IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Design and Analysis of Automated Trolley for Mechanical Operations and Medical Services

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ABSTRACT

Automated technology has become an integral part of the modern world. This paper proposes the design of a trolley that is automated using various IOT technology. All of us have been good aware of how the current situation has made us stay home for almost a year now. Especially in the medical fields there is no such device that could ensure a contactless environment. All the trolley used in the medical fields do not ensure a contactless delivery and can highly be infected with the virus. The need for no contact or contactless life has come into picture after this, so this paper aims at developing a mechanism to ensure that a contactless delivery of necessities in the Medical and Mechanical field is achieved. This is a trolley which would deliver food and any other necessity in the medical fields and carry tool piece to the workstations for the ease of the workers. By using the IOT technology with a few sensors, this trolley will be developed which will be fully automated. It will use camera sensor to ensure a hassle-free movement of the trolley, it will also be Wi-Fi controlled to ensure an easy and a distant access of the trolley.

Keywords: Automated trolley, Medical, Mechanical, Mechanism.

1. INTRODUCTION

In recent times of the global pandemic COVID-19 all our lifestyles and living habits have probably changed from staying home to not meeting our friends and to having a contactless life, we have seen it all. These precautionary measures were not only for the time up till which the pandemic lasted but also contactless life will be the new normal. With social distancing becoming the norm, the way we work, live and socially interact has changed. This essentially means we need to find a contactless way of existing and flourishing in the foreseeable future.

Technology will be pivotal in helping us cope and adapt. In fact, it will be the key catalyst in

creating a contactless world. A contactless life approach has been widely adopted after the great worldwide pandemic COVID-19. As life gets more into the contactless phase there is a need of machines which would lessen the contact between two people. So, we have designed a trolley with the idea of ATMOS "Automated Trolley for Mechanical Operations & Medical Services". Trolley is the mechanical device used for carrying load or to transport the material at various points. For different kind of applications, we must select specific type of trolley. To overcome the problem of specific task trolley, one new trolley is designed which can be used for more than one field application.

In medical fields food and other necessities are always carried by the hospital staff by pushing the trollies all around, for all the patients and in this condition, this can increase the risk of the person coming in contact with the hospital staff and the trolley to get infected with the virus as various patients have different kinds of diseases. It's risky for both the hospital staff and the patients as it does not ensure sanity. This trolley in medical purposes will be used to provide food, water and other necessity to the patients without having a direct contact with the other person. Providing patients, the best quality service without coming in contact of many people.

While using the trolley for medical application, the idea for using the trolley in another effective field also arises. So, for the effective use of the trolley can be done in the mechanical field. In mechanical fields or industries, a worker at once cannot carry all his tools, which can consume a lot of energy and time for the worker to carry his tools to the workplace. As in medical field, this trolley would also have a great use in the mechanical field. In mechanical field, within the prescribed limits of the trolley the worker can carry his tools, objects, or any other essentials in the trolley. This would save a plenty amount of time for the worker.

2. OBJECTIVES

i. To design the trolley which ensures minimum contact between two people.
ii. To reduce the manpower which would be required to push the trolley.
iii. To ensure that the time consumption will be reduced.
iv. To make the process of transporting food/necessity, easy.
v. To fabricate the trolley in such a way that it is light weighted so that it can move easily.
vi. To design the trolley to carry a decent amount of load.

3. DESIGN

There are many aspects that must be considered when designing a trolley. These aspects must be considered carefully so that the device works in a convenient and safety way according to the needs. The ideal length of the trolley is 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. The maximum load to carry is 90 kg. The wheels which are possible to use with this trolley are rubber tire wheels. The trolley is designed in such way that all the necessities or objects in the trolley are easily accessible to remove and keep in the trolley. The trolley is three storied which will help ensure placing different objects in it at different levels of it.

FIG 3.1.1: CAD model of the trolley.

The trolley is designed to be three storeyed with a drawer section consisting of one big and one small sized drawer . This section is provided for better and convenient reach of objects placed inside it . The right side of the trolley consists of a grilled section with a bin above . And beside it is a section to place the other tools or amenities.

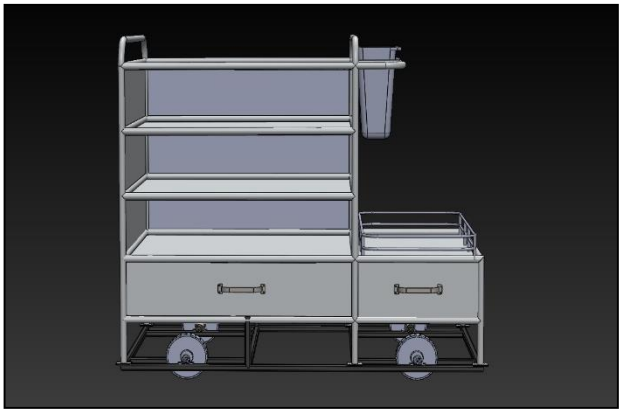

FIG 3.1.2: Front view of the trolley.

The base frame material is mild steel .

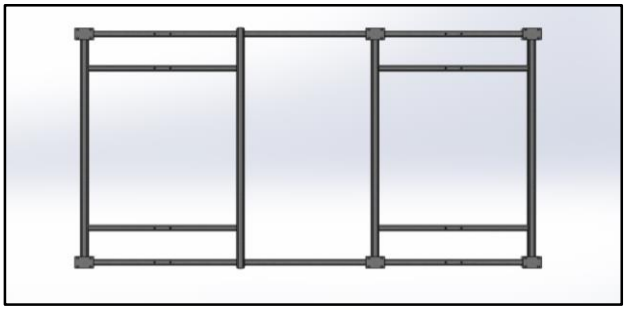

FIG 3.1.3: Base frame of the trolley .

The top frame of the trolley is made of Aluminium alloy 6061 material .

FIG 3.1.4: Top frame of the trolley.

3.2 BOLTING

Bolting is provided on the trolley as the base is Mild steel material and the above pipes are of Aluminium alloy 6061 material and it is not possible to weld two different materials hence bolting is provided to fasten the base frame and top frame together. Bolting is shown in the fig 3.2.

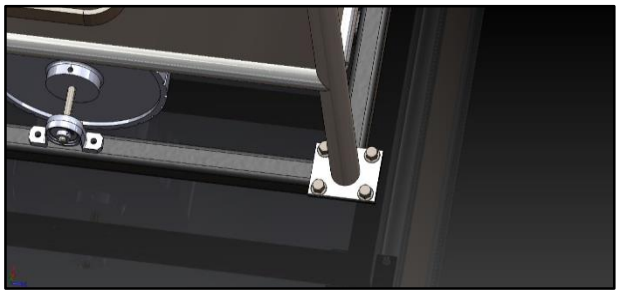

FIG 3.2: Bolting provided on the trolley.

4. ANALYSIS

4.1 STATIC STRUCTURAL ANALYSIS

Transportation load condition

The analysis is carried out assuming Transportation condition as a critical load condition.

F horizontal = 1 x g = 9810 mm/s^2

F vertical = 0.7 x g = 6768 mm/s^2

Where g = acceleration due to gravity.

4.1.1 Material

The material and its properties used for the top and base frame of the trolley are given below.

	Top frame	Base frame
Material	Aluminium Alloy 6061	Mild steel
Density (Kg/m^3)	2770	7850
Young's modulus (Mpa)	71000	200000

Table 4.1.1 : Material properties for top and base frame.

4.1.2 Global Analysis

The top frame part consisting compartments have given the weight load condintions and the base frame where the wheels are to be mounted have given the support conditions. Additionally accelaration load is given to whole frame to account the analysis for side thrust,wind resistance and resistance due to gradient of floor.

4.1.3 Boundary Conditions

Test model is assumed to be fixed at positions as shown in fig 4.1.3(a).

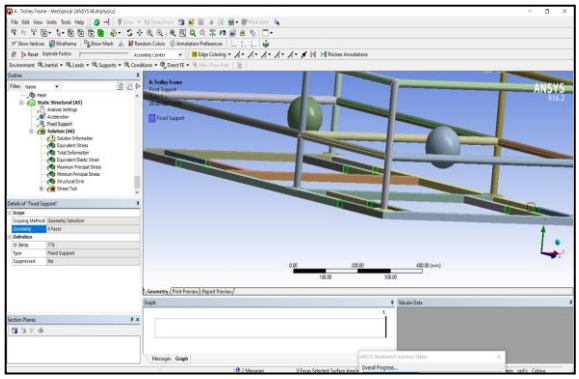

FIG 4.1.3.(a): Test model with support conditions.

Weight condition is given at point as 20kg mass at each point mass shown in fig 4.1.3(b)

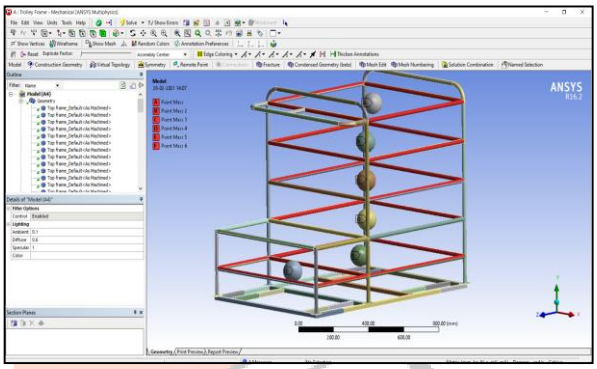

FIG 4.1.3.(b): Weight condition at 20kg.

Acceleration condition is given as 9810 mm/s^2 in transverse direction and 6867 mm/s^2 in vertical direction as shown in fig 4.1.3.(c).

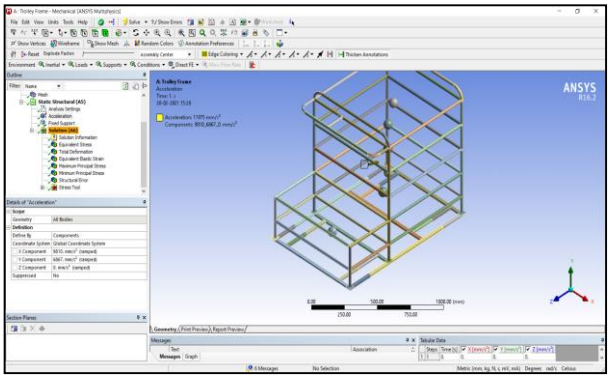

FIG 4.1.3.(c): Acceleration condition.

4.1.4 Mesh

Tetrahedron element type with 182495 nodes and 59537 elements.

Statistics	
Nodes	182495
Elements	59537
Mesh Metric	None

FIG 4.1.4.(a): Meshing element.

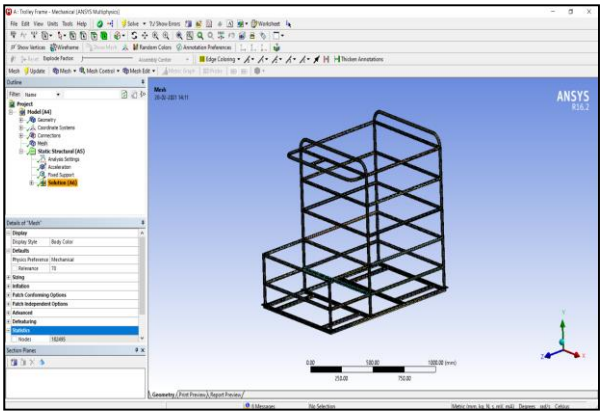

FIG 4.1.4.(b): Meshing on trolley.

4.1.5 Results

Results from global analysis are shown in fig 4.15 where the 6.6283 mm maximum total deformation is found at the top frame.

The maximum stress range is found at base frame is 105.55Mpa which is lower than allowable stress i.e. 325 Mpa.

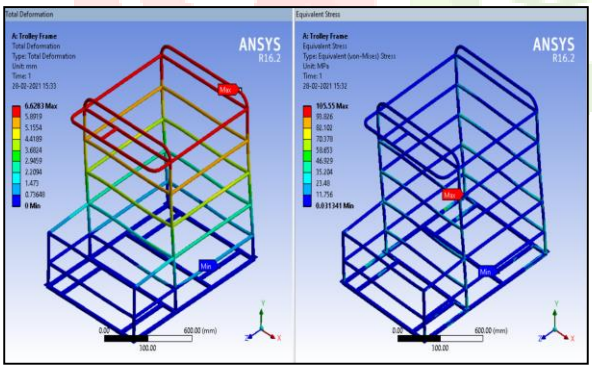

FIG 4.1.5: Results of analysis.

4.1.6 Factor of Safety

Factor of safety is shown in fig 4.1.6. The factor of safety above 1 or greater than 1 is considered as a safe design. Hence the design is considered to be safe.

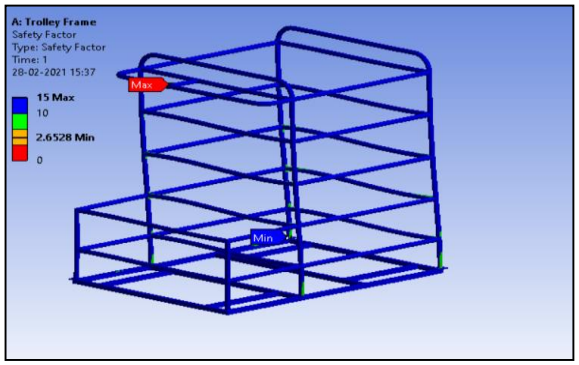

FIG 4.1.6: Factor Of Safety.

5. COMPONENTS USED

- ***Raspberry pi***

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV and uses a standard keyboard and mouse. Here the raspberry pi is programmed with python due to which the various sensors can be connected to it and the trolley can make its movements and make the various sensors work. The Bluetooth and Wi-Fi modules ensure that the trolley can be controlled from a considerable distance also.

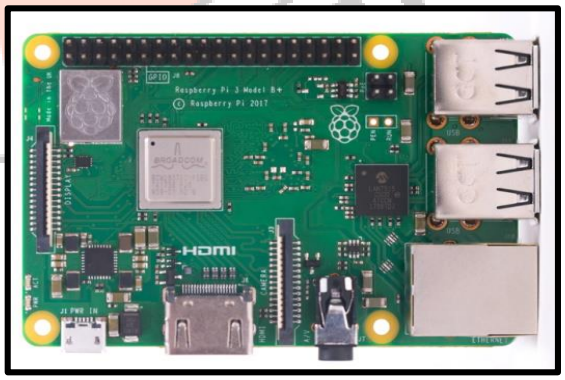

FIG 5.1: Raspberry pi

- ***Path/Line sensor (IR sensor)***

It helps in tracking a path or line with the given program.

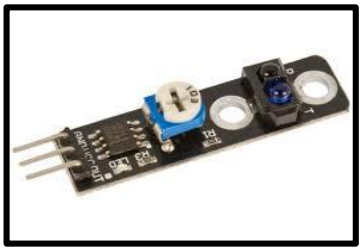

FIG 5.3: IR line sensor

- ***Camera Module***

The Raspberry Pi camera board v.1 has a 5 Megapixel sensor and connects via a ribbon cable to the CSI connector on the Raspberry Pi. The video and still image quality are better than a USB webcam of similar price. The camera sensor helps tracking all the directions of the trolley and hence ensuring proper movement of the trolley.

FIG 5.4: Camera module

- ***Motor module***

This L298N Motor Driver Module is a high-power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.

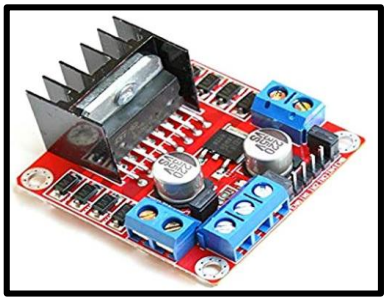

FIG 5.5: Motor module

- ***High Torque Gear DC Motor***

Its 300-600 RPM High Torque Gear Motor 12-24V.Base Motor is 555. Torque - 50-80 kg.cm. This is the best for high load application and take load up to 100kg.4 Motors directly attached to wheel. Power supply will be given with the help of Li-ion battery. To test the motor a 12v battery or 12V, 5 amps adapter can be used. The wheels are connected to the DC motor which provides the wheels to move and hence ensures the movement of the trolley at various speeds.

FIG 5.2: High Torque Gear DC Motor

SPECIFICATIONS	VALUE
Operating Voltage Range	12V to 24V DC
Recommended Voltage (DC)	24V
Rated RPM (at 24V)	600
Rated Torque (Kg-cm)	50
Full (Stall) Load Torque (Kg-cm)	80
No- Load Current (A)	0.6
Full Load Current (A)	5

Table 5.2: Specifications of the motor

6. MATERIAL USED

- ***Aluminium Alloy 6061 Pipes***

The top frame of the trolley is made of Aluminium Alloy 6061 Pipes .They are basically silicon and magnesium alloyed material incorporating aluminium. The product is good purpose alloy that is known for good formability, corrosion resistance, and medium strength. It is also renowned for excellent machining characteristics because of its appearance after anodizing.

FIG 6.1: Aluminium Alloy 6061 Pipes

- ***Mild steel***

The base frame is made up of mild steel . Mild steel (iron containing a small percentage of carbon, strong and tough but not readily tempered), also known as plain-carbon steel and low-carbon steel, is the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications. Square and rectangular steel tubes have the advantage of being stronger in bending while a round hollow sections have more stiffness in twisting.

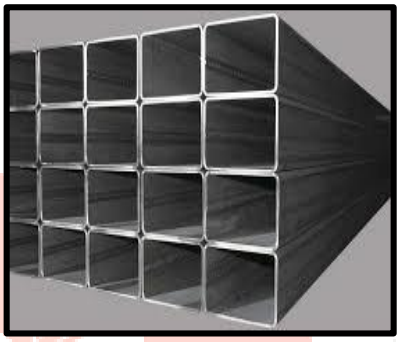

FIG 6.2: Mild steel square tubes

7. CONCLUSION

With a boost in the automated technology , this trolley would be useful in medical and mechanical fields. With contactless life being the new normal this trolley is an effective way to transport necessities with coming in least contact of many people. The camera provided in the trolley would act as a great way of distantly controlling the trolley. The trolley is designed in such a way that it it can take maximum amount of load. The structure is designed to have a low weight so as to ensure a easy movement of the trolley . This design is ideal to carry heavy loads and also the self weight of the trolley is less.

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