

Multi-function Robotic Arm

KirtanFadia¹, Sadiya Ansari², Dhara Shah³

Abstract- In recent year, with the increase usage of wireless application, the demand for a system that could easily connect devices for transfer of data over a long distance - without cables, grew stronger. This paper presents the development of a wireless mobile robot arm. A mobile robot that functional to do pick and place operation and be controlled by using wireless PS2 controller. It can move forward, reverse, turn right and left for a specific distance according to the controller specification. The development of this robot is based on Arduino Mega platform that will be interfaced with the wireless controller to the mobile robotic arm. Analysis such as speed, distance, load that can be lifted of the robot has been done in order to know its performance. Finally, this prototype of the robot is expected to overcome the problem such as placing or picking object that far away from the user, pick and place hazardous object in the fastest and easiest way.

I. INTRODUCTION

Nowadays, robots are increasingly being integrated into working tasks to replace humans especially to perform the repetitive task. In general, robotics can be divided into two areas, industrial and service robotics. International Federation of Robotics (IFR) defines a service robot as a robot which operates semi- or fully autonomously to perform services useful to the well-being of humans and equipment, excluding manufacturing operations. These mobile robots are currently used in many fields of applications including office, military tasks, hospital operations, dangerous environment and agriculture.

Besides, it might be difficulties to the worker whose must pick and place something that can affect itself. For example, things like chemistry that cannot be picked by human and for the military such as defuse bomb that needed robot to pick and place the bomb to somewhere and for user that needed robot to do pick and place item while sitting and much more. Therefore a locomotion robot can be replaced human to do work.

The robot is wireless controlled to ensure it can journey a long way from the user. The robot was prepared mechanically to be suitable for this RF to work.

Other than wireless controlled, IR sensor (TSOP 1838) is also a platform to control robot without using the cable. For this project, robot will be controlled in the all directions (forward, reverse, right and left). The actuator (arm robot) is

controlled by generating pulse width modulation, PWM from the pin at Arduino Uno board.

II. ROBOTIC ARM DEFINITION

A robotic arm is a robot manipulator, usually programmable, with similar functions to a human arm. The links of such a manipulator are connected by joints allowing either rotational motion (such as in an articulated robot) or translational (linear) displacement. The links of the manipulator can be considered to form a kinematic chain. The business end of the kinematic chain of the manipulator is called the end effectors and it is analogous to the human hand. The end effectors can be designed to perform any desired task such as welding, gripping, spinning etc., depending on the application. The robot arms can be autonomous or controlled manually and can be used to perform a variety of tasks with great accuracy. The robotic arm can be fixed or mobile (i.e. wheeled) and can be designed for industrial or home applications.

III. METHODOLOGY

3.1 Project overview

In this project, the hardware and software function are combined to make the system reliable. The Arduino Uno will be the inter facing for the robot and controllers are Arduino Uno, Servo motor & DC motor will control the movement of the robot. The project overview is shown in Fig1.



Fig 1. Uno connect with servo motor

3.2 Table description of system architecture:

Table 1 shows the project specification for this wireless mobile robotic arm. The main purpose of producing this specification is to clarify some important aspects of the

project and to make sure that the project is feasible as well as appropriate to use in the market.

Table 1: Specification of Wireless Mobile Robotic Arm.

Module	Specification
Interface	Arduino Uno
Sensor	IR TSOP 1838
Programming language	Arduino language
Actuator	Servomotor, DC motor

IV. MECHANICAL DESIGN

Fig 2 illustrate the designing of the robotic arm is shown with (a) main structure arm robot (b) arm robot design and Robot arm will have 5 outputs which consist of the base, shoulder, elbow, wrist and gripper.

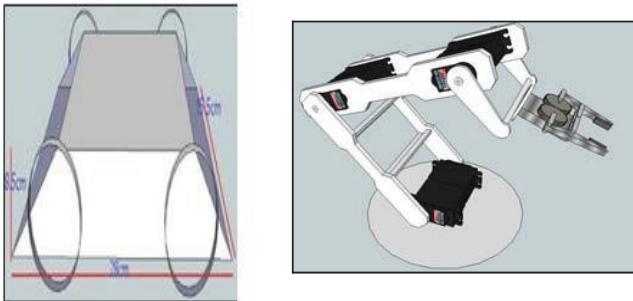


Fig. 2: Robot design (a) main structure arm robot (b) robot arm design.

For arm robot, servo holder such as bracket and U joint is use to place the motor and it is made formal minims because it is light weight. The robot gripper is also made of aluminum because of the same reason as the main robot arm structure.

Acrylic is used as the main material for mobile robotic arm because it is easy to be formed, cheap, strong and can bear the motor weight and movement. There are 4 servo motor and servo wheel attached to this mobile.

4.2 Software development

Software is a set of programs, procedures, algorithms and its documentation concerned with the operation of a data processing system. In this case, software is needed in order to complete task for the project.

Arduino IDE: The Open source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Max OS X, and Linux. The Environment is written in java and based on Processing and other open-sources Software. This Software can be used with any Arduino Board.

Google Sketch Up: To design the whole project that divided into two designing part. First is for the arm robot and other part is for the mobile robot.

PCB Wizard: Software that will be used to create and design the arrangement of an electronic device into board. This project used single layer board due to less component used.

4.3 Arduino Uno

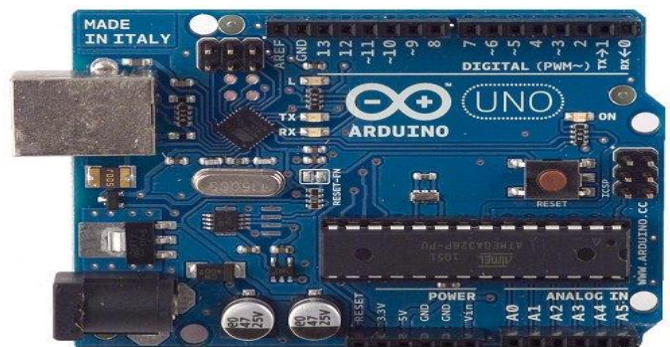


Fig. 4: Arduino Mega 2560.

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

4.4 Mobile robotic arm analysis

Fig 7 shows the wheel movement of the mobile robot. The robot can move forward, reverse, turn right and left. Light Emitting Diode (LED) will light up when button of controller is pressed.

From the entire input image, only the number plate is detected and processed further in the next step of character segmentation. In character segmentation phase each and every

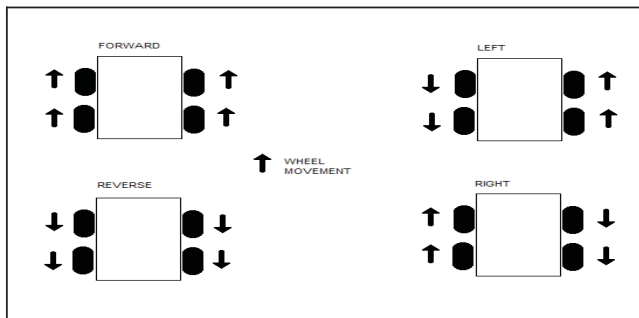


Fig. 7: Wheel movement of mobile robot.

The incoming power supply is important for mobile robot because it will control the speed of servo motor. Therefore, Table 2 shows the analysis for velocity of the robot in difference supply for 1metre distance.

Table 2: Time taken for difference powersupply

No	Power Supply (V)	Time taken (s)	Velocity (m/s)
1	9	4.83	0.20
2	8	5.83	0.17
3	7	23.8	0.04
4	6	Not finished	-

It show that, if power supply for mobile robot is decrease, it takes more time to reach 1metre distance. But when 6V power supply is used, there are no movement for mobile robot. So, it can be conclude that power supply for mobile robot (3600 servo motor) is proportional to the speed of the robot.

The workplace for arm robot is illustrated in Fig 8. The arm robot workplace is in revolute manipulator. It consist of axis that represent the degree of freedom (DOF). For this project, the mobile robot has 4-DOF.

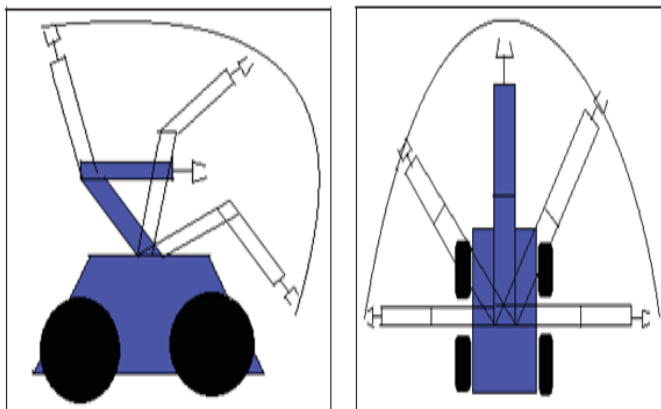


Fig. 8: Robot arm workplace (a) side view (b) plane view.

For the load that the robot arm can pick depends on the strength of servo motor. If the load exceeds the strength of the servo, it will cause the servo not working and can caused more usage of current in the servo motor. Table 3 shows the different load that can be lifted by the robot arm. Because this is a prototype project, the load that can be lifted by the robot arm is quite small.

Table 3: The different load that can be lifted by the robot arm

No	Load (g)	Function
1	50	Yes
2	100	Yes
3	150	Yes
4	200	No

4.5. Servo motor analysis

A servo motor has three wire output. Two of them are for power and ground and another one is lead feeds a position control signal to the motor. The positional of the servo will be controlled by using PS2 wireless controller. Initial position for robot is 90 degree of each servo. Fig 10 shows the different positions angle when different pulse width is injected into the servo motor signal wire.

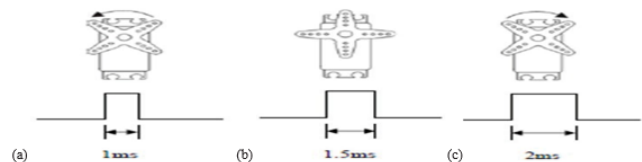


Fig. 10: (a) short pulse width (180 degree), (b) neutral position (90 degree) and (c) wider pulse width (0degree).

4.6. Circuitanalysis

There will be 3 power supplies in the overall circuit for this project as shown in Table 5.

Table 5: Specification for power supply in thecircuit

Power Supply	Battery	Circuit	Operation
1	9V	Supply for Arduino Uno	Arduino Uno On, receiver (Rx) operates and LED will lights up when controller (Tx) button is pressed.
2	9V	Motor driver	When controller button is pressed, Rx receive signal from Tx and send data to Arduino (interface). Then, data will be an output from Arduino and become input (5V) for motor driver to move the mobile robot as desired.
3	12V/1.2 Ah (Sealed Lead Acidbattery)	Servo motor(actuator)	Robot arm will be in standby mode (90 degree). Whencontroller(Tx) send signal (controller button is pressed) to Rx, the signal will be sent to actuator (servo motor) and drive the arm robot asdesired.

V. CONCLUSION

Overall, the objectives of this project have been achieved which are developing the hardware and software for wireless mobile robotic arm, implementing the pick and place system operation and also testing the robot that meets the criteria of purpose project. From the analysis that has been made, it is clearly shows that its movement is precise ,accurate, and easy to control and user friendly.

The mobile robot has been developed successfully as the movement of the robot including mobile and arm robot can be controlled wirelessly. This robot is expected to overcome the problem such as placing or picking object that away from the user, pick and place hazardous object in the fastest and easiest way.

RECOMMENDATION

Generally the robot program runs smoothly as planned. For the future recommendation, this robot can be equipped with a camera to view and display at the monitor screen. Besides that, the prototype robot's materials can also be upgraded so it can lift heavier load and do multifunction operation.

ACKNOWLEDGEMENTS

The authors would like to thank Faculty members, Project Guide Assistant Professor Dhara Shah and Hiral Pujara that giving an encouragement and support to complete this project and also fellow friend that helps and gives idea to overcome problem that occur while doing this project.

REFERENCES

- [1] R. C. Luo , K. L. Su,.A multi agent multi sensor based real-time sensory control system for intelligent security robot. IEEE International Conference on Robotics and Automation, vol. 2, 2003, pp.2394.2399.
- [2] Tan, Ming Chun (2005). Autonomous Robot Navigation using Radio Frequency. Bachelor Project.Thesis.UniversitiTeknologi Malaysia, Skudai.
- [3] Jennifer Bray, Charles F. Sturman (2002). "Bluetooth: connect without cables", Upper Saddle river, New Jersey: Prentice-Hall PTR
- [4] Robot entry, <http://education.yahoo.com/reference/dictionary/entry/robot> accessed on 7thApril 2012 at 2.00p.m.

- [5] D.L. Pieper. The kinematics of manipulators under computer control.PhD Thesis, Stanford University, Department of Mechanical Engineering, 1968. [6]L.Feng, J.Borenstein, D. Wehe, A Completely Wireless Development System for Mobile Robots. ISRAM conference, Montpellier, France, May 27- 30, 1996, pp.571-57