A remote-control liftable small vehicle by Arduino

Runnan Zou
Department of Mechanical Engineering, University of Ottawa
Ottawa, Canada
rzou043@uottawa.ca

***Abstract*—A system contained liftable vehicle and its controller is built based on Arduino and Xcode. The vehicle with an Arduino mega 2560 has the function of moving to all directions under the remote control, sensing obstacles, lifting its upper frame and sensing the moisture of the environment. The controller is built in Xcode with the function of connecting Bluetooth in vehicle, sending command towards vehicle and receiving data from Arduino. The whole system is carried out in reality. Functions of sensing obstacles, remote control, lifting frame and capturing moisture and temperature are validated in real environment. The result shows that the small vehicle can move, lift frame while sending moisture and temperature to controller.**

Keywords—Arduino, Xcode, Vehicle, Frame-lifting, Moisture and Temperature Sensing

I. INTRODUCTION

Since the increasing demand of investigating the wild environment while lowering security risk, the remote-control adventure robot/vehicle attracts more attention [1-2]. In the narrow circumstance with unknown environmental information, only small robot that can go through and explore it. Therefore, a small vehicle with flexible shape which could go into tiny holes and send back environmental information is worth to be designed. In this project, a controller and a small vehicle with a scalable frame and the function of sending real-time moisture and temperature to controller are designed.

The overall design of the vehicle and controller is shown in Fig. 1. The structure of the vehicle is shown in Fig. 2. As it is depicted, the system contains two parts, controller and vehicle. The vehicle has 6 subsystems, main control module, module of moisture and temperature capture, module of obstacle sensing, Bluetooth module, lifting control module and module of movement control. The vehicle control code is embedded in Arduino mega 2560 which receives signal from moisture and temperature capture module, obstacle sensing module and Bluetooth. The lifting control module and movement control module is then controlled by the main control board. The controller has a control and display interface which is developed in Xcode. The controller is able to build a connection between vehicle and computer to deliver command and data in time.

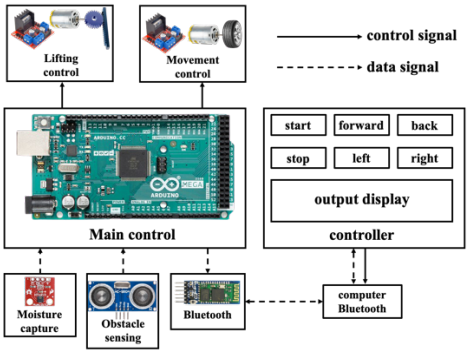

Fig. 1. The overall design of vehicle and controller

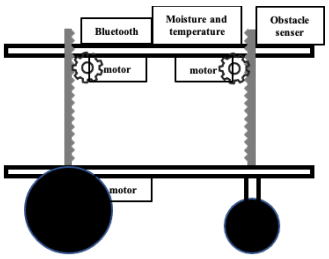

Fig. 2. The structure of the vehicle

II. DESIGN OF SUBSYSTEMS

A. Main control algorithm

The main control algorithm is in charge of receiving all senor's information and impose control towards lifting and movement module. First, the start signal is received from the remote controller from Bluetooth. Then the obstacle senser starts to measure the distance between vehicle and obstacle. When the distance goes under the preset threshold, the main control board commands lifting motors to lower frame. When there is no obstacle in a distance for several seconds, the frame is commanded to lift to its original height. The moisture and temperature module checks the environment moisture and temperature from time to time and send it to controller by Bluetooth. When receiving moving command from controller, the main control board processes the command and output high and low potential to motor controller. The control scheme and pin distribution are shown in Fig. 3 and TABLE I.

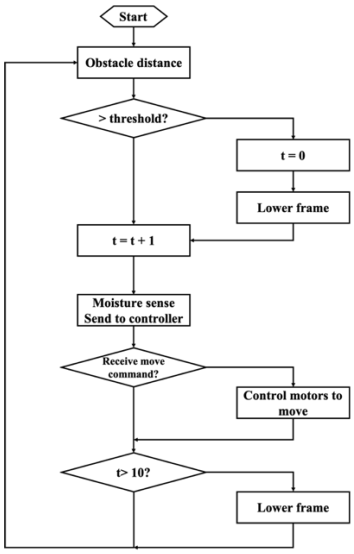

Fig. 3. The scheme of main control board algorithm

TABLE I. PIN DISTRIBUTION

Pin number	Usage
2	Trig(hc-sr04)
3	Echo(hc-sr04)
4	EN1(L298N-1)
5	EN2(L298N-1)
6	EN3(L298N-1)
7	EN4(L298N-1)

8	EN1(L298N-2)
9	EN2(L298N-2)
10	EN3(L298N-2)
11	EN4(L298N-2)
12	TXD(hc05)
13	RXD(hc05)
26	EN1(L298N-3)
27	EN2(L298N-3)
28	EN3(L298N-3)
29	EN4(L298N-3)
A4	CL(htu21d)
A5	DA(htu21d)

B. *Moisture and temperature capture module*

The moisture and temperature capture module has the code name of htu21d. There are 4 pins in htu21d, VCC, GNA, CL and DA. After connection and setting baud rate as 9600, with the function of "myHumidity.readHumidity()" and "myHumidity.readTemperature()", the real-time moisture and temperature can be captured [3]. The htu21d is shown in Fig. 4.

Fig. 4. The board of htu21d

C. *Bluetooth module*

The Bluetooth module use the board "hc05" that shown in Fig. 5. There are four pins connect to the main control board, VCC, GND, RXD and TXD. With the imported software library "SoftwareSerial.h", hc05 can be used by function "BT.read()" to receive message from Bluetooth and function "BT.println()" to write information to Bluetooth [4].

Fig. 5. The Bluetooth module hc05

D. *Obstacle sensing module*

The obstacle sensing module has the code name of hc-sr04 and it is shown in Fig. 6. The module has a port of Trig and a port of Echo. When set Trig as HIGH for 10us and then set it LOW, there will be an ultrasound sent to the front direction and the timer inside starts to calculate the time until receive echo [5]. Then the distance is calculated as follows:

$$s = (v_{sound} \times t_{back} / 2) / 1000 \quad (1)$$

Where s is the distance (cm), v_{sound} is the velocity of sound (340m/s) and t_{back} is time cost for echo receiving (us). Then the distance will be used to trigger the lifting module.

Fig. 6. The board of hc-sr04

E. *Lifting control module*

The lifting control module has 2 motor driver L298N, 4 motors and gear and rack. L298N is shown in Fig. 7.

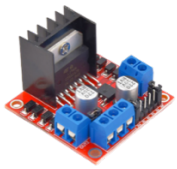

Fig. 7. The board of L298N

The power voltage for L298N is 6~12V. There are 8 pins in L298N. The 4 pins on side of L298N are connected to positive and negative poles of motors. Left 2 control the left motor while right 2 control the right motor. Four pins in the middle receive the control order. The input of these four pins are analog from 0 to 255 which determine the position of motor's rotor. In Arduino mega 2560, the function "analogWrite()" is used to write the desired position of the rotor.

The lifting system is shown in Fig. 8. The bottoms of 4 rack are fixed with the chassis while the top of them can go through the upper frame. There are 4 gears driven by motor that can drive the rack to lift the upper and lower the frame.

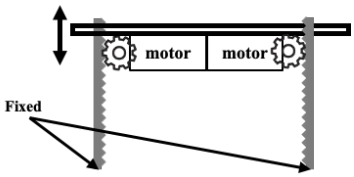

Fig. 8. The structure of lifting system

F. *Movement control module*

The movement control system contains one L298N and two motors. The rotational direction determines the direction of vehicle movement. The relationship between 2 motors' direction and vehicle' direction is shown in TABLE II.

TABLE II. THE RELATIONSHIP BETWEEN MOTORS' DIRECTION AND VEHICLE'S DIRECTION

Direction of left motor	Direction of right motor	Direction of vehicle
Forward	Forward	Forward
Forward	Backward	Right
Backward	Forward	Left
Backward	Backward	Backward

The control of these two motors uses the function of "digitalWrite()". When a port is set to "HIGH" and the other is "LOW", the rotor will rotate and it will rotate to opposite direction when the port is set in otherwise.

G. *Controller design*

The interface of controller is shown in Fig. 9.

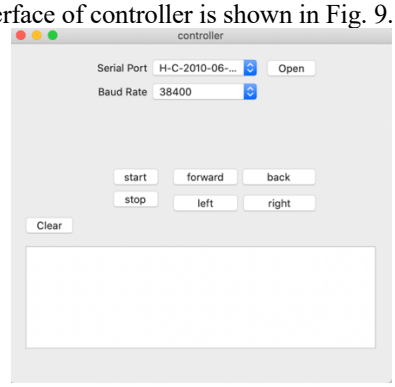

Fig. 9. The interface of controller

This interface is built in MacBook Pro by Xcode on the basis of open source project "ORSSerialPort". This open source project enables the MacBook Pro's Bluetooth to the 2nd generation Bluetooth which is utilized by hc05. Therefore, after setting the name of serial port and baud rate and clicking on "open", the controller is able to receive and send data from a remote Bluetooth.

Buttons "start", "stop", "forward", "back", "left", "right" are designed in the interface to control the movement of the vehicle. Each button is linked to a function which sends a different number to Bluetooth when triggered. For example, when the "forward" button is click, a number "1" is delivered to Arduino board by Bluetooth. Arduino read number 1 as ASCII number "49". The display box in the lower part displays the real-time message sent from remote Bluetooth.

III. VALIDATION AND RESULT

The vehicle and controller are built as Fig. 10.

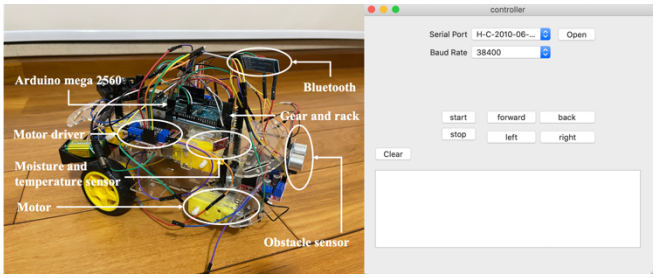

Fig. 10. The finished object of vehicle and controller

Each part of above described is shown in Figure 10. The vehicle and its controller are tested in my home with some artificial obstacles. With the preset set obstacle, the vehicle is driven by controller go straight forward it. The result shows that the vehicle lower its frame, go across the obstacle and lift the frame after several seconds. The temperature and moisture are updated in the display box in real time as it is shown in Fig. 11. Also, the vehicle can run as the controller's command. Therefore, the function of the vehicle and controller is tested and they all meet the design.

Fig. 11. The real time temperature and moisture

IV. CONCLUSION AND FUTURE WORK

In this project, a system contains a mart vehicle and a controller is designed and manufactured. The subsystems of main control, lifting control, movement control, moisture and temperature sensing, obstacle sensing and Bluetooth are built on vehicle. The controller is built by Xcode to realize the function of remote control, message receiving and display. With the preset environment, the design of the vehicle and controller has been validated. The designed functions of vehicle and controller are realized. Some conclusions can be drawn as following:

(1) The lifting structure of vehicle is able to achieve some simple tasks with obstacles.

(2) The connection between vehicle and controller built by Bluetooth is stable in a distance without too much occluder.

(3) The vehicle could move under the command of controller.

For future work, more improvement in aspect of promoting operation efficiency by updating algorithm and code. Also, there could be some improvement on sensor by adding more sensors on vehicle, such as camera, to build a more comprehensive understand of surroundings.

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