Design & Fabrication of Automated Trolley Working on Cellular Frequency

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Abstract— shopping trolley is essential equipment for shopping in supermarkets or grocery stores. However, there were also shopping trolley safety issues such as sliding down from an escalator. Therefore, we have developed an automatic human and cell phone operated shopping trolley to solve the problems. The shopping trolley was equipped with sensors for easy movement in the shopping area. So that users can enjoy shopping and pay more attention on their children during shopping without the need of pushing the shopping trolley. This paper presents the technical construction of GSM based vehicle that could be operated from almost anywhere if GSM network exists. The process starts with initiating a call from the cell phone to a cell phone which is in auto received mode stacked in the vehicle. In the course of a call, if any of the keypad buttons was pressed a tone corresponding to the button pressed is heard at the other end of the transmission which is called Dual Tone Multiple Frequency (DTMF) tone.

Key words: Automation, Shopping Trolley, Cell Phone, GSM based Vehicle, Remote Controlled Vehicle, DTMF

I. INTRODUCTION

The trolley is specially designed to reduce the effort as well as the time for moving the trolley from one place to another. Human beings have always developed technology to support their needs ever since the beginning of mankind. In today’s world, every supermarket and hypermarkets employ shopping baskets and shopping trolleys in order to help the customers to select and store the products which they need to purchase.

In this paper, we are focusing on the purpose of “Smart Shopping Trolley” which aims to reduce and possibly eliminate the total effort of customers, lower the total manpower requirement and expenses for markets and increase efficiency overall.

A cellular frequency control vehicle is typically defined as any mobile device that is controlled by a means that does not restrict its motion. A cellular control vehicle differs from a robot as, in that the remote control vehicle is always controlled manually and does not take any further action autonomously. It is vital that a vehicle should be able to move accurately to a target area; it should be adroit in motion within that area to fulfil its mission and to return accurately and safely to base.

II. LITERATURE REVIEW

Apoor designed shopping trolley can cause potential musculoskeletal injuries from manually pushing or pulling heavy loads. A market survey was conducted where the results shown that most of the users expected the shopping trolley to feature energy saving, pulling and pushing motion and adjustable height. Healthy and safety of users are prioritised when they are shopping in the supermarkets. Furthermore, customers especially parents cannot enjoy during shopping. This is because parents have to take care of children while shopping. In recent years, we have seen the appearance of several technological solutions for hypermarket assistance. It will be a great improvement on the existing system if the technology of IR, RFID’s are implemented. [1]

The vehicle is having a GSM module which is used to control the vehicle by user mobile phone. The mobile that makes a call to the GSM module placed in the vehicle will acts as a remote. In the course of the call if any button in the keypad was pressed, pulse sound corresponding to the pressed button was heard at the other end of the call. This tone is called as Dual Tone Multi Frequency tone. The vehicle received this DTMF tone with the help of GSM module placed in the vehicle will automatically sense and respond correspondingly and move in a direction as instructed by the operator.[2]

III. MECHANICAL COMPONENTS OF TROLLEY

The components used in the process of making and completion of the project are given below:

A. Aluminium Chassis

Chassis made up of aluminium is used so as to minimize the weight with good strength capability.

B. D.C. Motor

Four D.C. motors are used in each wheel section so to move the trolley accordingly.

C. Microprocessor Chipset

It is the brain of the trolley which acts as an interface between the operator and the trolley and allows the movement of the trolley guided by the operator.

D. Cell Phones

Two cell phones are used, one with the operator and another stacked in the trolley (which is in the auto receive mode). It works as the guide to the trolley. Cell phones work under the frequency range between 1800-2300MHz.

E. Battery

It is the power source for the trolley and its components.

F. Drive Motor

It is the main motor which distributes equal amount of power to every wheel, so that the slip of the wheel is minimized or eliminated.

G. Gear Box

It is used for increasing the torque while reducing the speed. It is also used for the transmission of the power from the drive motor to the wheel.
H. Miscellaneous
It includes connecting wires, handle, clamps, supporting bars, nuts and bolts, bearings, wheels, etc.

IV. DESIGN CALCULATIONS
A. Spur Gear Specifications & Calculations
1) Ratings
   System voltage: 6V-12V DC System current: 5Amps
   Motor rpm: 24 each
   Torque produced: 0.53 Nm

2) Known Parameters
   \[ P_f = 6V \times 5A = 30\text{ W} \]
   \[ N_p = 82 \text{ rpm} \]
   \[ T_p = 10 \]
   \[ T_e = 29 \]
   \[ D_p = 21\text{ mm} \]
   \[ \text{V.R.} = \frac{N_p}{N_e} = \frac{T_e}{T_p} = 2.9 \]
   \[ N_e = 28.27 \text{ rpm} \]
   \[ D_p = m \times T_p \]
   Therefore: \( m = 2 \)

3) Design Power
   \[ P_e = P_d \times K_i \]
   \[ K_i = 1.25 \]
   \[ P_d = 37.5 \text{ W} \]

4) Tooth load
   \[ F_t = P_d / V_p \]
   Where:
   \[ V_p = \text{pitch line velocity} = \frac{\pi \times D_p \times N_p}{60} = 0.079 \text{ m/s} \]
   \[ F_t = \frac{33.5}{0.079} = 437 \text{ N} \]

5) Bending Strength
   \[ F_b = S_{oh} \times C_v \times b \times Y \times m \]
   Where \( S_{oh} = \) (forged carbon steel, SAE 1045 heat treated) = 210 MPa
   For gear \( S_{oh} = \) (cast steel 0.2% carbon heat treated) = 196 MPa
   \[ C_v = 0.3 \]
   \[ Y_p = 0.485 - \frac{2.87}{10} = 0.485 - 0.287 = 0.198 \]
   \[ Y_g = 0.485 - \frac{2.87}{29} = 0.485 - 0.098 = 0.386 \]
   \[ (S_{oh} \times Y_p) = 210 \times 0.198 = 41.58 \]
   \[ (S_{oh} \times Y_g) = 196 \times 0.386 = 75.656 \]
   Pinion is weaker & hence design must be w.r.t. pinion

   From:
   \[ F_b = F_t \]
   We get:
   \[ b = 18.99 = 19 \]
   \[ b_{max} = 8.5 \times 2 = 17 \]
   \[ b > b_{max} \text{ consider } b = 19 \]
   \[ F_b = 75.656 \times 19 \times 0.3 \times 2 = 862.478 \text{ N} \]
   \[ F_b > F_t \text{ design is ok} \]

6) Dynamic Load
   \[ F_d = F_t + \frac{23 \times V_p \times ((C + e \times b) + F_t)}{21 \times V_p + (C + e \times b + F_t)} \]
   Where \( C = 11800, e = 0.05 \]
   \[ F_d = 650.61 \text{ N} \]

7) Endurance Strength
   \[ F_{eb} = S_{eb} \times Y \times b \times m \]
   Where \( S_{eb} = 700 \text{ MPa for 450 BHn steel} \]
   \[ F_{eb} = 700 \times 0.198 \times 19 \times 2 = 5266.8 \text{ N} \]

Check \( F_{eb} > F_d \) design is ok
Hence it is safe

B. Motor Specifications & Calculations
No. of Motors used: 4
Power output: 80 W
Motor rpm: 24 each
Torque produced: 0.53 Nm

In terms of voltage, we can put the equation as:
\[ \text{RPM} = \frac{K_i \times V}{1} \]
\( V \) = voltage constant = 1.5
\( K_i \) = induced voltage constant = 12 V
\( -N = 1.5 \times 12 = 1 \text{ rpm} \)

V. WORKING PRINCIPLE OF AUTOMATED TROLLEY
In this we are making a four wheel vehicle, with trolley mechanism on top to hold the various types of materials being selected by customers from the various racks in the shopping mall. The trolley will have the drive and steering mechanism being motorized and is backed by DC batteries. The project will work on calling method.

Fig. 1: Working Principle of Automated Trolley
In this we are making a four-wheel vehicle, with trolley mechanism on top to hold the various types of materials being selected by customers from the various racks in the shopping mall. The trolley will have the drive and steering mechanism being motorized and is backed by DC batteries. The project will work on calling method. Here, one cell phone will be held by an operator, the procedure commences with initiating a call from one cell phone to another which is in auto received mode by GSM module stacked in the vehicle. In the course of a call, if any of the keypad buttons is pressed a tone corresponding to the button pressed is heard at the other end of the transmission which is called Dual Tone Multiple Frequency (DTMF) tone, then in that case the receiver phone will automatically receive the command from the operator and the operator’s phone will send the code or the command whether to move to left, right, forward, reverse, or stop. The receiver phone will receive the command and accordingly the trolley movements are initiated. The battery will be attached to the receiver circuit; also the motor will be attached to the receiver circuit with the gear box coupled with the motor. Here the high torque and low rpm will be used.

VI. CONCLUSION
By developing a cell phone operated trolley, we have overcome the drawbacks of the conventionally used RF circuits as well as the conventional trolleys used in supermarkets. This cell phone operated trolley includes advantages such as robust control, minimal interference, a large working range and increases overall efficiency. The trolley requires four commands for motion control. The remaining twelve controls are available to serve purposes dependant on the area of application of the trolley.
REFERENCES


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