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Research Article

Smart Trolley using Accelerometer and Omni Wheels

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Abstract

In malls trolleys are required to carry a number of goods around as you shop. The customer has to pull the trolley from rack to rack, collecting items .Also the customer has to keep track of how much he is spending in order to fit it in his budget. To avoid this entire headache of pulling the trolley, waiting in billing queue, thinking about budget, we are designing a smart trolley that would reduce the customer's effort and making shopping easier. The smart trolley follows the customer while purchasing items and it maintains a safe distance between customer and itself. When a product is kept in the trolley, it automatically calculates the bill. The final billing will be a lot easier as no separate billing counter will be required.

Keywords: *Ultrasonic sensor, Barcode scanner, microcontroller, RFID Reader, Accelerometer.*

1. Introduction

An innovative product with social acceptance is always the most successful product .The one that aids the comfort, convenience and efficiency in everyday life is the most superior. The smart trolley is one such design.

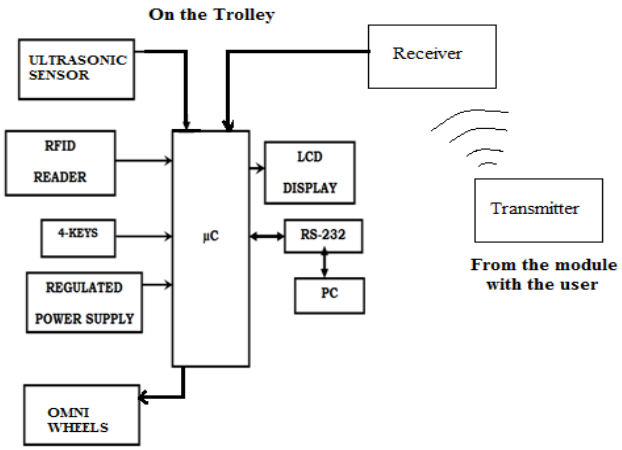

Figure 1: Block Diagram of the Entire System

The main objective of proposed system is to provide a technology oriented, low-cost, easily scalable, and rugged system for assisting shopping in person. The technologies being used in this design are more efficient than the traditional technologies .The developed system consists of 3 key modules:

- Motion control components: Following the user and obstacle detection
- Automatic billing component
- User Interface and display component.

Further this idea could be extended to completely eliminate the billing counters using internet banking and credit card interfaces.

2. Motion control components

a) Accelerometer and Transmitter (detection of target

Using an accelerometer plus a transmitter circuit tied with a necklace sort of module or a pocket device to customer. Each transmitter circuit will have its receiver which will be fixed on the trolley. Accelerometer is a device that gives signal conditioned voltage outputs in three directions X, Y and Z respectively. On putting the necklace, the position of the axes of accelerometer will be as shown in the figure.2

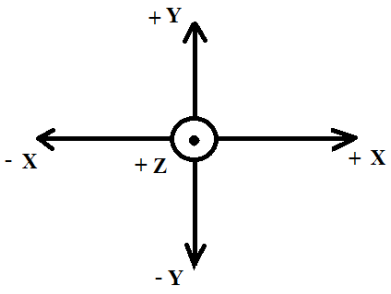

Figure 2 : Directions for Accelerometer

We will measure the Z axis and X axis readings continuously. We neglect Y axis as there is no relative motion present in this direction. The readings will be continuously transmitted to the trolley. Receiver on the

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trolley will feed these readings to the microcontroller and microcontroller will drive the trolley accordingly.

For example, if person wearing the accelerometer necklace goes in the forward direction, Z axis readings will change and will be positive. If person walks backward, readings will be negative. These readings are sent continuously to the microcontroller on the trolley. Microcontroller will drive the trolley accordingly. Similarly when the person moves sideways, trolley will also move in sideways direction; i.e. motion will be detected in the X direction. Due to use of Omni wheels, the orientation of the trolley will be same throughout

b) Omni Wheels (Motion towards detected human)

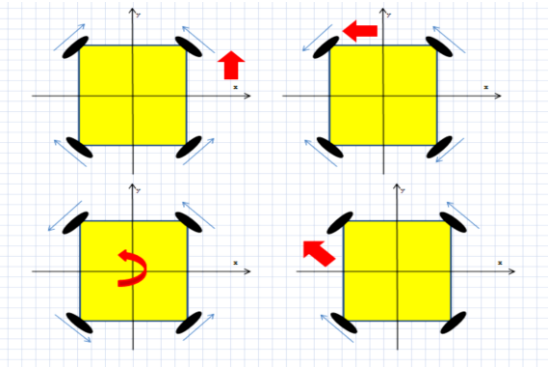

Figure 3: Motion using Omni Wheels

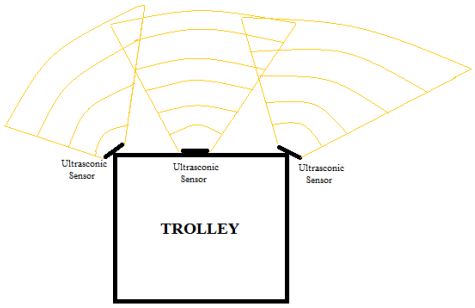

Figure 4 : Angles covered by ultrasonic sensors

Traditional two wheels differential drive are normally used for driving a robot and in this case, trolley. But they give only two out of three degrees of freedom, which are move forward/backward and rotate. Omni wheel drives can move freely in two directions. They can roll like a normal wheel or roll laterally using the wheels along the circumference. The rollers fitted on the circumference of the wheel allow them to move in lateral direction, giving them third degree of freedom. So trolley can move sideways too, and that to without changing its orientation.

We place the drive wheels at four corners of the chassis, with axels of all wheels along the corresponding diagonal of the quadrilateral. Now to drive the trolley in forward/backward direction, opposite wheels are rotated in same direction, counter to the direction of remaining two wheels. To move the trolley in sideways direction, two adjacent wheels are rotated in same direction, while remaining two are rotated in same but counter to the direction of the first two wheels. This is shown in Figure.3

c) Ultrasonic Sensors (obstacle detection)

Ultrasonic sensors work on a principle similar to radar or sonar which evaluates attributes of a target by interpreting the echoes from radio or sound waves respectively. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object.

Here, we are going to fit two sensors at front corners of the trolley making an angle of 45º angle to the front edge of the trolley. The coverage of these sensors is conical as shown in Figure4. So by placing two sensors as specified, it will cover the entire front area.

Now by continuously monitoring the readings of these sensors, whenever any of the sensors detects an obstacle, it can know the distance of the obstacle from itself. Now on detection of obstacle, we will check the other sensor's reading. If the obstacle for a sensor is away compared to the obstacle of other sensor, trolley should move in that direction, where distance of the obstacle is more, avoiding the nearer obstacle.

Thus the trolley keeps a safe distance from the user and also avoids bumping into other trolleys or the racks. While doing this, trolley follows the transmitter with the help of accelerometer.

- **Algorithm for the ultrasonic sensor is**

1. Send a short, but long enough 10us pulse on the trigger pin and set the timer
2. Wait for the echo line to go high
3. Time the length of the line it stays high
4. Estimate the time and by the formula, distance = speed × time, we get distance.
5. This obtained distance is twice the distance of obstacle from trolley since wave has travelled back and forth.

3. Automatic Billing System (RFID Card billing)

The automatic billing system will calculate the total bill by reading the RFID tags attached to the products put in the cart and will send total value to the display. Also the cart can be connected through UART to the printer to generate hard copy of the bill.

RFID is the special type wireless card which has inbuilt the embedded chip along with loop antenna. The inbuilt embedded chip represents the 12 digit card number. This magnetic signal is transmitted by the loop antenna connected along with this circuit which is used to read the RFID card number.

RFID reader is interfaced with the microcontroller. RFID reader works on weigand protocol and transmits the wireless signal at 125 KHz. RFID reader has two data line i.e. DATA0 and DATA1. Both the lines are active low and is connected at the external interrupt pins (INT0, INT1) of the microcontroller. Logic 1 is transmitted on DATA1 line and logic 0 is transmitted on DATA0 line.

Interfaced RFID reader continuously transmits the electromagnetic field across it. The range is max of 10cm. when the RFID tag/card comes within this range; the

RFID card gets powered up and provides their 26 bit ID data to the RFID reader.

Here each product has the individual RFID card which represents the product name. Here the microcontroller is already programmed with card number and interfaced with four switches.

When person puts any item in the trolley its code will be detected and the price of that item will be stored in memory. If user wants to delete any product from the trolley then he just need to take out that product from the trolley.

4. User Interface and display component

The display will show the following:
1. Number of items collected
2. Cost of current item
3. Total cost

Figure 5: Display Output

Control switches are provided on the trolley for the user to check the total cost of the items he is to purchase, what products he has taken, per unit cost of the item, etc. after completing the shopping, the user need to press the finish button. Also as we put the items the costs will get added to total. Thus the billing will be done at the trolley itself. Item name and its cost will be displayed on LCD as shown in Figure 5. At the billing Counter the total bill data will be transferred to PC by using wired modules.

- **Algorithm:**

1. START
2. Initialize LCD.
3. Check whether key is pressed
4. If yes then check whether key pressed is increment key or decrement key or download key and perform specified task i.e. to display on LCD and send data to PC.
5. Go to step 3.
6. If no then keep checking for RFID output.
7. If yes compare data with previous one (data present previously).
8. If yes remove item from list.
9. If no add and display list on LCD.
10. END.

Conclusion

In Smart trolley, there is no need to pull a heavy trolley, no need to wait in billing queue and no need of thinking about budget. The microcontroller based trolley automatically follows the customer. With the help of Omni wheels, it will be easy for the trolley to maintain its orientation and with ultrasonic sensors; absolute avoidance of the obstacles is possible. It gives number of products in trolley and total cost of the products on the spot.
Using such a product, the billing counter work will be reduced to almost null as the bill has already been generated. Further if credit card facility or any other wireless money transfer facility is offered on the trolley, the billing counter can be totally eliminated.

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