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Garbage Collection Robot on the Beach Using Wireless Communications

N.Varuneshreddy[1], K. Nikhil[2]
[1,2]*Student, Department of ECE, SRM Institute of Science and Technology, Ramapuram, India*

***Abstract*—This article presents the garbage collection robot on the beach using wireless communications. The robot is built on the caterpillar wheels, sizes 52x74x17 cm and the power is supplied from 12V 30Ah battery which is connected to 40W solar cells. The user can control a robot via a program developed from Visual Basic 2005 application based on Window XP. The commands from user are sent via bluetooth to PIC18F4550 for processing. In addition, it is also equipped with an IP camera with added pan/tilt capabilities which relays feedback information to the human operator via Ad-hoc system. The results of robot performances were found that the robot can move with an average speed of 0.5 meters per second on the sand via wireless communication and collect the big garbage with side 12.5 x 49 cm, for example, glass bottles, and plastic, etc. From the experimental results, it can clearly indicate that the proposed robot is superior to handle tasking conveniently, control capability, and operate environmentally friendly.**

***Index Terms*—robot, wireless communications, Ad-hoc network, garbage collecting robot, solar energy, PIC18F4550**

I. Introduction

Garbage is a major problem worldwide attention. It can be seen from organizations that support and fix this problem, such as Ocean Conservancy that is a non-profit environmental advocacy group based in Washington, D.C., United States. The organization reports on 23 August 2013 that over the past 27 years, over 9.5 million volunteers have removed 163 million pounds of trash from more than 330,000 miles of coastline and waterways in 153 countries and locations. At the present, more than 10 million pounds of trash along nearly 20,000 miles of coastlines were picked up by more than 550,000 people. In Tamilnadu, this problem affects to the destruction of the beautiful scenery and attractions. Moreover, it causes the problem about the sea animal death. For example, the death of the whale on the beach, Marina, Besant nagar because it eats the plastic waste. Although, some organizations try to clean the beach but the amount of the trash on the beach is still increasing at all time. Therefore, the development of the technology such as robot for collecting the garbage is the one aspect that is interested.

Until now, the service robots about cleaning robot for the swimming pools [1], the house [2], the wall [3] and the domestic stairs [4] are interested and developed continually but the cleaning robot for the beach does not be much interested. Therefore, this paper presents the development of a prototype garbage collection robot on the beach. This robot uses the Bluetooth for communication between the user and the robot. Moreover, IP camera with added pan/tilt capabilities can send the image data to the user via the Ad- hoc system. The details of this paper are organized as follows. In section 2, we will introduce the material and methods of the robot including the hardware and software implements. The result of the experiment and the conclusion will be described in section 3 and section 4 respectively.

II. Materials and Methods

This section describes the hardware and software implements. The complete system of garbage collection robot can be shown in Fig. 1 and Fig. 2.

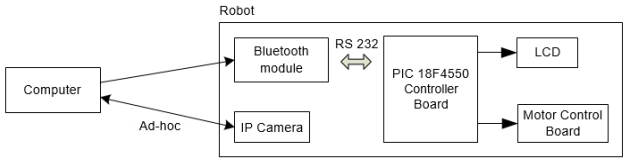


Fig. 1. Hardware architecture of garbage collection robot

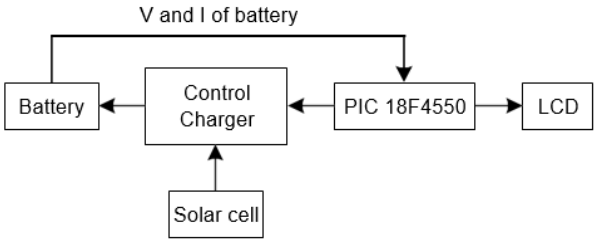


Fig. 2. Hardware architecture of power supply of the garbage collection robot

A. Hardware Implementation

The complete system of garbage collection robot is divided into 5 major parts: (1) power consumption, (2) structure and configuration of the robot, (3) microcontroller, (4) wireless communication module, and (5) IP wireless camera. The details of specifications for this robot can be shown in Table-1.

1) Power consumption

The primary source of power for the robot is the sealed lead acid battery (12V 30Ah). The voltage regulator (LM7805) is used to reduce the 12 Vdc from battery to 5 Vdc for supplying

the microcontroller and IP wireless camera. Optoisolator is used to pass the signal from the microcontroller to drive the gate of the RFP50N that is used to drive the motor at 12Vdc. Forty watts of solar cell is used to charge the battery. In this paper, we will not explain the detail of the solar cell design.

2) Structure and configuration of the robot

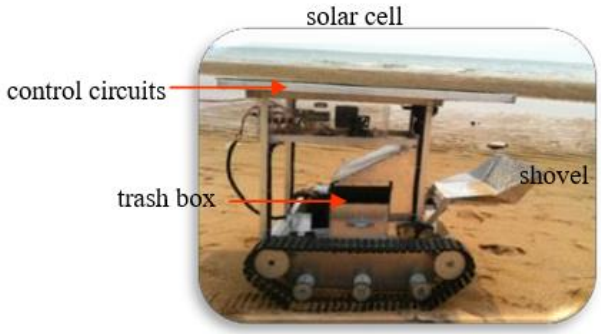


Fig. 3. The prototype of the garbage collection robot

The structure of the robot is made of aluminums sizes 52x74x17 centimeters. The shovel of the robot width is 49 centimeters and the trash box in the robot sizes 35x36x40 centimeters. The prototype of the robot can be shown in Fig. 3.

3) Microcontroller

A microcontroller (PIC18F4550) is used as the brain of the robot. It is a 40-pin dip, consumes low power and high speed FLASH/EEPROM technology. It consists of 256 bytes EEPROM memory, 35 Input/output, two external clock modes (up to 48MHz), 13 channels of 10-bit analog to digital converter, a capture/compare/PWM functions. The 16x2 LCD is used for displaying the user output command and status of the charging battery on the robot.

4) Wireless communication module

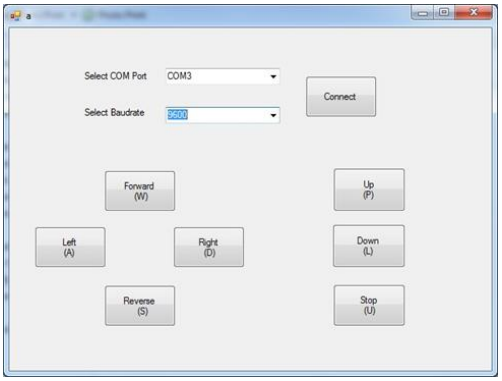
Bluetooth device class-2 USB dongles with a range of 10m and maximum output power as 25mW/4dBm is used to communicate between microcontroller and computer. Bluestrick on the robot is a Bluetooth Serial Port Profile device for wireless serial data communications via the Bluetooth radio system. It is a low cost, compact and easy to use this module. It can connect to the microcontroller via RS232 serial port.

5) IP wireless camera

The FosCam WPA Wireless IP Dual Audio Camera (FI8908W) is used as an IP wireless camera at Wireless Standard IEEE 802.11b/g. This camera allows people to get into IP cameras without a huge investment. The dimension of this camera is 110x100x108millimeters and the net weight is 418gram. It can pan or tilt at the angle 300° horizontal & 120° Vertical. The IP camera is installed on the robot. It will send the image in front of the robot to the computer via Ad-hoc mode by Connectify program. The image is displayed on the computer by IP Camera Tool software. Table 1: Specification of Garbage Collection Robot

B. Software Implementation

The robot controller software is developed in Microsoft Visual Basic 2005 as shown in Fig. 4. It is used to control the robot by navigation command as shown in Fig. 4, such as forward command (W). Flowcharts of the robot controller software are shown in Fig. 5. The W, S, A, D and U buttons on the keyboard are used to be the forward, reverse, left, right, and stop command respectively while the P (up) and L (down) are used to control the shovel.



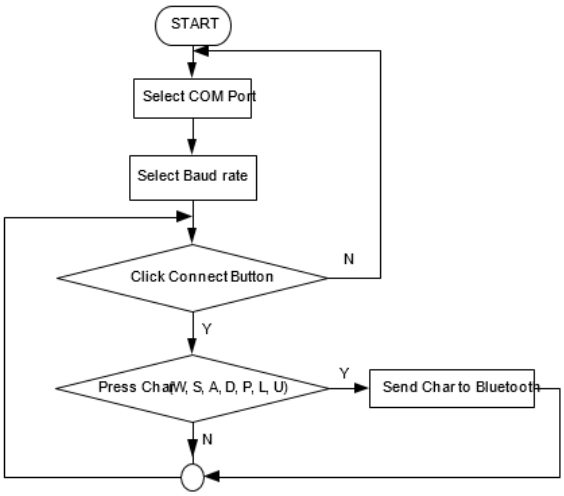


Fig. 4. Flowchart of the robot controller software (Computer Side)

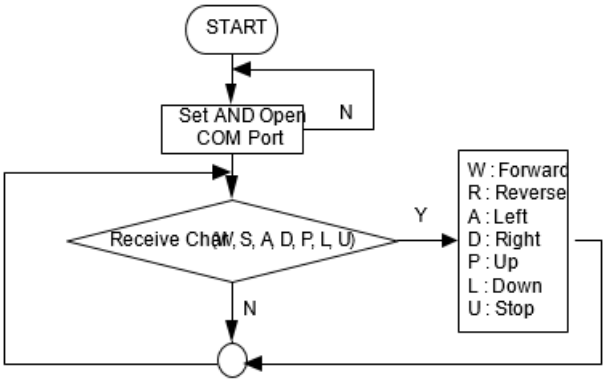


Fig. 5. Flowchart of the robot controller software (Microcontroller Side)

III. Results

A. IP wireless Camera Test

Fig. 6. Image from the IP wireless camera (The angle of depression view)

Fig. 7. Image from the IP wireless camera (Angle of elevation view)

The IP wireless camera which is installed on the robot is tested by measuring the delay time of transmitted image. From the results, it was found that the delay time of transmitted image and the sharpness of the image are depended on the distance between the robot and the user. The delay time of the long path will be more than on the short path. The distance that the camera can transmit the clearly image is the range 0 – 15 meters. The delay time of transmitted image is 0.5 and 2 seconds in the range of 15 and 25 meters respectively.

B. Robot Control Test via Bluetooth

In this test, the robot is tested by the user controlling via Bluetooth. All the movement of the robot can be controlled from the computer through the image from IP wireless camera. The robot can be controlled within 20 meters that is the limited of Bluetooth, so it can be improved by changing the Bluetooth to be class 1. The robot can move at a constant speed of 0.5m/s and the delay time are the maximum of 2 seconds.

Fig. 8. The garbage collection test (The large garbage)

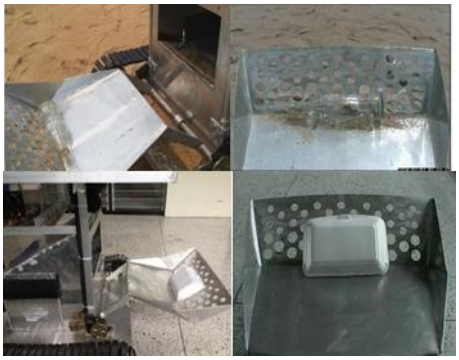


Fig. 9. The garbage collection test (The medium garbage)

The garbage collection robot was tested at Bangsan Beach, Chonburi, Thailand. The garbage collection robot can collect the several garbage such as the 1.5 litres plastic bottle, the 0.63 litres glass bottle, the poly foam box, etc. as shown in Fig. 7.

IV. Conclusion

This project developed the robot for collecting the garbage at the beach. Wireless communication (Bluetooth and Ad-hoc) was applied to the robot for remote controlling. The developed robot can move at 0.5 m/s on the sand. PIC18F4550 was used as the brain for processing all commands. The robot can move with an average speed of 0.5 m/s on the sand via wireless communication and collect the large garbage with side 12.5 x 49 cm. This robot is expected to overcome the garbage problem especially on the beach. However, this robot still be improved to operate automatically and control from the more distance.

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