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Designing an Automated Robotic Cart which can Ascend and Descend the Stairs Successfully

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Abstracts

Stair climbing mechanism is a very challenging mechanism in robotic applications. I wanted to design a stair climbing robotic cart which can climb the stairs successfully with the capability of caring 500 kgs. This ascending and descending mechanism increases the freedom of mobility for aged and handicapped person as heavy objects can be shifted from ground floor to top floor to the stairs.

Keywords: Stair climber, robotic cart, ascending mechanism, descending mechanism, mobility.

Introduction

The cart is usually deigned for transport purpose with two wheels pulled by a pair of animals. In such a way, my estimated robotic cart consists of pair of wheels at front which pulls the tracked wheels of rear part. The front wheel moves first and provides order or information to rear tracked wheels to move on. It's like commander and soldiers bond in army in which the soldiers only believe or obey the orders given by the commander. I going to mount suitable sensors in front part or commander part and also I firmly believe that it will provide accurate information about the environment to the rear tracked wheels.

Figure debits the front or commander portion of the robotic cart.

Suitable motor actuators, sensors are used to establish a good connectivity between the two portions.

Communications between them is as follows:

A perfect result can be obtained only by perfect connectivity and by perfect communications.

Front part/ commander part	Initiate the motor	Start to move and also send the message	Moves forward until sensing the collision	It stops &gives message to rear wheel	It moves on giving backup message
Rear part/soldier part	Receive message and start to initialize	Receives the message and moves on	Moves on continuously	Receive the message and stop at once	It moves forward

Robotic cart design methodology:

The design aspects of stair climbing robotic cart are as follows

- A triangular wheel design
- An appropriate sensor
- Mechanism to transmit power from motor
- Tracked rear wheel design.

A Triangular wheel design:

The designing of the wheel was done according to an average of width x height of a stair.it was decided to use aluminium for triangular plate and pulley due to its durability, strength and lightweight. Once the pulleys and plates are made, holes are drilled in the plates. Bushes are attached to provide the freedom of mobility. Next sprockets were added. They were attached to motor shaft through a bush and crews which is fitted to one

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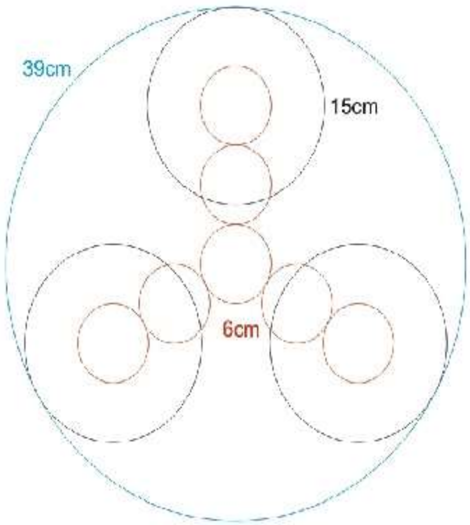
pulley on each wheel. The bearing and bearing houses were attached. So that they can accommodate each other.



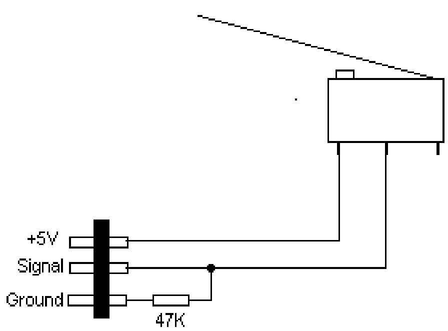
- If the robot is going up an incline of 30° then the additional torque required will be:
- sin 30° x 45Kg (robot weight) x 10cm (radius of the wheel in cm) = 0.5 x 45Kg x 10cm = 225 Kg.cm
- When the wheels get stuck and cannot turn then the entire Tri-wheel (blue) must rotate. The motor must now be able to lift the entire weight of the robot so now the additional torque required is:
- 45Kg (weight of the robot) x 27cm (radius of the entire tri-wheel) = 1215 Kg.cm.

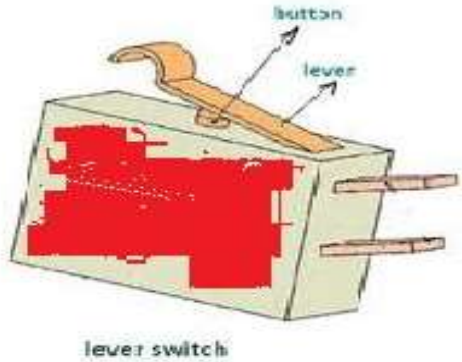
An appropriate sensors:

Without use of sensors, all robotic mechanisms are nothing. Two important sensors in robotic cart are
1. Bumping sensor,
2. Pyro electric infrared sensor (PIR).

2.2.1 Bumping sensor:

It is probably one of the easiest ways of lifting the robot to know it is collided with something. The simplest way to do this is to fix a micro switch to the front part so that when it collides, the switch pushed in making an electrical connection.

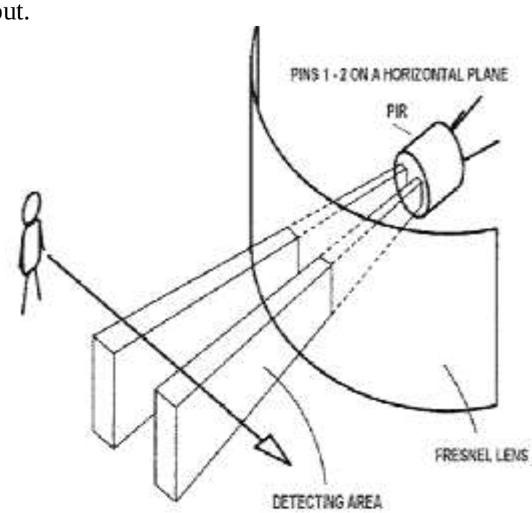


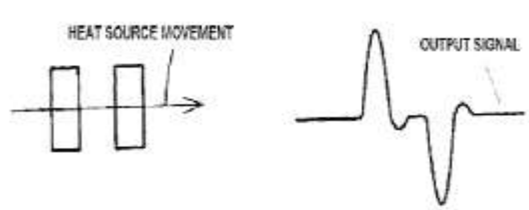


Micro switches are easy to connect to microcontrollers. They are ON and OFF making them digital.
Bump sensors can also be activated using spring mechanism.

Pyro electric infrared sensor (PIR):

PIR sensor allows the robot to sense motion, almost always used to detect whether a human has moved in/out of the sensors range. They are small, inexpensive, low power and easy to use without wearing out.





It detects the levels of infrared radiation. Everything except something better emit higher radiation. Along with the PIR sensors is a bunch of

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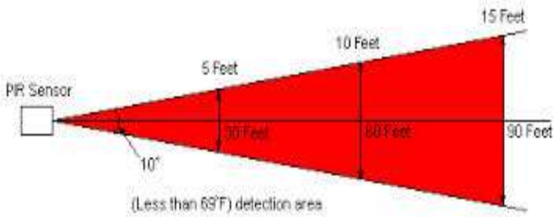
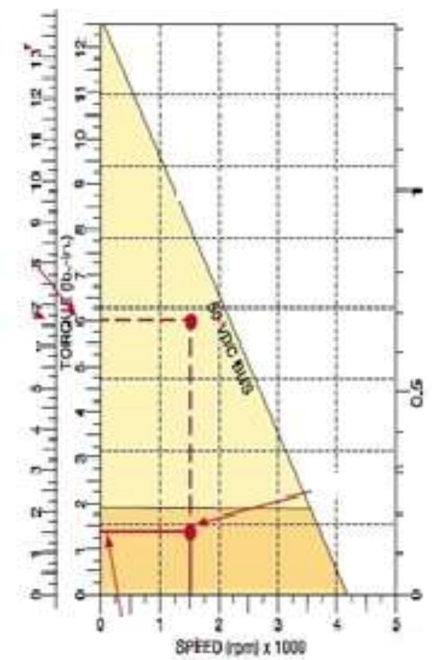
supporting circuits, resistors and capacitors. It detects and provides signal when a person some other things has left or entered the area so that the cart can move on without colliding with each other.



- **Size : ** Rectangular
- **Price : ** Rs.600/-
- **Output:** Digital pulse high (3V) when triggered (motion detected) digital low when idle (no motion detected). Pulse lengths are determined by resistors and capacitors on the PCB and differ from sensor to sensor.
- **Sensitivity range:** up to 20 feet (6 meters) 110 degrees x 70 degrees detection range
- **Power supply:** 3.3V - 5V input voltage,
- BIS0001 Datasheet (the decoder chip used)
- RE200B datasheet (most likely the PIR sensing element used)
- NL11NH datasheet (equivalent lens used)
- Parallax Datasheet on their version of the sensor

Mechanism to transmit power from motor:
A theoretical analysis of locomotion begins with mechanics and physics generally balance is not a main concern.Since all wheels are in ground contact at all times. A suspension system is required to allow all wheels to maintain ground contact when the robot encounters uneven terrains.
Wheeled robot researchers are focuses on the problems of fraction, stability, manoeuvrability and control unit.

DC motor:
Speed – Torque Curves
In constant speed applications, motors are defined in terms of horsepower (which is torque at a base speed). Servo motors normally operate over a wide speed range. The curves show continuous torque (define as torque which will not overheat the motor), and peak torque (defined as intermittent acceleration torque).



It is also necessary to know the current and voltage required for the motor to operate. The curves have a scale that shows current required for any torque, and voltage required for any speed. As an example, an application requires a continuous torque of 1.5 (0.17 Nm) lb-in at a speed of 1500 RPM. The peak torque required for acceleration is 6 lb-in (0.67 Nm).
This curve shows that the M-2240-A will work in this application. The bus voltage required is 50VDC. The continuous and peak currents required is 1.7 and 6.7 amps. From this information, we select a TSD control (5 amps continuous, 10 amps peak) with an 115VAC input (50VDC Bus).

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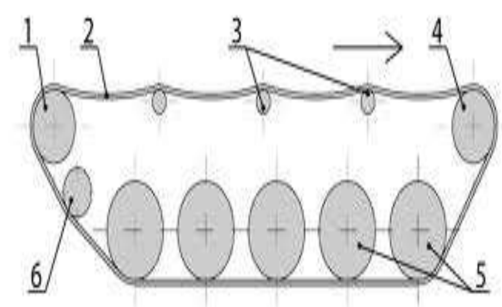
Tracked or rear wheel part:

Tracked (rear) wheels have a larger ground contact surface than wheeled vehicles and have more grips on stairs. It is because it has low centre of gravity, it can also resist up to 1000 kgs.

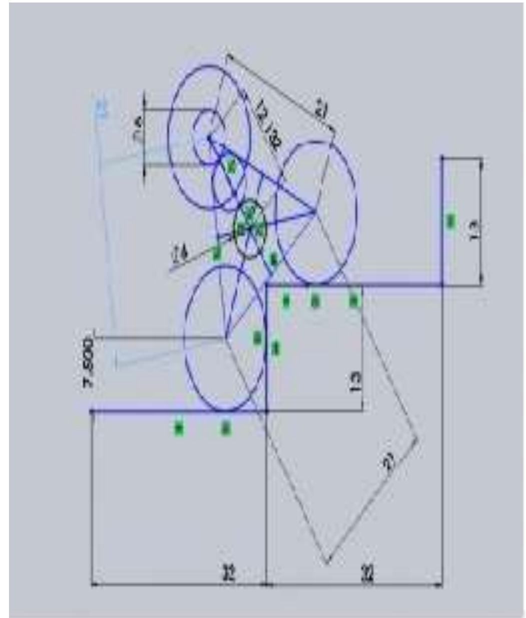
However analysis is limited to 2D, slippage, shocks and intermittent loss of track surface contact. Such phenomenon that is commonly encountered during stair climbing is neglected.



Working of robotic cart

It takes place stepwise. The robotic cart comes to rest momentarily after each step.

- Robot wheel touches the step (stair case).
- Lifting the front portion.
- Provides message to rear portion to lift
- Lifting the rear part.
- Following the above steps of the front part.
- The same mechanism used for descending the steps.



Conclusion

I have attempted to design stair climbing robotic cart for providing aid to aged and disable people. This attempt has been made to fabricate climbing mechanism with the available indigenous material and it is proved that the fabrication of stair climbing mechanism can be achieved. The final design of our robotic cart has a specific size of stair to work and it would be nice to expand this project to develop a structural model that could ascend and design a variety of stair dimensions.

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