Design and Fabrication of Stair Claimbing Load Carrier

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Abstract: ***In modern world, robots are employed in every possible place. It is especially used in major fields like defense, surveillance activities, transportation and in many other places. This paper is prepared basically on building a robot with a capability to climb stairs carrying ten kilogram of weight in addition to its own weight. This paper represents the structure, construction and possible applications of a stair climbing robot. People find it difficult move loads from one place to another. Vehicle with wheels can help them to move in a plane surface. It requires immense strength to make it move in an inclined plane and makes it useless in case of stair case. In this project, an attempt has been initiated to design and construct a stair climbing load carrier. Stair climbing load carrier is a +mobile robot which can be operated to carry loads in different terrains. It can help in smooth and safe transition especially in stairs. This can be utilized to carry loads up to a specific weight in inclined surfaces or stairs. The size of the device is compact. It can render its contribution for portable work. It can be used for transportation of material. It is completely made by mild steel making it light weight and also makes it is easy to carry.***

Keywords: Stair Climbling Robot, Load Carrier

I. INTRODUCTION

The most common type of stair climbing robot is the vehicle built using tri-wheeled mechanism. The tri-wheel assembly must be aligned in-line with the pin insertion, which requires immense effort to accomplish with high accuracy. The pin will end up without performing the action of retraction under load to transition to stair-climbing mode. As compared with the chain-and-sprocket approach, the components used are under considerable mechanical stress, and therefore are relatively heavy. Mechanical pin-based systems need's the tri-wheel assembly to rotate to an acute angle, the point at which the locking pin is inserted in-order to lock the assembly at an angle that enables the unit to be manually turned onto two wheels.

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The major issues with the mechanical pin method are its strength and complexity of the system.

Embodiments of the present disclosure relate generally to stair-climbing wheeled vehicles, and more particularly to an electrically-powered, belt driven, stair-climbing wheeled vehicle having an Electric twist throttle- controlled mode for facilitating maneuverability of the vehicle and also helps in manual balancing. The present invention is more suitable in application to hand trucks, luggage carriers and other wheeled vehicles. When compared with other mechanical designs, the idea employed in the present invention is essentially electronic, and enables us to operate with no significant addition of components or production costs, and also avoids complexity of the system.

In Industrial areas and construction sites where load carrying is a significant part especially carrying loads in an inclined plane or in stairs, Cranes and lifts can be employed for the purpose of load transfer but the cost incurred and the space utilized must be considered, which emphasizes that there is a need of an alternative system. To overcome this problem, we came up with an ideology of a load carrying robot which is comparatively cheaper and also requires less space.

Many sub-assemblies or parts are being used to build this device. We had employed proper techniques for operating the machines and equipments while fabricating the entire setup. The project was initiated by selecting the component materials which were to be employed, because it will affect the product quality and also the overall cost of the machine. With this in consideration, we had designed this machine with the maximum quality and low cost with maximum efficiency.

II. OBJECTIVES

- It must be able to carry loads in staircase
- It must be Easy to handle
- It must be simple in construction
- It must not consume lot of space
- It must be cost effective
- There must not be any noise and vibration.

III. COMPONENTS USED

The various components involved in the fabrication of this machine are described below

Frame

A frame is the physical element of a motorized vehicle to which all other components are attached. It can be compared to the skeleton of an organism. The main function of the frame is to support the vehicle's components and body. It plays a major role in absorbing static and dynamic loads, without under-going any deflection or distortion.

Rollers

The lateral cross-sectional area of pulleys in pair are tactically called Rollers. It is made up of mild steel which is used to transmit the power from motor to the rubber tracks. There are two main cylindrical rollers which are used to transmit the power.

Idle rollers

An idle-rollers helps in keeping the vehicle balanced and helps in achieving maneuverability in inclined plane. It is used in a system to transmit the power from the rotation of the main shaft of a motor to another rotating device, for example the crankshaft-to-camshaft gear train of an automobile. In this system idler is used to transmit power from rollers to belt by adjusting the belt tension.

Stepper motors

A stepper motor or stepping motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be controlled to move and can be held at more than one position without any position sensor for feedback which leaves it to be an open-looped controlled system, as long as the motor is carefully operated to the application with respect to torque and speed.

Rubber belt

Belts are used to transmit power, and in especially in transmitting power over long distances, around corners. The belts are made of polyurethane material. It has been chosen depending on the durability and strength. A belt system basically consists of two or more pulleys also referred to as drums. They are placed in an order to form endless loop of carrying medium. One or both of the pulleys are powered, moving the belt and the material on the belt forward due to the friction. The powered pulley is called the driver pulley while the other pulley is called the idler pulley or a driven pulley.

Electric twist throttle

The electric twist throttle operation is as similar to how motorcycle throttle operates. When the throttle is engaged, the motor provides power and propels the belt, Therefore the carrying the load forward. These are used mostly in the e-bike throttles and requires the handful of effort to operate. The full twist of the throttle occupies the entire handlebar. In-order to operate the twist throttle, the operator simply grabs his hand over the throttle and twists it back towards himself. Throttle is connected to the controller, which in turn is used to controls the speed of the motor based on the twisting of throttle.

Weight sensor

Weight along with weight distribution must be noted with the help of a sensor through which we can ensure that the vehicle does not get overburdened. The measurement of the weight may be accomplished by transducers, a sensor to measure weight and weight distribution. Thereby, when a user is attempting to mount the vehicle, the transducer sensors may sound an alarm, which in-turn alerts the end user, and automatically brings the vehicle to rest by locking the operation of the vehicle, whenever the weight is excessive, or that the weight is not acceptably distributed, which may end up either possibly causing tilt, or causing tilt as indicated by one or more tilt sensors. Such weight transducers are mostly mounted in the bottom part under a protective portion of the loading tray of the vehicle.

Tilt sensor

The accelerometer sensors are employed to measure tilt and acceleration, and, more specifically, according to embodiments of the present invention, the accelerometer sensors are used ultimately to sense the angular position of the frame relative to the ground. In one of the operating modes such as transport mode, the angle of tilt brings the center of mass to be located approximately over the center of wheel which is in contact when the frame is tilted for transportation, such as approximately 20-45 deg off the vertical. Whereas in ascent mode, the angle of tilt is kept to an extent of about 5-15 degrees to ensure the leading wheels clear an adjacent stair.

Fig. 1 Accelerometer sensor of stair climbing robot

IV. SELECTION OF MATERIALS

The material selected must posses the necessary properties for the proposed application. The various requirements which were satisfied are strength, surface finish, rigidity, chemical stability, etc. Apart from these external factors like Physical, Chemical, Mechanical, Manufacturing point of view are some of the points concerned in selecting the material.

The various physical properties concerned are melting point, thermal conductivity, specific heat and coefficient of thermal expansion, specific gravity, electrical conductivity, magnetic properties etc. The various mechanical properties concerned are strength at various loads such as tensile, compressive, shear, bending, torsion, impact, dead, gradual, hardness, wear resistance and sliding properties. As in any other problem, in selection of material, the cost of materials plays in important part and should not be ignored. Sometimes factors like scrap utilization, appearance and non- maintenance of the designed part are involved in the selection of proper materials.

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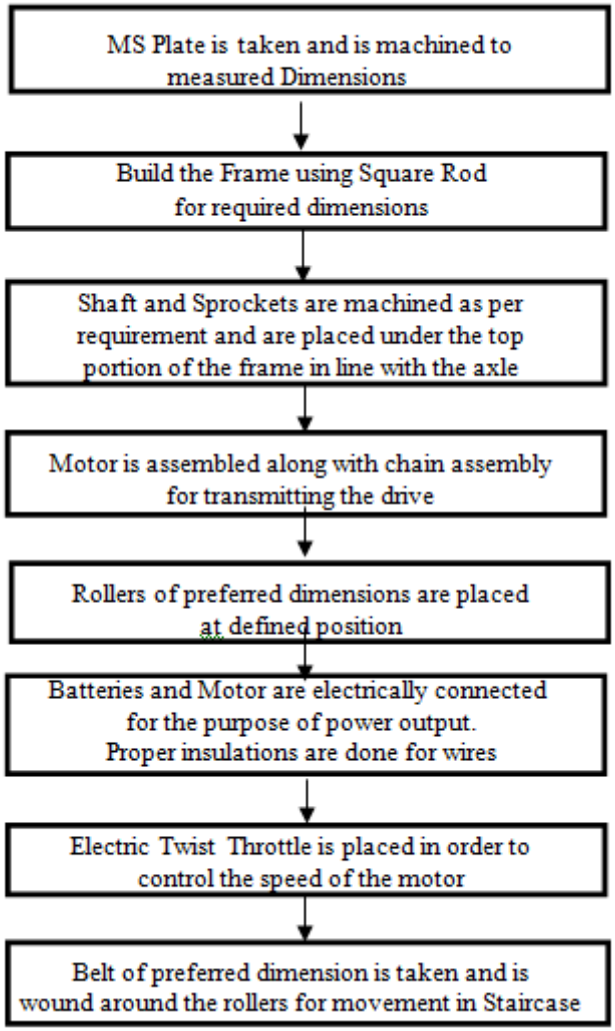
Table. 1 BILL OF MATERIALS

PART NAME	MATERIALS	QUANTITY
FRAME	MILD STEEL	1
ROLLER	NYLON	6
MOTOR	-	1
CONTROLLER	-	1
BELT	ROUGH TOP	2
TRAY	WOOD	1
CHAIN SPROCKET	MILD STEEL	4
IDLERS	MILD STEEL	4
BATTERY(12V)	-	5

V. METHODOLOGY

The method of fabrication of the stair climbing robot starts from machining the rigid MS Plate which is taken and is machined to measured Dimensions as per the specifications. It enables us to have an idea on the maximum weight which could be carried be the robot. The work of Building the Frame using Square Rod of required dimension is performed. It helps in identifying the dimensional restriction of the product which could be used. Shaft and Sprockets which are the key for proper functioning of the robot are machined as per requirement and are placed under the top portion of the frame in line with the axle. Motor of the desired power is assembled along with chain assembly for transmitting the drive. Rollers of preferred dimensions are placed at defined position. Batteries and Motor are electrically connected for the purpose of power output. Proper insulations are done for wires thereby protecting the charges. Electric Twist Throttle is placed in order to control the speed of the motor and it governs the speed of the vehicle. Belt of preferred dimension is taken and is wound around the rollers for it to perform the stair climbing movement without much difficulty. The Methodology used for fabricating stair climbing robot is MS Plate is taken and is machined to



VI. FABRICATION

Frame

It is made up of mild steel square hollow rods and steel plates. The process starts with the cutting of the rods and plates using gas cutting machine, and then it is bended to an appropriate angle. Sharp edges are smoothening by portable grinding machine. To fastener frame and other components, drilling operation performed as per the dimensions. Arc welding is used to join the square hollow rods and steel plate. Bush is made up of mild steel solid cylinder. It is first cut into small pieces of rods then it is machined the sequence of operation like facing, turning, step turning, drilling and boring. Finally, it is permanently fixed with the frame by Arc welding.

Shaft

It is a mild steel rod which is cut into required length then it is machined based on the sequence of operation like facing, turning, drilling and threading. External key way is cut on the shaft for mounting the driven sprocket.

Roller

It is made up of nylon which is cut into required length then it is machined to the sequence of operation like facing and turning. Grooving operation is also performed in the nylon roller for even seating of rubber belt. Internal key way is made so that it forms a lock on shaft.

Tray

It is made up of plywood which is used to cover the frame and carrying load on top of the machine. It is provided to carry non-uniform loads or dimensionally varying loads. It is cut as per the requirements. Drilling is use to cut holes for fixing the tray with frame. Partition of the tray is made to separate load from battery.

Handlebar

It is made up of stainless steel which is used to control the carrier by throttle. It is a hollow rod which has external threading is provided on the rod used to join the handlebar and frame. T-joint is used which connect the rods of the handlebar

VII. WORKING PRINCIPLE

The invention includes a chassis with a pair of front wheels and one pair of rear wheels, in the preferred embodiment. The rear wheels are powered, and the pair of front wheels are ideal. The rear roller is attached to the driving shaft of the motor. The rear roller is the driver. All the rollers are connected with the help of a rubber belt. When the driver roller is rotated the vehicle moves in the direction of rotation. Each pair of rear wheels is rotatably mounted on a longitudinal beam which makes the vehicle stable. The beams are then interconnected by a central jack shaft. The wheel over wheel function is provided for easier stair climbing purpose and in case of flat surface the one pair of wheels in the front just becomes an ideal wheel and helps in maintaining the tension of the belt.

The hand-truck consists of a rigid frame mounted along with a rotatable axle. The frame has a load-bearing nose, of a typical conventional hand trucks, and a user handle. A geared motor and battery are supported on the frame. The motor and battery are operatively connected, and the motor is operatively connected to the axle by gear train so that rotational torque may be applied by the motor to cause the belt assemblies to rotate both clockwise and counterclockwise about an axis of axle while the frame remains fixed.

Active Swing Idler Mechanism

This idler is located at the same height as the front and rear main idlers in order to achieve grounding pressure at the middle area of crawler belt. When the crawler approaches the top of the stairs, the swing arm moves and pulls the idler up, bending the crawler belt. This motion prevents the sudden change of the posture of the crawler.

It will be noted that the vehicle does not attempt to balance itself, but rather relies upon a person climbing the stairs to guide the hand truck and to provide stability as the hand truck climbs the stairs.

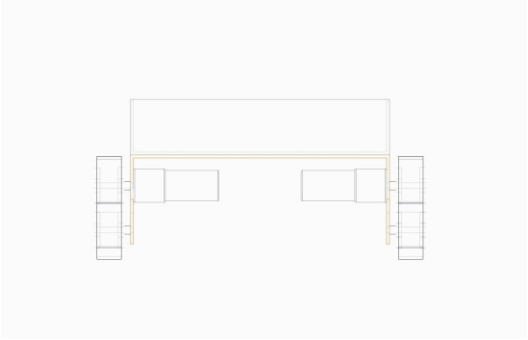


Fig. 2 Front view of stair climbing robot

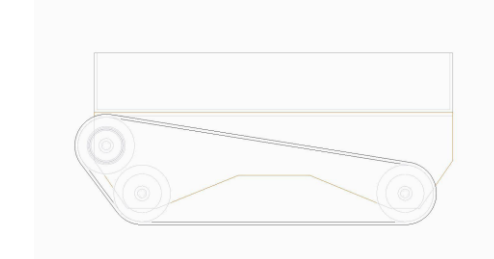


Fig. 3 Side view of stair climbing robot

Fig. 4 Top view of stair climbing robot

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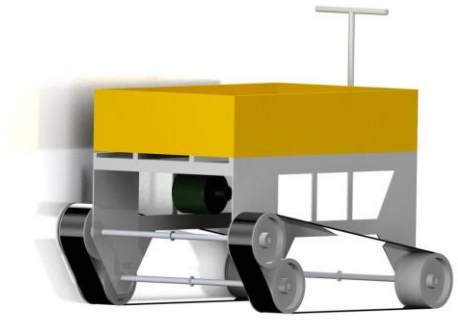

Fig. 5 3D view of stair climbing robot

VIII. MERITS

- Reduce the work load of the labour as it is a motorized vehicle.
- Easy to handle under any condition
- Skilled person is not required to operate as mechanism is simple
- It can be automated by the usage of effective sensors
- Comparatively Less space consumption
- It is portable and simple in construction.
- It does not produce much noise and vibration.

VIII. APPLICATIONS

- It is used to carrying loads in inclined planes and in stairs.
- It can be used in small and medium scale industries
- Apart from industrial usage it can be used in hospitals to carry medical kit Bags and Instruments.

IX. CONCLUSION

The stair climbing robot act as a multi terrain load carrying vehicle used in the industry. The invention has been described and pictured in a certain degree of particularity, it is understood that the present disclosure has many futuristic developments which can be made such as numerous changes in construction, combination and arrangement of parts and steps, controllers, camera (optical sensor) may be included without departing from the spirit and scope of the invention as set forth in the claims.

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