its original position to be the path for the coin to get to the proximity sensor. As shows in Figure 6 (a) coin passed validation and (b) coin directed to the proximity sensor.

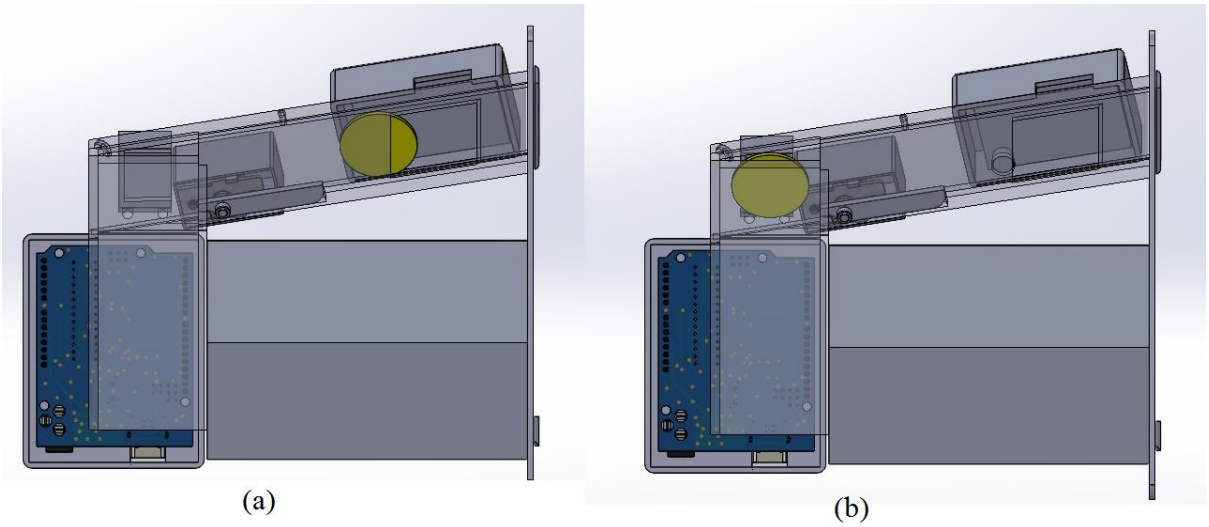

Figure 6: (a) Coin passed validation (b) Coin directed to proximity sensor

Once the coin passed by the proximity sensor, the coin is accepted by the device and is ready to accept another coin that is deemed genuine. Figure 7 show the genuine coin is accepted by the acceptor.

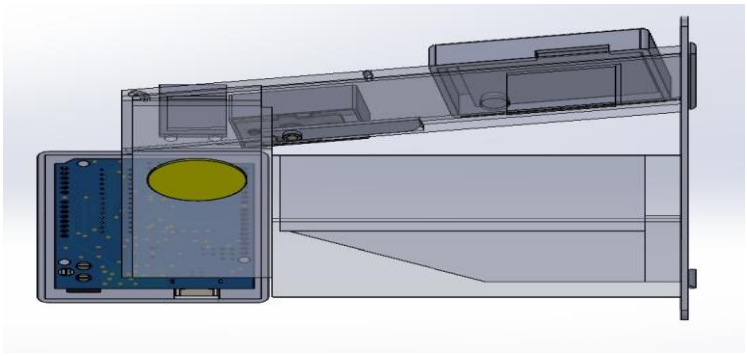

Figure 7: Genuine coin is accepted

Next is the rejection hole test, the coin with diameter designed at 23 mm fall to the rejection chute via the rejection hole because the coin is smaller in diameter than the hole. This shows that the rejection hole working mechanism to drop any coin smaller than 25 mm in diameter works well and the mechanism does not require any form of work by the device. Figure 8 shows the small size coin is to be inserted into the coin slot and stop through the rejection hole while Figure 9 show the coin drop through the rejection hole to the rejection outlet.

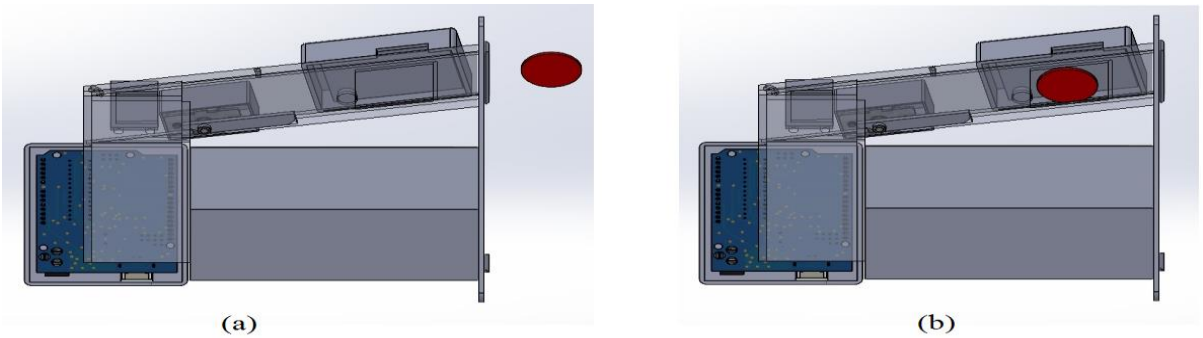

Figure 8: (a) Rejection hole (b) Coin stop through the rejection hole

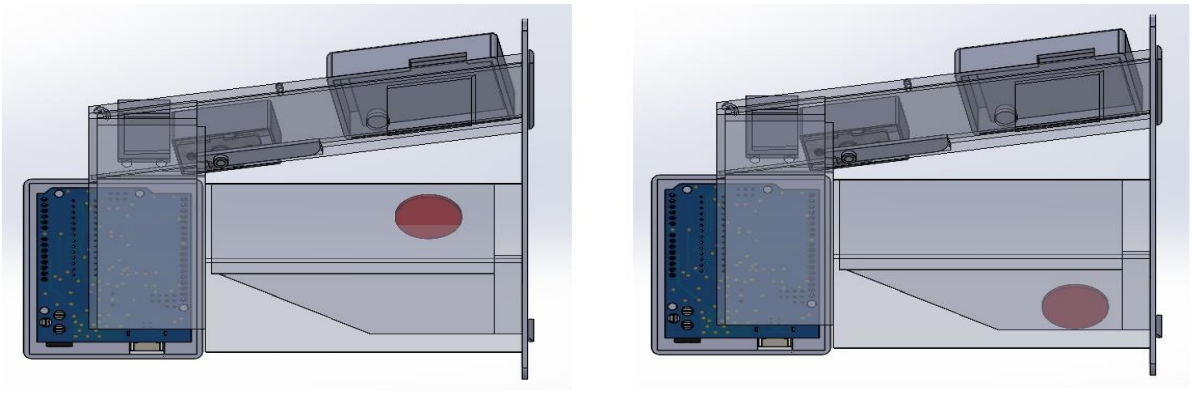

Figure 9: Coin drop to the rejection outlet

The final test on the design working mechanism is the test on the flipper to reject fake coin that are bigger than the 25 mm in dimension. For this test, a fake coin with diameter 27 mm that exceed the rejection hole size were inserted. This is to ensure the hole opened up by the flipper is enough to reject a fake coin validated by the metal sensor and rejected the coin by the flipper flipping down actuated by the solenoid. Figure 10 show the (a) fake coin inserted to the coin slot and (b) fake coin validated by metal sensor.

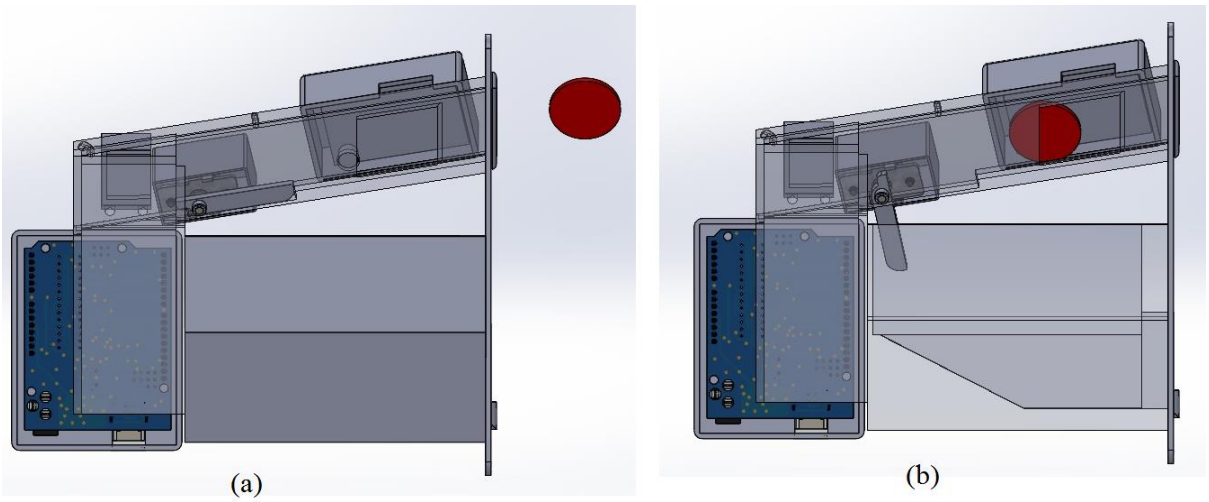

Figure 10: (a) Fake coin inserted to the coin slot (b) Fake coin validated by metal sensor

The fake coin that able to passed by the rejection hole then went through the metal sensor to sense that it is a fake coin which then triggered the flipper to open up a hole to reject the coin. The flipper is designed to ensure fake coin or fake rounded object that passed by the rejection hole are ejected by the flipper flipping down and rejecting the coin back to the user. This is to ensure there will be no scamming during the transaction. Figure 11 show the (a) fake coin dropping through the flipper hole and (b) fake coin rejected and reach the rejection outlet.

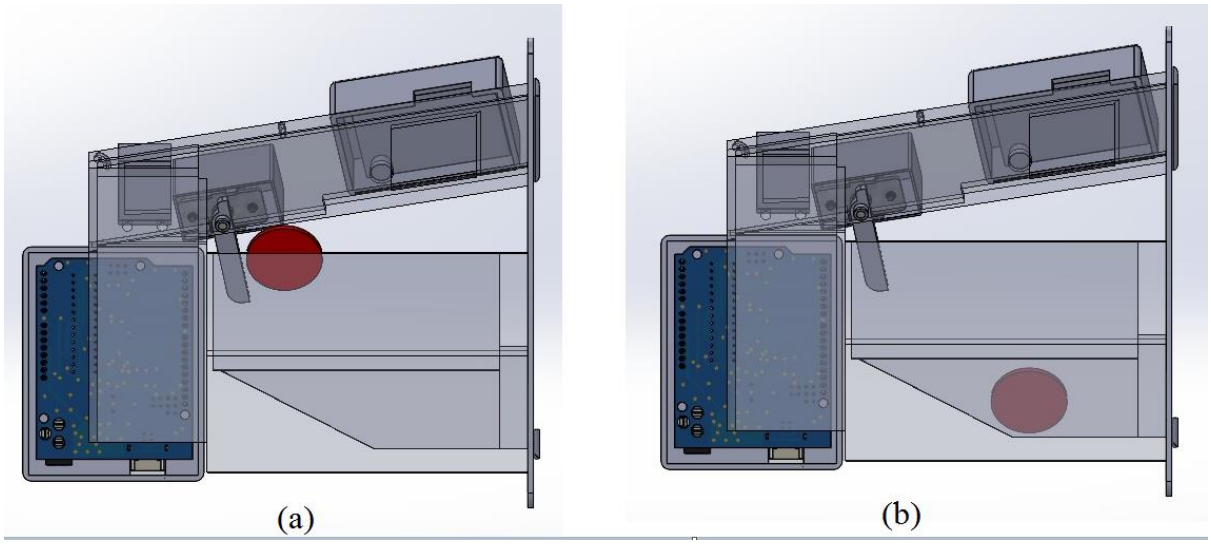

Figure 11: (a) Fake coin dropping through the flipper hole (b) Coin rejected

3.2 Estimated cost

The component of the design of the coin acceptor consist of sensors, actuators and microcontroller. Table 1 present the list and price done by doing online survey for the material and item costs.

Table 1: Material costing

No.	Item	Quantity	Price (RM)	Total Price (RM)
1.	PLA Filament	1	30.00	30.00
2.	Metal sensor	1	5.00	5.00
3.	Proximity sensor	1	10.0	10.0
4.	Solenoid	1	8.00	8.00
5.	Arduino Uno	1	15.0	15.0
		TOTAL		68

Other than that, there were also additional cost to produce this coin acceptor. Table 2 represent the other costs for this project and Table 3 represent the total cost if the design is to be fabricated.

Table 2: Other costs

No.	Item	Quantity	Price (RM)	Total Price (RM)
1.	Fabrication cost	1	40	40
2.	Manufacturing cost	1	30	30
		TOTAL		70

Table 3: Total cost

No.	Item	Total Price (RM)
1.	Material cost	68
2.	Other costs	70
	TOTAL	138

The total expected cost to fabricate this design will be around RM138 which is lower than the commercial coin acceptor that can be found in the online shopping platform where the price range is estimated around RM150-300.

4. Conclusion

In conclusion, the objectives of the project which is to come out with a design of a low cost coin acceptor for the vending machine is achieved where the estimated cost is going to be around RM138 which is lower than the market price where a coin acceptor approximately cost around RM150-RM300. This is the price that can be found in the online shopping platform such as Shopee and Lazada. Next, the rejection hole works as a new mechanism that help to achieve the objective of the project by applying the project scope where the acceptor can only accept the second series of RM 0.50 which is 27 mm in size, and at the same time lowered the hardware and maintenance cost for this design by reduces the number of sensor and hardware used. This is the reason that the cost of producing the design is lower than the market price which help to achieve the objective of the project which is to come out with a low cost coin acceptor for the vending machine.

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