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Ultrasonic sensor based wireless luggage follower

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ABSTRACT

We, as an inquisitive human race, have been trying to make things easier since the dawn of human time. The objective here is to develop a fully functioning prototype of a wireless follower module which has simple manoeuvring and load bearing capabilities while following a user. Two basic forms of communication are employed to achieve the same, namely radio communication and ultrasonic ranging. The complete module consists of two separate parts which are basically the transmitter and the receiver. The transmitter part consists of one ultrasonic sensor (HC SR04) and the radio frequency operated module transmitter (RF 434 MHz).The receiver part consists of two ultrasonic sensors and the radio frequency operated receiver. The transmitter part is supposed to be with the user while the receiver part is mounted on a motor powered and wheel driven 'luggage'. A working model has been developed and the results are presented.

KEY WORDS: ultrasonic sensor, radio communication, luggage follower, wireless sensor networks.

1. INTRODUCTION

A lot of features are available in modern architecture for the physically challenged like gentle slopes in place of the stairs, voice simulators using the vibrations of the throat to generate an artificial voice, highly sensitive cochlear implants. The main idea behind the work is to meet the requirements of a person who might not be able to carry his or her luggage due to health or physical limitations. In principle, this can be used in any number of places. In households it can be used for carrying stuff around during rearrangements to make the work more efficient. Similarly, if high powered motors are used this can be used in industrial work space too for carrying stuff around in warehouses and such.

A Wireless digital follower has been conceptualized for shopping malls. As people keep shopping the products, the cart analyses and records the items and their price. Price is the parameter which is digitally ''followed'' by the cart internal system. Customers are just required to pay the final amount showed on their cart. Eliminates queue lines, reduces the wastage of time. An electronic luggage follower has been developed at Florida International University. GPS is used as the ranging device, which is expensive but pretty spot on with the results. Viability tested in simple environments such as college campus and shopping malls.

Handful of similar ideas has been conceptualized but it remains to be seen how far its practical purposefulness can be achieved while absolutely minimizing the costs involved. The materialization of an idea usually boils down to cost effectiveness versus time management. The objective of this work involves mainly in achieving minimum cost as possible.

2. DESIGN APPROACH

Part Modifications: A typical HC SR04 ultrasonic ranging sensor is a standalone displacement measuring device in itself. It uses the echo and trigger to send the pulse and measure it on the rebound. But for all purpose and intent of this work one of the sensing ports of the sensor has been blocked. Blocking one port on each of the sensor gives us the functionality to calculate the displacement between the receiver and transmitter and also the manoeuvrability on the wheels as one each of these sensors are mounted on the left and right wheels of the receiver carrying luggage. So instead of the echo, the pulse wave in just one direction is required, which is from one sensor (on the transmitter) to the other (on the receiver present on the movable part) and calculate this distance.

Sensor Calibration: After the initial modifications, ultrasonic sensors are tested with the requirement. Before making the setup wireless, a calibration has to be performed with the wired setup. A code was compiled to run in arduino, which performs the following important functions

i) Providing the trigger pulse for the setup to start

ii) Calculating the distance of the transmitter from each of the receiver side sensor and then converting it to cm for easier verification

iii) Providing half a second delay between each pulse

The distance values on the output window of the Arduino software is verified with the actual values of the distance. If the error margin is 1%, we assume the sensors to be calibrated.

Motor and Driver Board: After verifying that the sensors are responding to the displacement correctly, the distance values are converted to equivalent PWM values. PWM signals are basically responsible for sending the current values to the motor via the motor driver board (L293D), both of which are now connected with a power supply along with the Arduino board. It involves a simple principle- current value is directly proportional to the distance. This would mean that farther the transmitter goes, faster the motor will rotate so as to catch up. Similarly, if the distance to the two sensors is not equal, that is to say that the luggage needs to turn , the motor opposite to the direction the luggage needs to turn, will start to rotate faster compared to the other motor causing the luggage to turn in that direction. After aligning itself in the same direction, the motors will start to rotate symmetrically again.

Wireless Operation: RF434 MHz module is used to make the whole set-up wireless. It consists of a transmitter and receiver, each of which is mounted on its counterpart on the luggage and user setup. To make the whole setup work wirelessly as smooth as possible the trigger pulse needs to be synchronized with all the components. There is also a buzzer for if the distance between the user and the luggage exceeds a limit.

3. COMPONENTS USED

Ultrasonic ranging sensor (HC SR04): The ultrasonic ranging sensor used in the module is a standalone transmitter-receiver set in it. So it can measure distances using an ultrasonic transmission via the transmitter and calculating the time on the rebounding echo on the receiver.

Timing pulse: A short 10us pulse to the trigger input is required to start the ranging, and then the module will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo. The Echo is a distance object that is pulse width and the range in proportion. The range through the time interval between sending trigger signal and receiving echo signal is calculated as follows. The range = high level time * velocity (340m/s) / 2. It is preferred to use over 60ms measurement cycle, in order to prevent trigger signal to the echo signal.

L293D motor driver IC: The L293D IC is a motor driver circuitry which works on the concept of what is an H bridge basically, which allows high voltage to be drawn in either direction. As there are two separate H bridge configurations in a single chip, it can operate two DC motors independently. It is quite commonly used in Arduino projects due to its size and voltage requirement other than the fact that it is cheap and easily accessible

Measurement angle: Although designed for up to 45 degrees cone of range, its best performance is within 30 degrees of the same as shown in Fig. 1

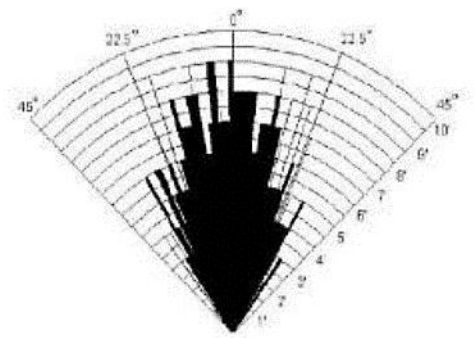

Fig.1. Best in 30 degree angle

Wireless module (RF434MHZ): The radio frequency operated wireless module used in the project is a combination of the RF Link Receiver and Transmitter (434 MHz)

Working Model: The snapshot shown in Fig. 2 demonstrates the motor working with changing relative position of the transmitter. The protruding pole of the motor has been affixed with a piece of cardboard to show the rotation. It's also clearly visible in the second picture that the motor has rotated after the position change of the transmitter.

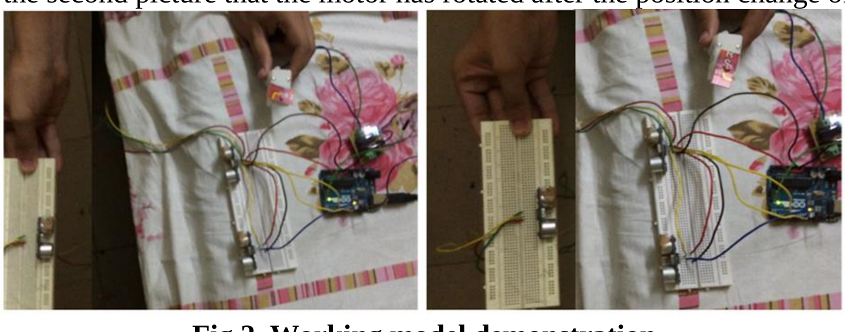

Fig.2. Working model demonstration

Cost Analysis: The total cost of the working model is Rs.2320/-. Mass manufacturing of the product would further decrease its cost. Hence developed product is cost effective than the conceptualized ideas discussed in the literatures.

4. CONCLUSION AND FUTURE WORK

It is a very useful tool for physically challenged person to carry luggage at railway stations, airports. The proposed idea can be easily extended using high powered motors and better driving circuitry for bigger applications. For the purpose of this project, it is just a quixotic problem. The problem with RF module is the penetrating ability through some obstacles like a lead boundary, yet it is still better than many other ways of communication. As ultrasonic sensors and RF modules are limited in their abilities to do anything more than basic communication and ranging, a micro controller can be included to keep track of an authenticating signal to make sure that only the original pair of luggage and user are interacting.

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