

# Electrically Operated Multipurpose Trolley

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**Abstract.** Present paper deals with design and fabrication of industrial trolley which can be used to transfer luggage or items from one place to another place. A trolley nowadays are important for transferring different items from place to place in our daily life or even in working life as per the requirement. We can see trollies in shopping mall, airport and industries for handling the goods. In the airport, passengers use trollies to transfer their luggage till the check in counters. Sometimes they face higher weight issues at the check in, making them pay the excess baggage charge or dispose of few important items thereof only. This creates an uncomfortable and awkward situation at the check in. And if the passenger is an old age or senior citizen it's really a very panic situation. Additionally, a survey based on a prepared questionnaire carried out at Muscat airport revealed the need for substantial improvements in the present trollies in terms of comfort in luggage handling, loading and unloading of the luggage and the need for weight of the luggage at the time of loading itself. Furthermore, many food and kitchen industries use trollies to receive and transfer the goods items to the store after weighing them. The Arduino based electronically operated steerable trolley developed here aims to address few of these key issues by measuring the weight of the items directly from the trolley with easy movement by electrical power from battery. The trolley has been designed using AUTOCAD and stress analysis of the structure has also been performed using CREO V3. The fabrication is completed as per the design and tested for its performance. The testing performed on the trolley shown that for the maximum load of 90 kg including the passenger weight, the time taken by the trolley to travel on a smooth horizontal airport surface for covering a distance of 10 m with full and half rated speed of motor is 7 seconds and 9.6 seconds only respectively. The trolley was also successfully tested for elevated slope at the Muscat airport requiring additional 25 seconds more at the full rated speed at maximum loading condition of 90 kg. Additionally the trolley provides few added benefits such as charging of smart devices by using photovoltaic system technology and sliding platform for easy loading and unloading of the goods. The future work includes use of lighter aluminum alloy material along with use of solar panels for operation of the trolley.

## 1. Introduction

Luggage is an almost indispensable part of traveling. On the other hand all airlines allow limited weight of luggage for every passenger and if it goes beyond the limit, the passenger has to reduce its weight or pay extra money at the counter. For example, Oman air, which is the flagship carrier of the Sultanate of Oman, allows only 30kg of baggage for each of their passenger [1]. This could be challenging specially for those who are moving to live in other country. As a result, passengers may suffer a hassle in front of the check-in counter while weighing their luggage and trying to avoid extra airport charges. Never the less, the offloading, opening, reducing closing and uploading luggage on the counter scale till its weight is within the permissible limit might cause inconvenience to other customers who are waiting in the queue. Another, most of the industries like industrial kitchen use trollies for items for transportation. The items are received as inventory which has to be weighed before transporting to the store which needs more effort and more number of staff to do this process. Therefore, a method that could help in avoiding long queues at the airport check-in counter and improve the industrial trolley transportation was thought for.



A trolley is a device that eases the transportation of luggage from one place to another. Depending on what is to be transported, trolleys can be plastic, metal or wooden. Wheel type and size can also vary depending on the types of ground the trolley is traveling over and the work environment. The aim of this report is to introduce a new innovative product that can add value in the current aviation industry and increase the quality of airport available facilities and customer service.

The objectives of this project are to design, fabricate and testing of a multipurpose trolley in order to avoid the hassle of extra airport charges, to avoid the delay that may be caused by some passengers in reducing weight of luggage at the counter, to make the process of up/down-loading luggage of the trolley easier, to get power to charge smart device from the trolley itself and easy as well as safety for users to drive and control.

The advantage of automatic trolley is that it runs automatically by electrical power which get power from rechargeable battery. Two DC motors are connected in back wheels which moves the automatic trolley and control the direction (forward, backward, left and right) of it which is achieved by using joystick and speed controlling by voltage regulator by using Arduino programing system. Elastic rope is provided to hold items on the trolley taking into account for safety. Sliding platform is designed to help carrying luggage on the automatic trolley without handling it. Power bank is attached and get power from photovoltaic cell to charge all smart devices. Weighing the Items or luggage is possible on the automatic trolley and the weight will display on the digital screen and a vertical plate is provided for advertising the item.

Normally in shopping mall there are trolleys called shopping carts [2] which look like basket used by costumers to transport their purchased items inside shop and to the car parking area. Usually super market workers returned the trolley in the stored area after used by customers and some super markets put a coin lock system for each trolley to encourage the customer to return the trolley back to the store area by themselves. Also, this type of trolleys cannot adjust the height of pulling and pushing motion and also need a manually pushing or pulling heavy loads which can cause potential musculoskeletal injuries. During shopping many customers especially parents cannot enjoy because they have to take care to their children. For that the automatic trolley used for shopping mall or supermarket is designed and fabricated which can sense and follow the customer while shopping.

The automatic trolley used sensors system for target position, loading amount, control and communication between trolley and remote consoles for control signals. Also it's attached with ultrasonic sensor to prevent objective collision. This trolley has the drive and steering mechanism which is motorized by DC batteries. It gets activated by showing a tag, then it will start following the tag by sensing it. If any obstacle is present between trolley and the tag, it will stop and give buzzer sound and when that objective move away it will start moving.

This trolley can trace black line with the white surface on the floor by Infra-Red (IR) line sensor equipped with IR transmitter and receiver. The microcontroller will receive the sensor output and give a right command for the motor driver for moving the trolley in any direction according to the commands given. It's programmed based on the sensor output.

In the conclusion, the customers can enjoy shopping and take care of their children by only selecting the items and put it inside the trolley without any effort or worry about the trolley movement which uses a sensor system that can follow customers and maintain safe distance between customer and the trolley while movement in shopping malls in smart way.

This project is made exclusively for the people [3] who has a physical challenge to travel from one place to another. Mobile aid wheel chair has been designed with joystick controller and can be run both indoor and outdoor environment with all possible direction of movement like right, left, back and straight. In addition the DC motor is used for wheel chair movement which gets the power from the led acid batteries. The batteries are rechargeable, weightless and harmless compared to other batteries. Also, this project use GSM and GPS system for mobile application and possible to track trolley user using the Google maps. The construction of the wheel chair in made from mild steel and this project can be used in hospitals which can improve the comfort of patient during their needs such as visiting various clinical points such as scan center. This will result in the effort and cost involved with the care taker. The extension of the project can use solar panel for the power supply. The solar energy will be given to the dc to dc converter through the rechargeable battery to the embedded controller and the motor system which will be useful for saving energy. Some intelligent sensors can also be used i.e. a sensor that senses our brain thinking, that automatically grabs the direction we need to move. The path required to travel can also be guided with the help of Google map through voice controller. These developments would make the proposed work a complete power pack application.

This journal [4] is about design and fabrication of a stair climbing hand trolley which can carry and transport goods on floor as well as upstairs with less effort comparing to carrying manually that reduce cost of transportation and human labor. This trolley has three wheels on the left and three on the right that enable it to climb upstairs. It is observed that the trolley moves uniformly over a flat surface as well as upstairs without any jerk, vibration and noise. Modification on the existing design such as fixing a separate frame enable the easy movement of the trolley for climbing steps of different sizes. Trolley performance was good with uniform sizes for the steps compared to non-uniform step size and the trolley could operate up to maximum of 44o inclination of the steps.

Material handling trolley is designed [5]. In casting industries most difficult task is to carry and pour molten metal into moulds where the risk associated with molten metal handling is more. At present this task is operated manually by crucibles and various ladles like gear ladle for both small and medium scale industries. Now a day's manpower requirement for this process is minimum two workers for ladle handling. The aim is to reduce manpower by employing transfer trolley mechanism for molten metal handling and pouring so only one worker will be able to perform this operation. It will make this process more efficient and user friendly. As the labor requirement is reduced so alternately the cost of production is also reduced. The design of the trolley is safe and can be implemented in casting industries or foundries for small, medium scale castings and manpower requirement are also reduced to only one worker thereby the production cost is also reduced.

A Smart Trolley which use a chip [6] with two bar code scanners and a Battery kit to allow users to self-checkout at Super Markets. Normally the customers have to drop every product which they wish to purchase into the shopping cart and then proceed to checkout at the billing counter. The billing process is quite tedious and highly time consuming and has created the need for shops to employ more and more human resource in the billing section, and yet waiting time remains considerably high. In this paper, "Intelligent Shopping Basket" is proposed which aims to reduce and possibly eliminate the total waiting time of customers, lower the total manpower requirement and reduce the expenses involved in manpower and infrastructure thereby increasing the overall efficiency. The scanned products are automatically billed in the wireless smart device for their purchases, thereby significantly reducing turnaround time. By this mechanism, the time consumed for work of scanning and billing every single product at the cash counter can be avoided.

Al Taws kitchen was visited [7] to know their transportation process. It is a big kitchen and they are using trollies for transferring items from the receiving zone to store. The items are received as inventory which has to be weighed before transporting to the store. The worker moves the trolley about 250 meters each way (from receiving zone to store area) that involves more human labor and cost involved in transporting the goods.

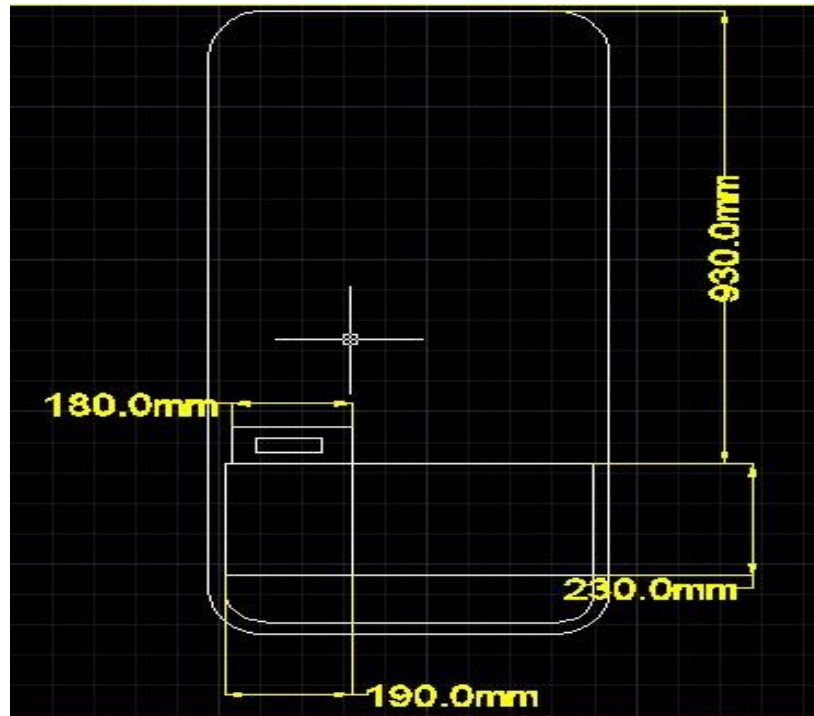
A detailed survey is made for the passenger [8] usage of existing trolley at Muscat international airport. A detailed questionnaire is prepared for various factors such as trolley control, replacement of automatic trolley with manual trolley, size of the trolley, weight of the trolley and electronic gadget charging and majority vote for the electrically driven multipurpose trolley.

## **2. Research Concept**

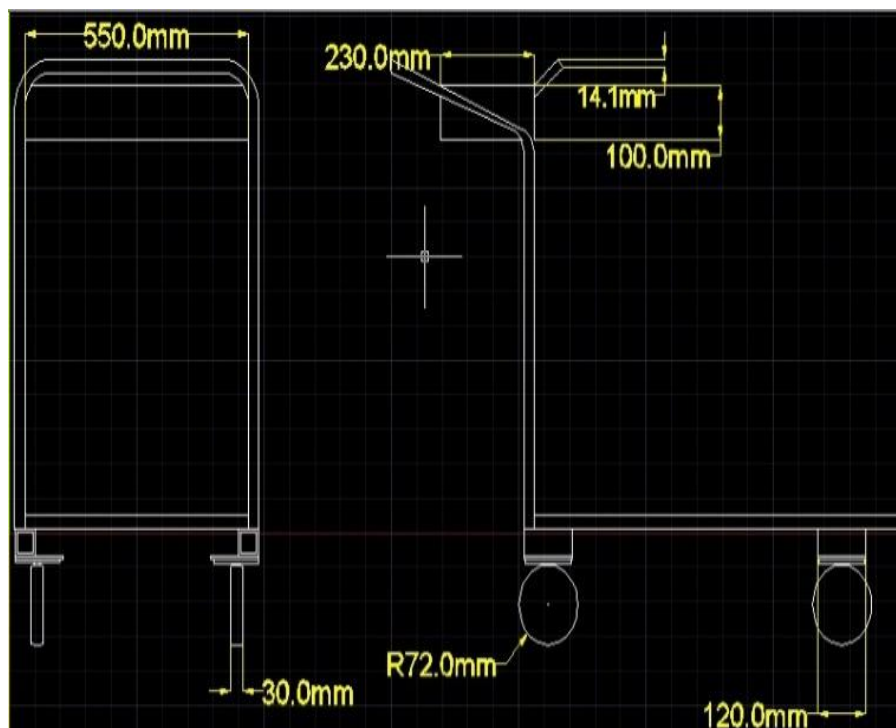
The design and fabrication of industrial trolley using electrical power to transfer luggage from one place to another reduces human effort. The present work is expressing the same concept using electro-mechanical advantage. Sliding platform concept for loading and unloading is used to avoid vertical lifting of heavy weight. To avoid excess baggage issues at check in counter at the airport, digital display of the weight is also incorporated into the trolley.

## **3. Methodology of Experiment**

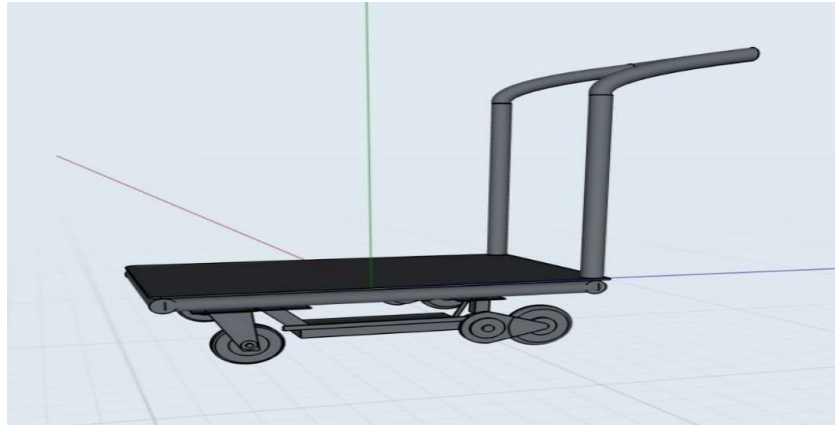
There are many aspects that have to be considered when designing a trolley. These aspects have to be considered carefully so that the device works in a convenient and safety way according to the needs [9]. Trolley height of 1400mm or less allows most users a reasonable view of the area ahead of the trolley. Trolley length should be between 1.5 and 2 times its width because if it is too long, the trolley is difficult to steer, or fit into lifts or other small spaces and if it's too short, operators tend to steer the trolley by twisting their spine. The maximum load need to carry is 90 kg. The wheels which are possible to use with this trolley are rubber tire wheels. Material selection for the trolley is very important as the heavy load on the trolley has to be carried by the parts and parts strength is based on the type of material used. Moreover the parts should have enough strength to carry the load. Material should be chosen such a way that the parts are capable of supporting the load at the same time possess less weight. Mild steel is selected for the trolley as it possess more strength, easily available, easy to fabricate and cheap. AUTOCAD drawing of the top, side and rear views of the trolley are given below. 3D modelling of the trolley is done using sharp 3D software.



**Figure 1** AUTOCAD Top view of the trolley



**Figure 2** AUTOCAD Rear and side view of the trolley



**Figure 3** 3D drawing of the trolley

Analysis for stresses in the automatic trolley structure due to various loads applied are analysed using ptc Creo v3 software [10] and the details of stress values are given in Figure 4 below.



**Figure 4** Stress analysis of the trolley structure using PTC Creo v3 software



Maximum stress on the structure is found below the permissible value for the material and hence the design is safe for carrying the load.

Fabrication process is the next step taken after designing the project. In the project fabrication process needed to make the base plate, framework of display board and display board. The steel base plate form is cut into the required dimensions using a cutter and finished using grinding machine. Similarly the hollow steel tube is cut into the required dimensions using a cutter machine and bend into the required shape using manual arching followed by welding it to the base. Supports for wheels are cut as per the requirement and welded to the base of the trolley. Wheels with rubber tire are fitted to the wheel support. Control panel is made as per the requirement to accommodate power bank, voltaic cell, joy stick, voltage regulator and arduino board [11]. A plastic container is fitted at the bottom of the base to accommodate battery, motor drivers as well as the relays. Trolley is painted using silver paint. The complete assembly of the trolley is shown in Figure 5 below.



**Figure 5** Two different views of the complete assembly of the trolley

#### 4. Results and Discussion

Automatic trolley has been fabricated and tested for its performance and the outcome of the testing has been presented below. Table 1 shows the difference between real weight and scale reading in ten times.

**Table 1** Real weight and scale reading

	Real load (kg)	Scale reading (kg)
1	0	0
2	10	9.8
3	20	20.2
4	30	30.6
5	40	40.4
6	50	50.6
7	60	60.5
8	70	70.4
9	80	80.5
10	90	90.5

The automatic trolley weighing scale result shows the high accuracy when compared with the real weight. The weight used is rice bag and dumbbell weights. The maximum difference is 0.6kg which mean 94% accuracy.

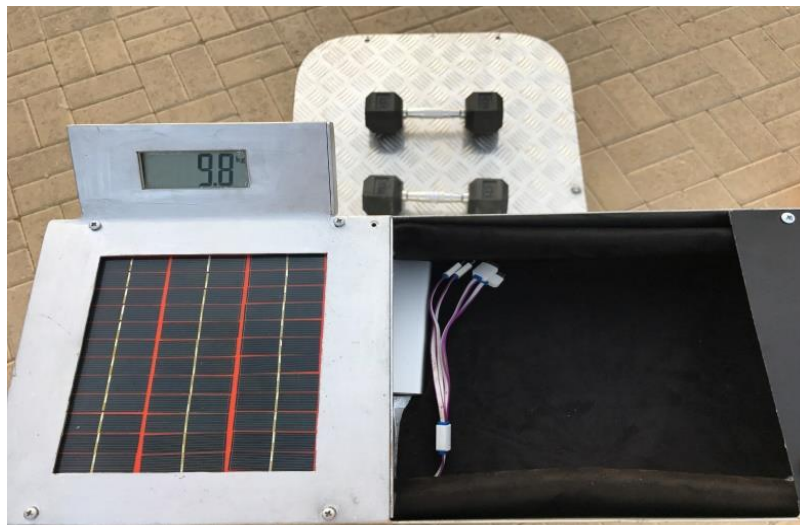
**Figure 6** Accuracy test of weighing scale

Table 2 shows the required time in seconds for automatic trolley to travel a distance of 10m with different weights carried for motor run at full speed as well as half speed.



**Table 2** Time required to travel 10m

	weight carrying	Time to cross 10m (seconds)	
		50% motor speed	100% motor speed
1	0	5.25	4.32
2	10	5.6	4.6
3	20	5.9	4.9
4	30	6.5	5.2
5	40	7	5.5
6	50	7.4	5.8
7	60	7.9	6
8	70	8.6	6.4
9	80	9	6.7
10	90	9.6	7

This experiment was done in open area to test the performance of the motors of automatic trolley. Rice bag and dumbbell weights are used to obtain different weights. The automatic trolley can carry 90 kg with full motor speed and travels the distance of 10 meters in 7 seconds and requires 9.6 seconds to cover the same distance with 50% motor speed with the same load carried. The test was successful and the automatic trolley movement was smooth and automatic with speed controlling in all direction without applying human effort.

**Figure 7** Automatic trolley for testing

## 5. Conclusions and Future work

An Automatic trolley with all dimensional constraint is designed. The 3D model of the trolley is designed in the sharp 3D Software with isometric view generated. Stress analysis on the trolley structure and sliding platform is done by using Creo V3 software. The individual drive motors for the rear wheels enable the forward movement, backward movement as well as clockwise and anticlockwise rotation.

Therefore, the time period required for movement during transportation is less as compared with conventional trolley. The time required to travel 10 m of distance on a horizontal floor for full speed and maximum load condition is 7 seconds whereas the time required to travel 10 m of distance on a horizontal floor with half speed and full load condition is 9.6 seconds. Various drawbacks which were present in the conventional trolleys such as excessive human labor and more time involvement were reduced. Photovoltaic cells used for charging the power bank which in turn charge smart devices. Moreover heavy weights can be easily loaded with sliding platform and the weights can be directly measured using digital weighing scale available on the trolley. Handle of the trolley can be easily folded which makes it enable to be transported easily from one place to another. Also, front wheels are free in movements which get advantage to drive the trolley manually in case if there is no power to charge battery.

The trolley was done using mild steel material for the purpose of demonstrating which is strong and cheap. However, aluminum material which is more expensive and lighter can be used for the purpose of manufacturing. Aluminum is chosen because of the less density and anti-corrosive property as well. Another possible way of extension is accommodating the driver on the trolley itself and run the trolley just by controlling the joystick. Electrical power generation during running of trolley can be a future work in order to save energy. To upgrade the airport facilities, airport information like airline times, get their boarding pass tickets through the trolley itself as well as guide the passenger to the airplane gate that make traveling easier and comfortable.

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