Design And Development of Human Following Robot (Cart)

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Abstract: For a robot that performs autonomously, the communication between the person and the robot is the most important factor. A significant awareness has been observed regarding the usage of such a technology. This research has a trivial involvement in the development of such robots. Robots that function fully autonomously should not only complete the jobs that are desired of them but also somehow establish a connection between themselves and the person operating them. A lot of research has been done of these kinds of robot and a lot of work still needs to be done. In order for a robot to communicate and interact with the person, it should also be capable of following that particular person. Keeping this in mind, there should be a capacity in the robot to get information from the surroundings while perusing the required object. The primary goal of our work was to design and fabricate a robot that not only tracks the target but also moves towards it while doing the tracking. In order to make things simpler, a unique handmade tag was placed on the person that the robot needs to follow.

***Index Terms* - automation, smart trolley, smart living**

I. INTRODUCTION

Nowadays, most of the things in this world use the technology for more productive life. The people always find something to help them doing a works rather doing them self because of their busy life. However, this new technology which is designed for shopping or carrying heavy thing has never used before. Trolley is a large metal basket or frame on wheels is used for transporting heavy or large items, such as supermarket purchases or luggage at an airport or railway station and transferring a heavy item in industry. By using a trolley, humans do not need to feel bothered and will not get tired for carrying goods although it is quite lot. In manual trolley, human labor is still required to utilize trolley. They still need to push the trolley or bring the basket to bring the stuff. So, if there is a trolley that can be run automatically, then bring the stuff will be easier and efficient. After making observation and thinking some idea, a decision to build an Automatic This Automatic Trolley Human Follower is combination of general trolley with concept human follower robot. Robots can support humans in complex everyday tasks, such as indoor and outdoor navigation and information supplying, or carrying heavy objects. The purpose of designing this project is to help shopping management or industry to use this tool as a commitment to improved quality of service and work. With implementation of our work and integrating the same with automatic stores it will be changing the whole world scenario of shopping. In this work further, applications are not detailed. Rather it is focused on navigation and other facilities of the trolley. It has got wide range of applications.

Human following smart trolley is a trolley having some special features and has the capability to follow its leader that is, the customer. Even though this work is dealing with the aspects of the trolley, with minor alternations it can be used in various sections of the day-to-day life. This includes sections of Medicare, Childcare and material handling. Automation in day to day life with IoT technologies are the latest trend embracing the world and global markets.

Block diagram

The sensor (IR) transfers image data for detection of tag, the microprocessor carries out the localization process and localize the position of the person carrying the tag. This data is then transferred to the control unit, by calculating the distance from the tag, the microcontroller controls the speed of the motor by controlling the current supplied to the motor therefore controlling the rotations of the wheels.

II. PROBLEM STATEMENT

Our aim is to design a trolley which will follow the human being and can carry the weight so as to reduce the effort required by human being.

To assist elderly or disabled people in supermarkets, our goal is to design and build a trolley that is capable of following them, and carry weight for them. During shopping we have to carry shopping cart all over the mall, so the human following trolley can follow the shopper anywhere the shopper goes without any actual effort.

To assist industrial worker to carry heavy weight along a distance without any manual effort. As we know industrial worker have to carry components and heavy weight from shop to shop, or use line following trolley but to define a path we have to change the line setup every time so a human following trolley will follow worker without any required setup

III. OBJECTIVES

- To design a system which will control the trolley speed according to the speed of human.
- To design a system this can carry weight up to 40kgs.
- To design and produce a versatile trolley that is user friendly for human and makes their life more productive
- To produce automatic trolley that can carry a heavy thing to move from one point to another point

IV. DESIGN

A. Design of Trolley

This trolley frame has been designed by using MS square pipe frame, and four wheels. The figure 3.3 (a) shows the dimension of the vehicle frames for length, width and height. The frame that has been design has 800mm length, 650mm width and 500mm height.

B. Design of Transmission Shaft

F = 700 N
T=686.7 Nmm
1) Material selection – Selecting plain carbon steel
(C – 0.15 % - 0.4%) 30c8 Syt= 400 N/mm2
Sut= 500 N/mm2
According to ASME code τmax = 0.3 * Syt τmax = 0.3
* 400 τmax = 120 N/mm2
τmax = 0.18 * Sut τmax
= 0.18 * 500
τmax = 90 N/mm2 …. Minimum hence selected
2) Maximum bending moment on the shaft
M=FL/4
Take, Kb= 2, Kt= 1.5 … (For stationary shaft and sudden load)
Te=√ (Kb*M) 2+ (Kt*T) 2
Te= √ (2 113750)2 + (1.5 686.7)2
Te= 227502.33Nmm
Design of shaft on the basis of shearing and twisting Diameter of shaft
ζmax=16 *Te/π D3 (1-k^4)
90=16 227502.33/ π D3 (1-0.8^4)
D= 27.93mm
D~ 30mm
d=0.8*D
d=0.8 *30
d=24mm
Design of shaft on the basis of maximum bending
Ϭmax=syt/nf …. (Take NF=2)
Ϭmax=400/2
Ϭmax=200n/mm2
Me=1/2 [(kb.M) + √ ((kb.M) ^2+ (kt.T)^2]
Me=1/2[(2*113750) + √ ((2*113750) *2+ (1.5*686.49) ^2]
Me=227501.165Nmm
Ϭmax= 32Me/ (πdo^3[1-k^4])
=32*227501.165/ (πdo^3[1-0.8^4])
do=26.97~28mm
K=di/do
di =0.8*28
di= 22.4mm
By comparing diameters from both the procedures
Selecting D=30mm d=24mm …. (Maximum diameter)

C. Design of Screw Jack: -

Design of Screw

The maximum load on the screw is when the jack is in the bottom most position. In this position of link CD is shown in fig.

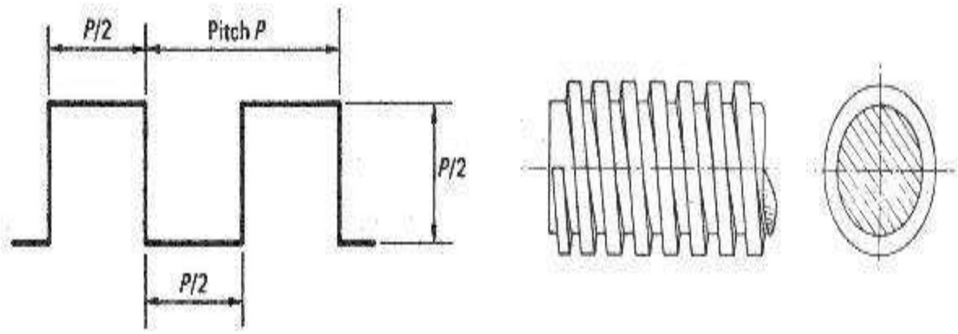

Fig. No. 1: -Screw

CosΘ=100-15/110 =39.4

Pull in the screw, f=w\2

tanΘ

Where,

F= force exerted on screw w= load

• Total force in the screw due to both the nut P1 = 2f Where, P1= total force

For the screw to be safe in tension, dc= √p1x4

πxσt Where, dc= core diameter σt= tensile stress

• Now, we adopt pitch= 6 mm

• Outside diameter of screw, do= dc+p

• Mean diameter of screw,

dm= 1\2 (dc+do)

• Helix angle,

= tan−1µ

Effort required rotating the

Screw, P=P1×tan (α+ϕ)

Where, P1= total force

• Torque, T=P × dm/2

• Torsional shear stress in screw, τ=16T/πdc3

Direct tensile stress in screw, σt= 4p1², πdc3

• Maximum principal stress in screw, σ1= σt +1 √σt2+4τ2 2 + 2

Which should be less than 100 MPa, hence safe.

a) Maximum shear stress,

τmax = 1√σt2+4τ2

Which should be less than 50 Mpa , hence safe.

V. PRIMARY SENSOR IR: -

A. IR sensor

An infrared sensor (E18) is an electronic instrument that is used to sense certain characteristics of its surroundings. It does this by either emitting or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion.

Infrared technology is found not just in industry, but also in every-day life. Televisions, for example, use an infrared detector to interpret the signals sent from a remote control. Passive Infrared sensors are used for motion detection systems, and LDR sensors are used for outdoor lighting systems. The key benefits of infrared sensors include their low power requirements, their simple circuitry and their portable features

Fig No. 2: - IR Sensor

Fig No. 3: - Ultrasonic Sensor

Infrared waves are not visible to the human eye. In the electromagnetic spectrum, infrared radiation can be found between the visible and microwave regions. The infrared waves typically have wavelengths between 0.75 and 1000µm.

The infrared spectrum can be split into near IR, mid IR and far IR. The wavelength region from 0.75 to 3µm is known as the near infrared region. The region between 3 and 6µm is known as the mid-infrared region, and infrared radiation which has a wavelength greater higher than 6µm is known as far infrared.

B. TRASONIC SENSOR

Ultrasonic sensors transmit sound waves at a frequency which is too high for humans to hear. Then they wait for the sound to be reflected back and calculate the distance based on the time required. This is similar to the radar measures time it takes a radio wave to return after hitting the object.

C. SCREW JACK

A jackscrew, or screw jack, is a type of jack that is operated by turning a lead screw. It is commonly used to lift moderately heavy weights, such as vehicles; to raise and lower the horizontal stabilizers of aircraft; and an adjustable support for heavy loads, such as the foundations of houses.

D. ASSEMBLY OF SCREW JACK

A mechanical jack is a device which lifts equipment. The most common form is a car jack, floor jack or garage jack which lifts vehicles so that maintenance can be performed. Car jacks usually use mechanical advantage to allow a human to lift a vehicle.

Fig No. 4: - Mechanical Toggle Jack

Toggle jacks show in Fig 1 are simple mechanisms used to drive large loads for short distances. The power screw design of a common toggle jack reduces the amount of force required by the user to drive the mechanism. A toggle jack is operated simply by turning a small crank that is inserted into one end of the jack.

VI. MANUFACTURING PROCESS

Manufacturing processes are the steps through which raw materials are transformed into a final product. The manufacturing process begins with the creation of the materials from which the design is made. These materials are then modified through manufacturing processes to become the required part. Manufacturing processes can include treating (such as heat treating or coating), machining, or reshaping the material. The manufacturing process also includes tests and checks for quality assurance during or after the manufacturing, and planning the production process prior to manufacturing.

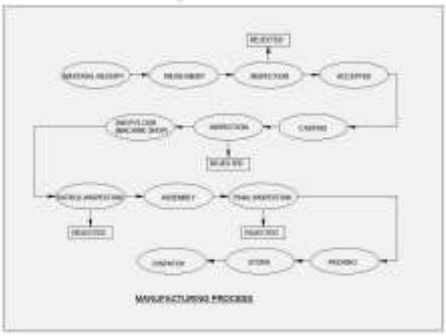

Fig No. 5: - Manufacturing Process

A. METAL CUTTING

Metal cutting or machining is the process of by removing unwanted material from a block of metal in the form of chips. Cutting processes work by causing fracture of the material that is processed. Usually, the portion that is fractured away is in small sized pieces, called chips. Common cutting processes include sawing, shaping (or planning), broaching, drilling, grinding, turning and milling. Although the actual machines, tools and processes for cutting look very different from each other, the basic mechanism for causing the fracture can be understood by just a simple model called for orthogonal cutting.

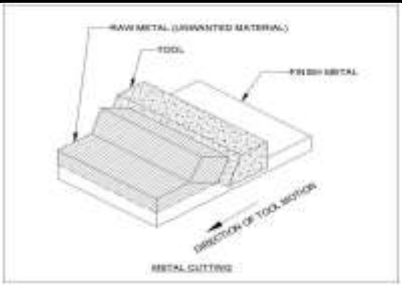

Fig No. 6: -Metal Cutting

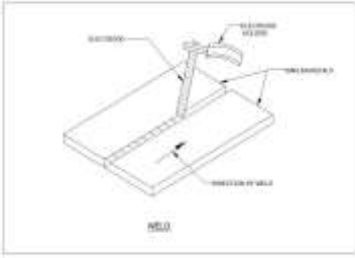

Fig No. 7: -Welding

B. WELDING

Welding is a process for joining similar metals. Welding joins metals by melting and fusing 1, the base metals being joined and 2, the filler metal applied. Welding employs pinpointed, localized heat input. Most welding involves ferrous-based metals such as steel and stainless steel. Weld joints are usually stronger than or as strong as the base metals being joined. Welding is used for making permanent joints. It is used in the manufacture of automobile bodies, aircraft frames, railway wagons, machine frames, structural works, tanks, furniture, boilers, general repair work and ship building.

C. DRILLNG

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole of circular cross-section in solid materials. The drill bit is a rotary cutting tool, often multipoint. The bit is pressed against the work piece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the work piece, cutting off chips from the hole as it is drilled.

VII. RESULTS

Thus, this intelligent shopping cart provides great Convenience and efficiency to customers in store by allowing the customers to shop without any sought of tensions. There is no need of pushing or pulling the heavy loaded cart because it automatically follows the customers and does the billing by providing the smooth shopping. So, with the help of this designed cart the human labor can be reduced by taking the overall shopping experience to a different level.

By plotting Load vs. Time, tabulations were made for different loads keeping the Distance constant.

The objective of the follower robot is to track and follow the person who is obtained. It is achieved by using ultrasonic sensor and IR which detects and follows the person and avoids obstacles also and according to that executes further controlling actions.

VIII. CONCLUSION

Human following smart trolley is a good alternative when compared to the conventional trolleys which are being used currently in the market. Huge amount of work, time and money could be saved by the implementation of the concept. The technologies similar to the ones implemented in the work could be used in other sectors such as in Medicare field as a nurse following robot, in childcare or in material handling in manufacturing industries. Further application of the same along with an exclusive app cum wallet feature will be the biggest stepping stone to the full automated stores or fully automated shopping. Furthermore, if possible, the tracing facilities of the trolley should also be developed for the efficient tracking of the trolley inside the market. But as of now the extrapolation of coordinates is difficult and is a tougher ask to deliver.

Actual Photographs

Fig No:08 Actual Photographs

Fig No:09 Actual Photographs

Fig No:10 Actual Photographs

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BIOGRAPHIES

Mr. Vitthal K. Khemnar holds master degree in Mechanical Engineering. He completed his master’s degree from Savitribai Phule Pune University, Pune. He has published 05 research papers in various national and international journals. He is also member’s various professional bodies such as LMISTE, LMISME, IAEng