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Wireless Controlled Luggage Carrier

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Abstract: *The proposed in the paper device is essentially a personal porter that follows an operator around to wherever the destination may be. The Autonomous Luggage carrier code-named "The Stalker" is a hands-free load carrying propulsion system that maintains a safe following distance behind the user; thus allowing total freedom of movement. The intention is to automate the act of hauling luggage which is commonly encountered while going through the tedious and often exhaustive routines associated with airport travel. A group wireless control is developed.*

Keywords: *Luggage carrier, group control, wireless control.*

Introduction

The stalker (Fig. 1) will be capable of but not limited to stop and travel in busy lines. It will also be capable of following the user to distant terminals at variable speeds. In addition to the usage in airport applications, the stalker may also be implemented in many other settings, such as for transporting medical equipment in hospitals, usage at cruise ports, nursing homes or assisted living facilities, and many other miscellaneous personal use. The applications of this device also tailor to allowing more freedom to handicapped or elderly individuals who want to assert their independence. Still another use of this device is for laborers/professionals who are often going back and forth on job sites consuming valuable time simply transporting their equipment [1].

Fig. 1. The stalker

Fig. 2. The braslet

The basic design functionality of the stalker entails wireless connectivity to the user. The wireless tethering is accomplished through the use of sensors on a bracelet/strap worn by the user (Fig. 2), and sensors on the stalker unit. A security feature is also implemented on the stalker – an alarm system that will sound if the luggage is tampered with or if the stalker unit falls too far behind the user. A LED will illuminate on the bracelet to alert the operator of low battery power. A flashing light mounted on the stalker will alert the other passers-by of the presence of a moving device. An emergency stop button is also attached to the bracelet in the event of a malfunction.

Design objective and functionality

The task at hand is as follows. To build and demonstrate an autonomous luggage carrying device that follows the operator wirelessly. The mechanism is programmed to follow the operator and maintain a certain safe distance (maintaining approximately 3-4 feet).

The device will be outfitted with an onboard battery charger that plugs into a wall outlet for recharge. This is presumably done overnight before use to assure a fully charge battery for uninterrupted usage. A revolving light mounted on the post will alert other pedestrians of the moving device. This will help minimize or eliminate others from walking in the path between the operator and the device.

Key Components

To satisfy the products' intended usage and requirements, a list of the following components were found to be necessary.

- 18 V DC Motor (Fig. 3):
  - For cart propulsion;
- Battery and battery charger:
  - Plugs into 110 VAC outlet,
  - Recharges 18 VDC battery,
  - Proposing using 3 18V batteries in parallel for longer operating duration.

Fig. 3. DC Motor

- Limit Switches (Fig. 4):
  - For detection of full left and full right steering back to a microcontroller;

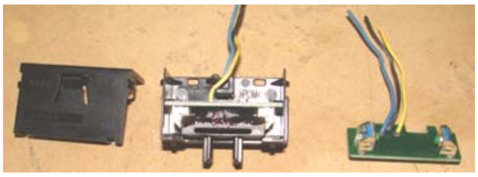

Fig. 4. Limit switches

- Flashing LED light and siren (Fig. 5):
  - To alert if the cart is no longer within the required distance of operator;
- Prefabricated cart:
  - Completely assembled,
  - Changed the configuration so that the handle side is the front of the cart,
  - The front wheels were replaced by one larger wheel for propulsion.

Fig. 5. LED light and siren

- Clutched 12 V DC motor (Fig. 6):
  - For steering;

Fig. 6. 12 V DC motor

- Pololu IR Beacon (Fig. 7):
  - Directional and distance sensor,
  - Dimensions: 1.35´´ radius,
  - Range: from 6 inches up to 20 feet,
  - Supply Voltage : 6-16 V.

Fig. 7. IR Beacon

- SyRen 10Motor controller (Fig. 8):
  - **Input voltage:** 6-24 V nominal, 30 V absolute max,
  - Up to 10 A continuous. Peak loads may be up to 15 A for a few seconds,
  - Synchronous regenerative drive,
  - Will return power to the battery any time a deceleration or a motor reversal is commanded,
  - Saves power by returning the inductive energy stored in the motor windings to the battery each switching cycle,
  - Feature a PWM frequency of 32 kHz,
  - Utilized for steering.

Fig. 8. SyRen motor controller

- MC7 Motor Controller-Drive (Fig. 9):
  - **Input voltage** 12-36 V,
  - Used to control drive motor,
  - 35 A continuous (cooling),
  - PWM output,
  - Utilizes 3 IRLZ48 power Hexfets,
  - Manual speed control with potentiometer ,
  - Control with PWM control,
  - Ramped forward and reverse speed acceleration.

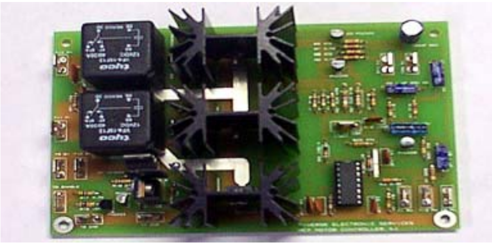

Fig. 9. Motor Controller-Drive

- Ping Distance Sensor (Fig. 10):
  - **Supply Voltage** – 5 VDC,
  - Supply Current – 30 mA typ; 35 mA max,
  - Range – 2 cm to 3 m (0.8 in to 3.3 yrds).

Fig. 10. Distance sensor

Sensor circuitry

Below is given a diagram of the internal IR Beacon sensor logic. The sensor pair comes as a kit and requires soldering of the components on the circuit boards (Fig. 11).

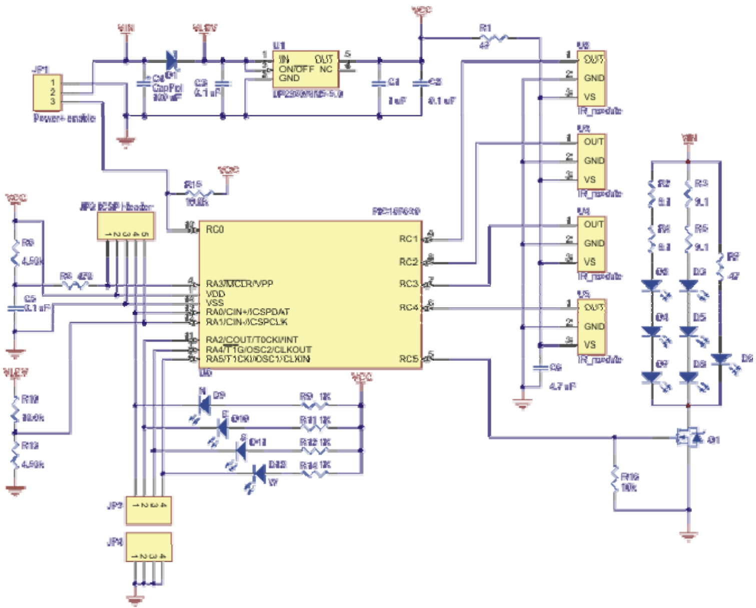

Fig. 11. Sensor logic

Sensor operation

The heart of the logic for this device comes from the pair of Beacon IR sensors. The devices are transceivers meant to be used in pairs to give robots simple means for detecting each other. The beacons work by transmitting and detecting infrared light, similar to television remote control. Each beacon has four IR emitters and

four IR detectors. The beacons alternate between transmitting and receiving so that they never get confused by reflections of their own transmissions.
The transmit and detect cycle is carried out more than one thousand times per a second, and a small microcontroller monitors all four detectors to decide the direction to the other beacon. The beacons have four red LEDs that indicate the direction to the other beacon; if you take two beacons and rotate them, the LEDs will always keep lighting up in the direction of the other beacon (Fig. 12).

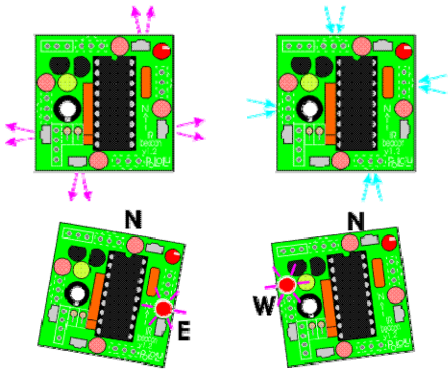

Fig. 12. LED Sensors

The Beacon has four digital outputs that indicate which of its four sides detects the other beacon in the strongest way. You can establish the direction to another beacon within a few degrees by rotating the beacon back and forth and noting the point where the output switches from one side to another. An enable input lets you select between an active mode and a low-power mode (Fig. 13).

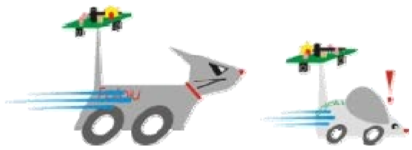
Fig. 13. Modes

Component layout

Lower view is shown in Fig. 14.

- One clutched DC motor controls the direction of the front wheels similar to a rack and pinion design on an automobile.
- The drive motor applies a torque to the single large front wheel via friction from a smaller wheel mounted on the drive motor.
- A rechargeable 18 V battery is mounted under the cart with access to plug in the transformer plug for recharge.
- The Basic Stamp, siren, and charger are mounted on plexi-glass mounted to the bottom of the cart.
- Both drive and steering controllers are mounted on the bottom of the cart to maintain proper ventilation to prevent overheating.

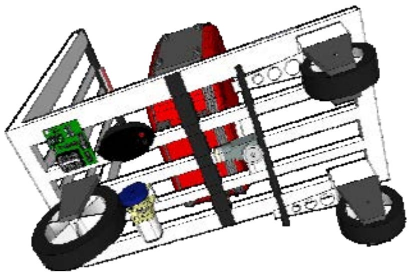

Fig. 14. Lower view

Steering operation

- Steering is first initialized (Fig. 15) to by sweeping full left, then full right to determine the center point.
- Steering determined by N, S, E or W direction in relation to a cart indicated on a Sensor.
- If East or West of the device is detected, the wheel turns then the drive and waits for the north direction to be detected.
- Blinders made of plastic added to the north facing receiver to the beacon to narrow the field of a view similar to blinders on a horse.

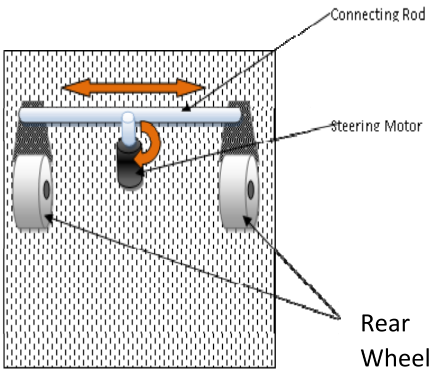

Fig. 15. Steering operation

The programming

In the programming (Fig. 16) there are several components that were tested separately, and then all brought together into one single program that controls the cart. The distance sensor and the drive motor generally work together, while the steering is dependent upon the Pololu transceivers.

Due to the nature of our distance sensor (Parallax PING sonar sensor), which is extremely accurate for big flat surfaces, but not so accurate when it comes to seeing a person that is in front of it, we were forced to program a buffer into the distance readings. In fact, we take three readings in a row, which are then stored in three different variables. If all three readings are larger/smaller than our distance threshold, then the motor is turned on/off, otherwise, nothing happens until all three readings are consistent [2].

The general flow of the program is shown by the chart.

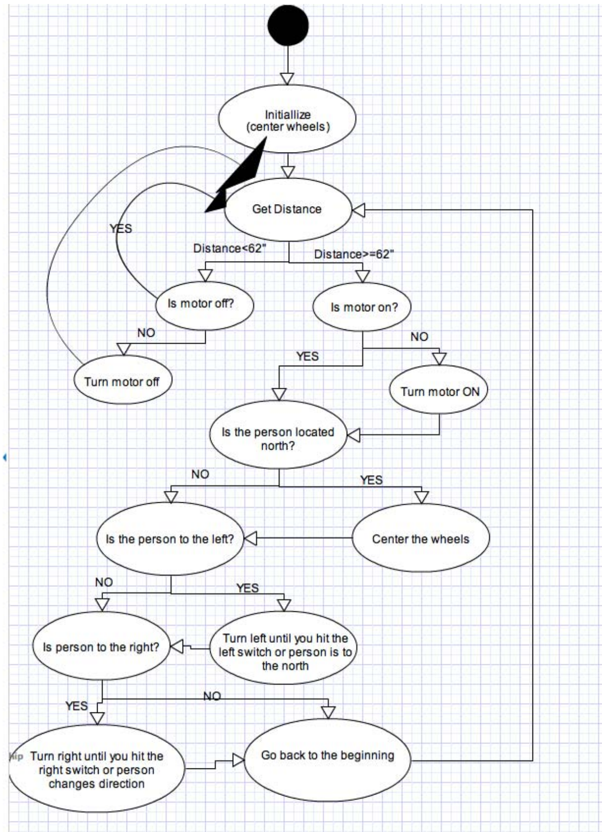

Fig. 16. Programming

Intended markets

- Airports,
  - Possible rental through airport for traveller use;
- Hotels and resorts,
  - Used by guests rather than bell men;
- Hospitals,
  - For transferring of medical equipment or other items;
- Cruise ports;
- Nursing homes;
- Assisted living facilities;
- Personal use.

Targeted consumers

- The elderly,
- Handicap individuals,
- Travelling with young children,
- Pregnant women,
- Injured passengers (e.g., temporary cast),
- Business professionals,
- Outdoor job site workers,
- The elite and the lazy.

The next step

We will develop methods for a group control of mobile luggage carrier and for obstacles detecting and handling.

The following types of group robot control are available [3]:

Following the leader of the group is the easiest task, since only a few include a robot. The first robot accepts the signal from the driver, the second receives the signal from the first, the third from the second, and so on.

Grouping is the next game step. Here each robot can adopt the role of a leader of the others.

After grouping comes, order the so called **"Tag" (marking**). Here the robots must use strategy to avoid "marking" of the other robots, i.e., they should not be pursued as a bait.

This type of marking is similar to the above said and is known as **"Manhunt" (prosecution**). Here we have two teams of robots, each one of them trying to select (mark) all members of the other team.

The next step is a game of **"Winning the flag"**. Here again there are two teams, as in "Manhunt", but now the aim is to take the flag of the adversary and to bring in the base in their own team.

For management purposes and to achieve "social interaction", separate tasks are programmed, such as other carriers to follow the operator or the first carrier (Follow the leader and clustering).

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Устройство для переноса багажа с безпроволочным управлением

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(Р е з ю м е)

Устройство, которое описано в статье, представлает в сущности персональный переносчик багажа, который следит за оператором независимо от дестинации его движения. Автономное устройство для переноса багажа, названное “The Stalker”, осуществляет задачу без помощи рук, что обеспечивает полную свободу движения. Цель разработки автоматизировать акт переноса багажа во время продолжительных и трудных авио маршрутов. Разработано групповое безпроволочное управление.