Diyala Journal of Engineering Sciences

ISSN 1999-8716
Printed in Iraq

Vol. 10, No. 3, pp. 44-53, September 2017

WIRELESS MOBILE ROBOTIC ARM CONTROLLED BY PS2 JOYSTICK BASED ON MICROCONTROLLER

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(Received: 25/5/2016; Accepted: 18/7/2016)

ABSTRACT In the last year, with a huge usage of wireless enforcement and where nearly everything which was controlled by humans is being automated by using robots. In this paper a control system of the mobile robotic arm was built by using a PS2 joystick and the microcontroller (Arduino UNO) and sends the command by the master Bluetooth (HC-05) that represents the transmitter part. Where the receiver receives the data by the slave Bluetooth (HC_05) to generate the specific motion by take the command from Arduino UNO. The purpose of this paper is to design and implement a mobile arm robot for dangerous and difficult places that humans can't reach it and make the specific tasks.
Keywords: *Microcontroller, PS2 joystick, wireless, mobile robot, robotic arm.*

1. INTRODUCTION

A robot is a machine that can perform several actions [1]. A robotic arm is a robot rigger, which can carry out many functions as a human arm. In industries, a robotic arm performs various different jobs such as welding, trimming, picking and placing etc. The greatest advantage of these arms is that it can work in hazardous areas and also in the areas which cannot be accessed by human [2], while Mobile robots have the capacity to travel roughly in their surroundings and are not situated in one physical location.

In recent years, a robotics research focuses on improving systems that display modularity, redundancy, flexibility and software connection with other machines. The researchers focus on an industrialization process by completely automating by using an intelligent sensors, while others try to settle the analytical foundations on building concepts of robotics [3].

The aim of this work is to design and implement a mobile arm robot for dangerous and difficult places that humans cannot reach it and make the specific tasks.

2. LITERATURE SURVEY

- **N. Firthous Begum**, 2015 [3] introduced a wireless controller system, the transmitter consists of HM2007 voice kit to recognize the command and a PIC microcontroller to control the transmitting process by RF module. While the receiver consists of RF module to receive the command, the PIC microcontroller receive pictures of object from android application and gives the output signal to the robot for pick and place operation.
- **Saravana Kumar K**, 2015 [4] introduced a system to control a mobile robot via Bluetooth which involves a wireless camera to explore the movement area. The transmitter represented by android application, while the receiver consists of the Arduino microcontrollers that receive the command by Bluetooth module to generate the specific motion.
- **Aiman Ansari**, 2015 [5] proposes a Cleaner mobile robotic arm to make cleaning process become easier. The transmitter represented by android application, while the receiver consists of the Arduino microcontroller that receive the command and gives the output signal to the Motor Shield L298n to make the specific action

- **Prerna Jain**, 2014 [6] introduced design to reduce human victims in a terrorist attack by designing a spy robot. This robot can get the information easily from a foe spot by wireless camera. A mounted LED's performed like chameleon job by using Color sensor. Gas sensor is used to detect the poisonous gas. The wirelessly RF transmitter joystick used as robot controlled.
- **Mohd Ashiq Kamaril Yusoff**, 2012 [7] presents a mobile robot arm to make pick and place operations and move right, left, reverse and forward by using the wireless PS2 controller which represent the transmitter. While the wireless PS2 receiver will be interfaced with the Arduino Mega platform to control the robot.

3. PROPOSED SYSTEM

The proposed scheme, as depicted in fig (1), consists of a transmitter part and mobile robotic arm part. The command sends through PS2 joystick using Bluetooth for both robotic arm part and mobile platform.

3.1 The Transmitter

The controller part as shown in fig (2), consist of the PS2 joystick to give the specific motion, The Arduino UNO microcontroller board, which represents the brain of the system, the master Bluetooth (HC-05) which transmit the command to the receiver. After connecting between the Arduino and PS2 joystick as shown in table (1) and fig (3), the Arduino code has been downloaded and then test the action of the joystick by open the serial monitor to see the data that will be transmitted. PS2 joystick consist of fourteen analog buttons (△, ○, ×, □, L1, R1, L2, R2, up, down, left, right, Select and Start), two analog sticks and three digital button (L3, R3 and the analog mode button). The buttons that used in this paper shown in fig (4) with their action.

The PS2 joystick send and receive a byte of data at the same time by serial communication. The clock is held high until a byte is to be sent. The PS2 signals have been real time reading by the Matlab as shown in figure (5). The clock signal generated from Arduino to PS2 joystick to keep in synchronization. It is held high until a byte of data is to be sent. The attention signal generated from Arduino to PS2 joystick it is going low during transmission. A 3.3V power and ground are taking from Arduino to PS2 joystick. An eight bit data signal sends from the PS2 joystick to Arduino as serial transmission synchronous to the falling edge of clock. While a command Signal sends the command from Arduino to PS2 joystick as an eight bit serial transmission. As shown in fig (6), the transmitter process started by serial connection on digital pins of the Arduino and then define the Bluetooth and PS2 joystick pins. After all definition, the baud rate and pin mode must be set, then the Arduino inter into the loop to check the button pin each time and send the data by the Bluetooth.

3.2 The Reciever

The receiver consists of the Arduino UNO microcontroller board, which represents the brain of the system, the slave bluetooth (HC-05) which receives the command from the transmitter to generate the specific motion.

As shown in fig (7), the receiving process started by serial connection on digital pins of the Arduino and then define the bluetooth and the output pins. After all definition, the baud rate and pin mode must be set, then the Arduino inter into the loop to check the serial data from the Bluetooth each time and send the command to the motors of robot to turn on or off. Some of important Arduino's instruction and its action that was used in the transmitter and receiver program are illustrated in table (2).

3.2.1 Mobile Robotic Arm

The bluetooth receives the command from the transmitter to generate the motion by the control of the wrist (up, down or stop) and the hand (open, close or stop) motors through the motor driver (L298) as shown in fig (8).

The robotic arm was constructed from an OWI Robotic Arm Edge kit Model OWI-535 [8]. The robotic arm sits at 6.3 x 15 x 9 inches and weighs 2.5 on its own. Its original design was powered by 4 D Batteries and controlled with a five switch hardwired controller which has five control points. Vertical scope of 15 inches, horizontal scope of 12.6 inches and lifting capacity of 100g [9].

3.2.2 Control of Mobile Robot

In the mobile robot as shown in fig (9), The Bluetooth receives the command from the transmitter to generate the motion by control four movements (forward, backward, left, and right) or to stop all motors through the motor driver (L298).

The platform that was used is Rover 5. This robot consists of four DC motors. Each motor is supplied with a gearbox. The encoders generate pulse signals which can be used to measure the speed and direction of the motors [10].

3.3 Bluetooth (HC-05)

The Bluetooth (HC-05) module is an easy to use, which designed for transparent wireless serial Connection setup.

Bluetooth serial module is used for converting serial port to Bluetooth. This type has two modes: master and slave devices [11].

Bluetooth is a standard for short range, low power, low price wireless communication that uses radio technology. A Bluetooth transceiver is a frequency hopping spread-spectrum (FHSS) device that uses the 2.4 GHz ISM frequency band and its star topology [12]. This Bluetooth high immunity and faster than other types of devices that use the ISM band radio because it can change the transmission frequency 1600 times per second [13].

At least two conditions require to make communication between two Bluetooth modules:

1. The master and slave communication.
2. The correct password.

Setup the bluetooth module is an important issue which must be considered in order to use and run it in any application. Before linking the bluetooth to the system, the HC-05 must be setup by using a computer for adding the required bluetooth settings to change the main factory parameter. First inter the Bluetooth to AT mode by setting the KEY pin (PIN34) to be high Level by supplying this pin with 3.3V and then the Arduino was used to link the Bluetooth as shown in table (3) with PC and by using the serial monitor of Arduino to enter the key at the end of commands, the factory parameters have been changed as shown in table (4).

After settings the module according to the table (4), the 3.3V that supply to the KEY pin removed and then reset the module. After reset the module, the status LEDs of the slave and the master will be fast blinking and then the Pairing LED goes steady. When the master Bluetooth is setting (AT+LINK=<address>), the specific HC-05 will be chosen and by entering the password (as shown in table (5)) the linking is done. The bluetooth (HC-05) network is called a Piconet, or a small network, which can have up to eight stations, one of which is called the master, the rest are called the slaves. The communication between the master and the slaves can be:

1- One to one, as used in this paper.
2- One to many.

4. SIMULATION AND PRACTICE MODEL

The proposed system was designed and simulated using Proteus program, as shown in fig (10). The program loaded to Arduino microcontroller kit and the practical control system model was built, as shown in fig (11).

5. RESULTS

After linking between the master and the slave Bluetooth, the command from PS2 joystick will be sent to the microcontroller, then the Arduino will send the data to the slave Bluetooth as a serial number to generate the specific motion as shown in table (6) and table (7). When the slave Bluetooth receives this data, the motors of the robot will be turned on or off according to the serial number.

6. CONCLUSION

The proposed system provides a good solution for dangerous and difficult places that humans can't reach it and makes the specific tasks by using Bluetooth which provide low power, low price and short range wireless communication. The uses of PS2 joystick with microcontroller are a good and easy platform to control robots.

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Table (1): connecting between the Arduino and PS2 joystick.

Arduino pin	PS2 joystick wire
12	Brown: data
11	Orange: command
GND	Black: ground
3.3V	Red: power
10	Yellow: attention
13	Blue: clock

Table (2): the important instruction and its action for the transmitter and receiver.

Instruction	**Action**
#include <SoftwareSerial.h>	Allow serial communication on digital pins of the Arduino.
#define BT_SERIAL_TX 0	Define TX of Bluetooth as pin 0 of the Arduino
#define BT_SERIAL_RX 1	Define RX of Bluetooth as pin 1 of the Arduino.
Serial.begin(baudrate);	Set the baud rate for serial data transmission.
Serial.println(data);	Prints data to the serial port.
digitalWrite(digital pin,status);	Write a HIGH or a LOW value to a digital pin.

Table (3): Bluetooth (HC-05) pin configuration.

HC-05 Pin Name	Analog Function	Arduino linking
KEY	Command Mode	+3.3V
Vcc	Supply voltage	+5V
GND	Supply Ground	GND
TXD	Serial data transmit out	Pin 11
RXD	Serial data receive in	Pin 10

Table (4): The main factory parameters of HC-05 that must be setting.

The Instruction	The Action
AT+ ROLE =1	Get master mode
AT+ ROLE =0	Get slave mode
AT+RENAME= XXXXX	Specified the Bluetooth name
AT+PSWD=XXXX	Specified the Bluetooth Password
AT+UART=38400	Set the baud rate
At+ADDR?	Get the address
AT+LINK=<address>	Connect the master to the slave by entering the address of the slave to the master Bluetooth

Table (5): Chose the specific Bluetooth.

Main parameters	Master Bluetooth	Slave Bluetooth
Address	98:D3:31:F5:13:14	98:D3:31:FD:0C:7C
Name	PS2	Robot
Password	1234	1234
Baud rate	38400	38400

Table (6): serial number and motion for slave Bluetooth to control the platform.

Motion	Serial number
Forward	0001
Backward	1010
Left	1000
Right	0011
Stop	0000

Table (7): serial number and motion for slave Bluetooth to control the robotic arm.

Motion	Serial number
Elbow up	0010
Elbow down	1001
Hand open	1011
Hand close	0101
Stop	0000

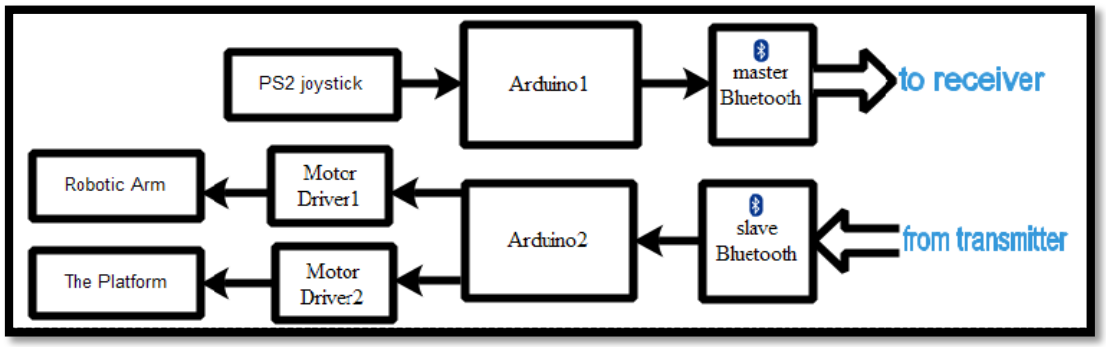

Figure (1): The proposed system organization.

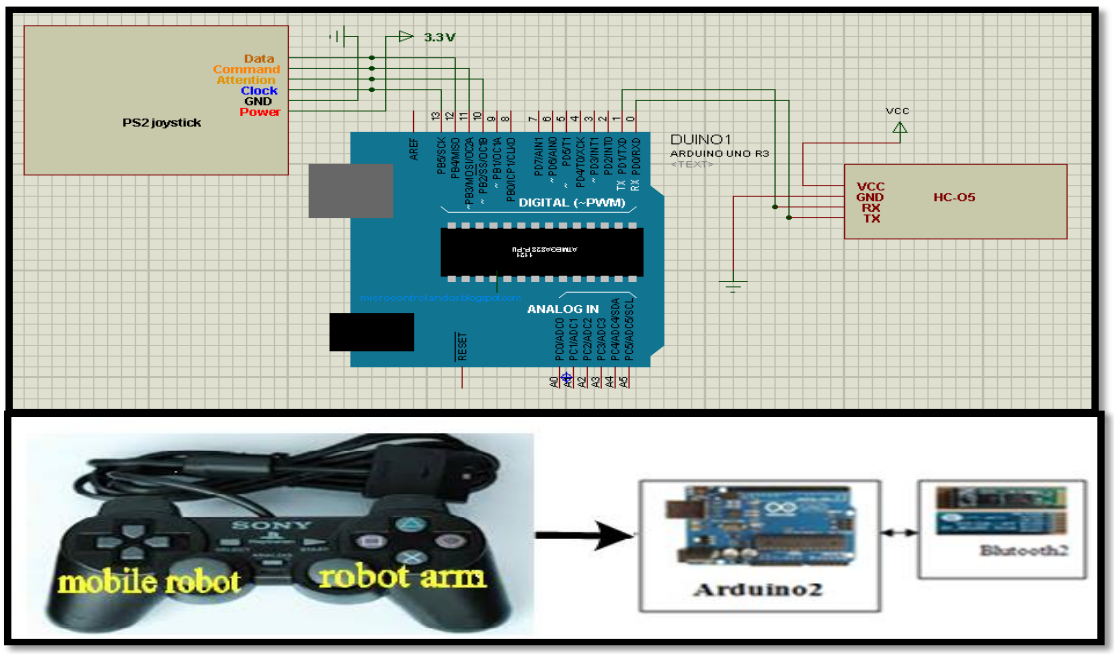

Figure (2): The controller part.

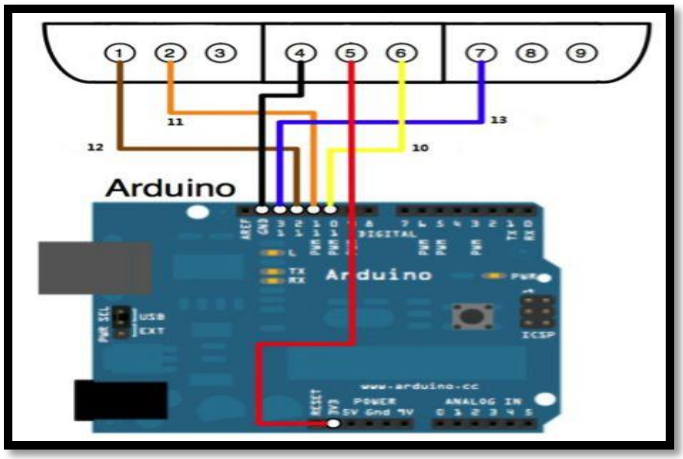

Figure (3): Connecting the Arduino with PS2 joystick.

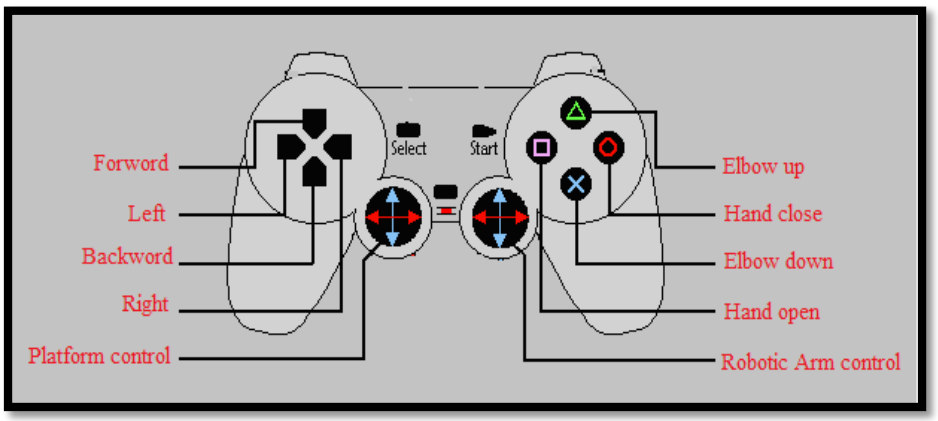

Figure (4): PS2 joystick buttons with their action.

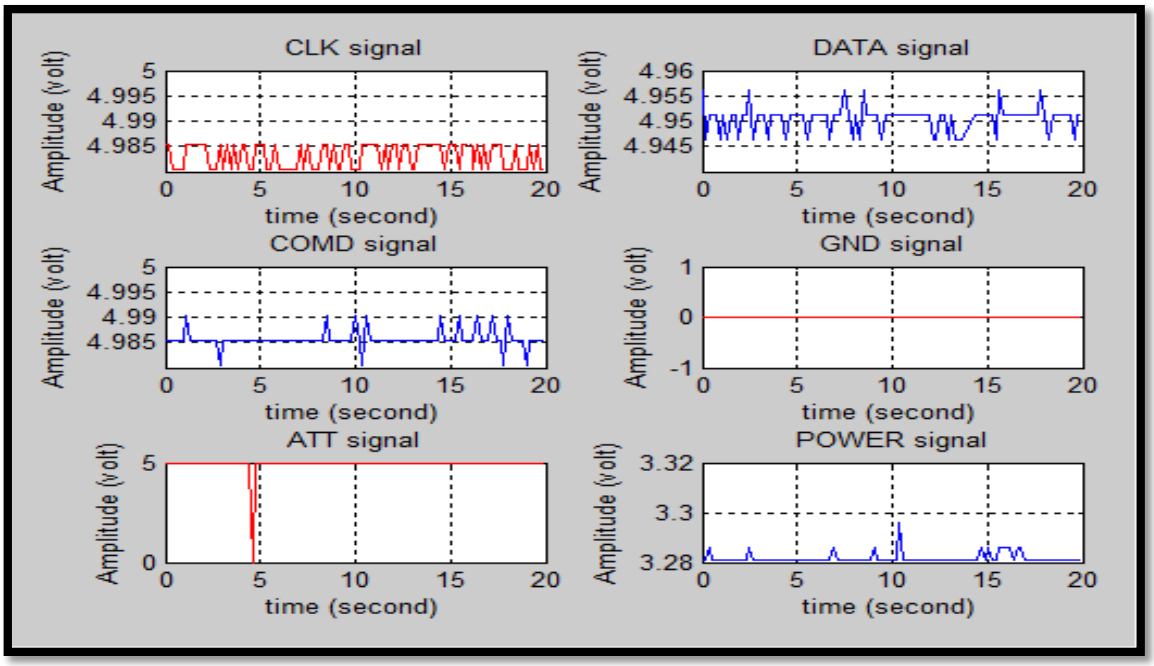

Figure (5): PS2 joystick signals

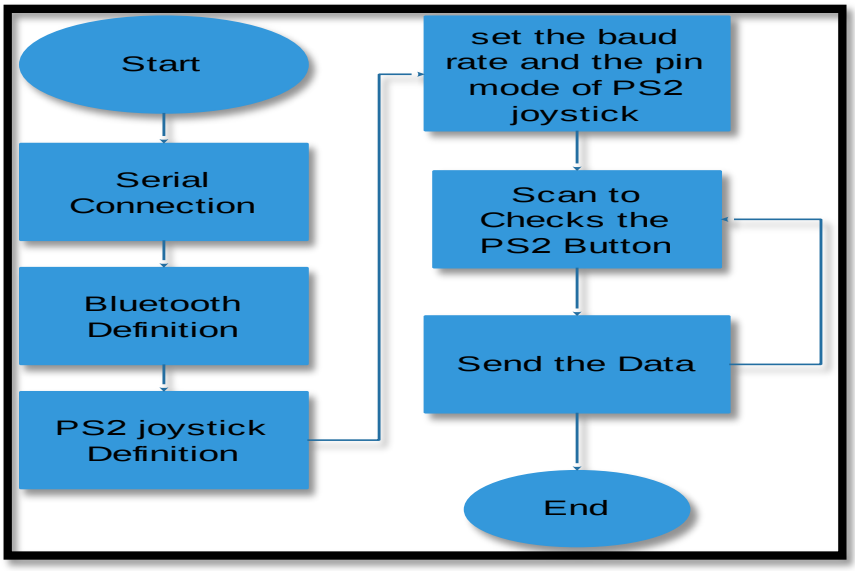

Figure (6): Flow chart of transmitter process**.**

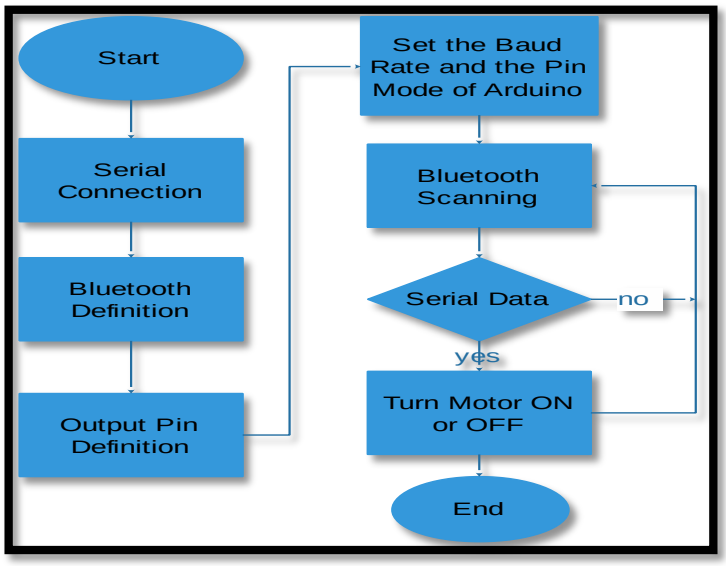

Figure (7): Flow chart of receiver process.

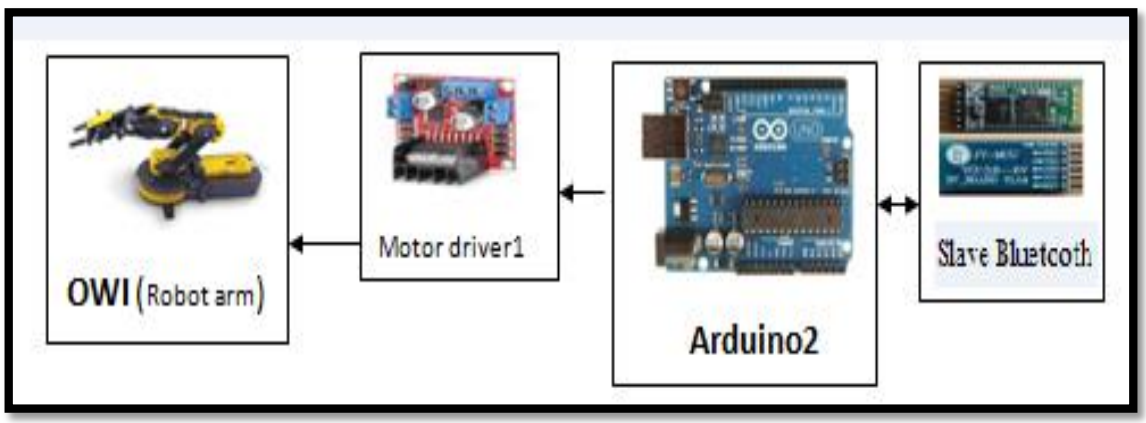

Figure (8): Control of Robotic Arm.

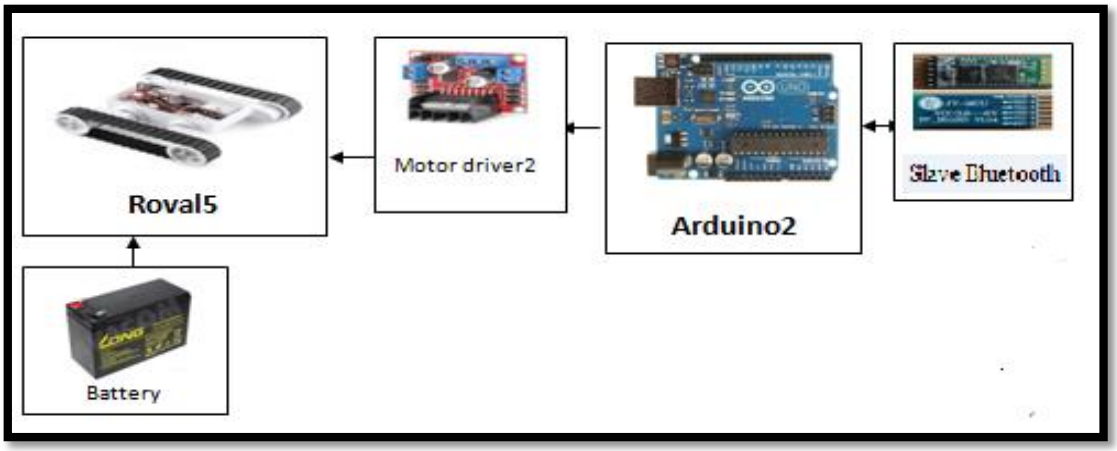

Figure (9): Control of Mobile Robot.

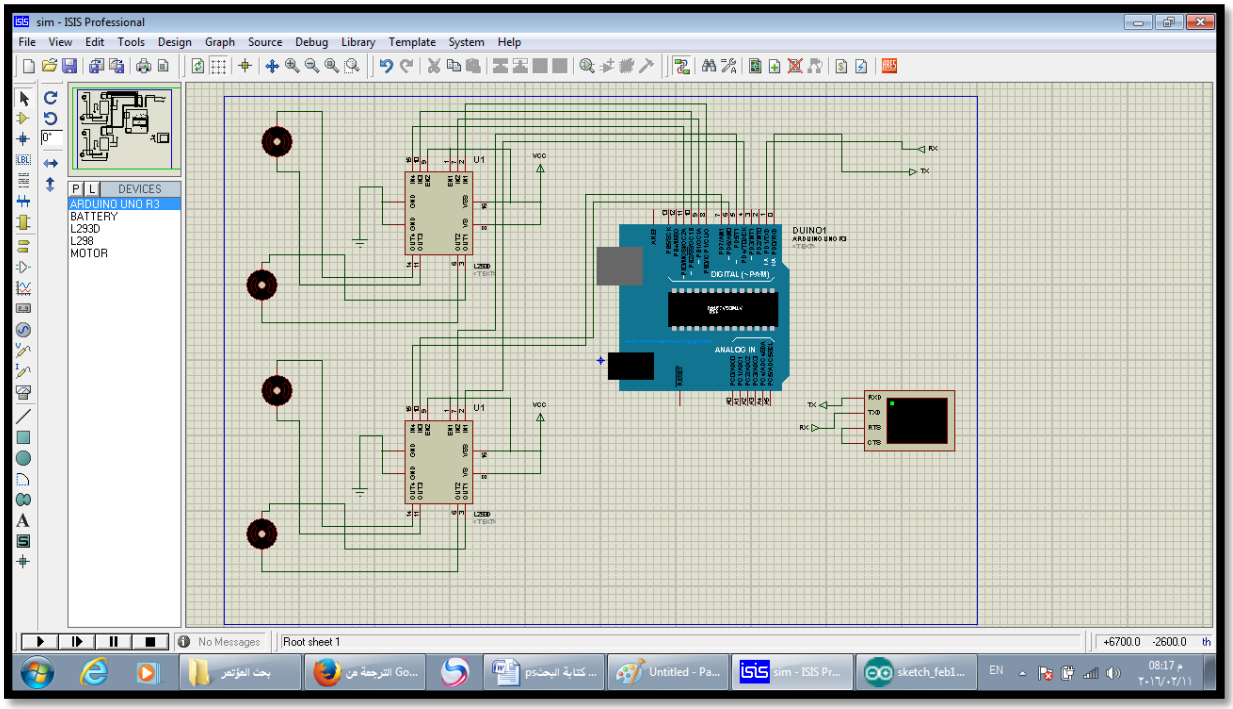

Figure (10): simulation using Proteus program

Figure (11): practical control system model

ذراع الروبوت المتحرك اللاسلكي المتحكم به عن طريق عصا التحكم PS2 المستند على المتحكم الدقيق

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الخلاصة

في السنوات الاخيرة مع زيادة استخدام التطبيقات اللاسلكية و حيث كل شي تقريبا كان يسيطر عليه من قبل الانسان اصبح الان التحكم بة اليا عن طريق الروبوتات. في هذا البحث تم بناء نظام تحكم بذراع متحركه عن طريق استخدام (PS2 joystick) والمتحكم الدقيق (Arduino UNO) وارسال البيانات عن طريق the master Bluetooth (HC_05) الذي يمثل الجزء المرسل. بينما يقوم الجزء المستقبل باستلام البيانات عن طريق (HC-05) the slave Bluetooth وتنفيذ الحركة المطلوبة وذلك باخذ الاوامر من المتحكم Arduino UNO. ان الغرض من هذا البحث هو تصميم ذراع متحركة اليا لتقوم بالمهام الخطيرة و الوصول الى الاماكن التي يصعب على الانسان الوصول اليها .