Design and Implementation of Bluetooth Controlled Collision Avoidance 4 Wheel Robot using Arduino with Linear Interpolation Method for Detersmination

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Abstract- Robotic Systems have become an important part of our lives by entering many fields. The most important topics they were on are, Homeland Security, Labor and Human Safety. The topic of this paper is design of a four-wheeled and Bluetooth controlled search & rescue robot which was designed at Solidworks and 3-D printed. Designed robot is controlled by Arduino UNO, Motor Control Shield, Bluetooth Shield and a mobile app. By using proximity sensor, it was intended to make robot avoid collision. Motor speed parameter that was sent to Arduino was calculated by Linear Interpolation.

Key words: Android, Robotics, Mechatronics, Land robot, Arduino, Linear Interpolation.

1. Introduction

According to the studies conducted, it is observed that in the event of any natural disaster the first 48 hours are very important to save human life. At recent years, many robots took part in human rescue operations. At places where it was dangerous to send rescue teams, taking advantage of robots, both security of rescue teams was maintained, and results were improved. Generally, those robots move by following some rules those were set by software developer. T. Braun was able to examine target area by creating a topographic map by using autonomous field robot at his study [1]. At another study, A. Birk,designed a security and rescue robot which operates at places where are dangerous for human[2]. K. Kuhnert was able to communicate with the autonomous robot that he designed by using RC [3]. Frank E. Schneider et al mentioned benefits of robotic competitions for advancement of robots [4]. A robot which uses a 3D map to navigate was created by S. Se [5]. Informations about universalize the use of robots by designing a robot at home was given at another study [6]. Paul S. Schenken, gives information about a field robot robot which can be used for research and colonization of Mars [7]. At a similar study that is about a suspension system of robot which will be used for discovery of Mars was mentioned is important [8]. D. Hernandez designed an open source robot which is used for education. That robot can be controlled by Arduino and Raspberry Pi [9]. At another study a hybrid search & rescue robot was designed to work under dangerous conditions. [10]. M. Gupta et al designed an Arduino based field robot with metal detector [11]. Shivaprasad B. developed a field robot which can be used at fertilization and cleaning by using 6 DC motors. It is possible to collect information via sensors on robot [12]. At another work, robotics effect on military technology was shown. M. S. made a study by designing an autonomous field vehicle which can patrol and take camera record [13]. S. W. Hobbs, made a study on field test of Marsobot [14]. C. Rajan mentioned his studies on design

and analysis of a robot based on Arduino at a paper [15]. At another work, a search & rescue robot which is used after earth quakes was mentioned [16]. J. Casper made a study about human-robot interaction during World Trade Center incident [17]. Jennifer L. Casper, analyzed search & rescue robots on action and listed problems of smart robots at his study [18]. Y. Liu, written a paper about benefits of search & rescue robots which are autonomous and can operate on rough terrain and stairs [19]. At another study, it was mentioned about robots which has suspension system and can act on rough terrain, and their advantages on search and rescue, recon and military duties was stated [20]. At JPL labs under NASA's sponsorship, B. Wilcox's study which is about designing a field robot to examine the surfaces of Mars, Venus and other planets at Solar System presented three important design criteria which are remote sensing and computational power, mobility test results, Computer Aided remote control, half- autonomy and behavior control [21].

At this paper, information about design of field robot's parts and its production, its electronic components, software was given. Mobile application that was written makes it possible to control robot by mobile phone or tablet. Sensor data which was used for passing as parameter of motor speed control function was obtained by Linear Interpolation.

2.Design And Implementation

The 4 Wheel robot has mainly three sub-systems as design, Android and Arduino software and, electronics. The 4 Wheel robot desing in Solidworks 2015 CAD program and have a main body, 4 wheel, DC motors, Arduino microcontroller, HC-06 Bluetooth module, motor driver and distance sensor explained in this section.

Main body, composed of two different parts. Main body and body top cover. Fig.1, Fig.2 and Fig.3 show these parts respectively. and it is designed

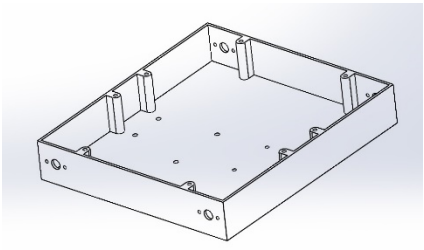

Fig.1. Main body

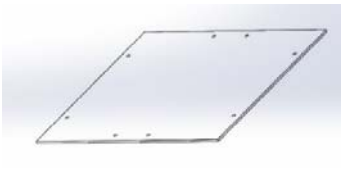

Fig.2. Body topcover

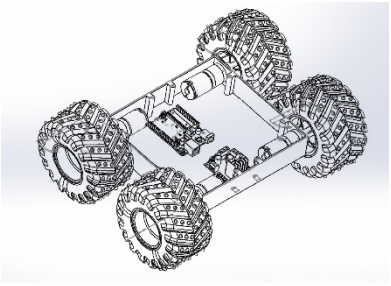

Fig.3. Main body

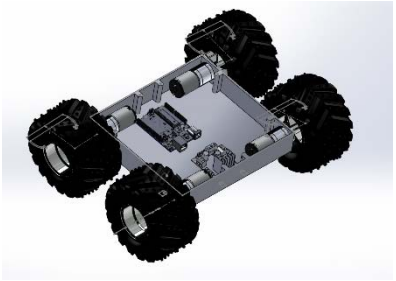

Fig.4. Land robod CAD desing

There is two part of the product for land robot. Firs part, main body and second part is a cover. Eigth screw fort he assambly this parts and All kinds of lands designed Solidworks(2015) and created by using 3D printer.

2.1. Design of Electronic System

In this Project, four 12V, 350 RPM DC motor used an one 3s Li-po battery. Table 1. List of the electronic materials used in this Project.

Table 1. List of the electronic materials used in the land robot.

Battery	Li-po 4s battery 11.1V(nominal voltage)
Motor	12V 350 RPM DC motor
Motor Driver	L298N
Microcontroller	Arduino Uno
Wireless Shield	HC-06 Bluetooth module

Distance Sensor	Ultrasonic Sensor - HC-SR04
Arduino Battery	9 volt AA battery

The Li-po 4s battery has an electric charge value of 2200 mAh, allowing the device to operate for about 20 minutes. The 9-volt battery used for the Arduino feed, the Arduino UNO microprocessor, the HC-SR04 Ultrasonic distance sensor, which is required for the produce signal which is used create required functiom parameter to drive motor, and the HC-06 Bluetooth module at the same time. The HC-06 Bluetooth module is powered by a 3.3 Volt output via an Arduino microprocessor. The ultrasonic distance sensor is actively operating by supplying 5 Volt output via Arduino. Fig. 5 and Fig. 6 show the sensor and communication modules used in the images.

Fig.5. HC-06 Bluetooth module

Fig.6. HC-SR04 Ultrasonic Distance Sensor

Fig.7. Final version of the robot

2.3. Design of Software

The Android app has been developed to allow control the motion of robot. The Android application is based on the MIT App Inventor 2 program, which is an open source software that is distributed by MIT. There are 6 buttons on the application, forward, back, left, right, stop and Bluetooth button. When the stop button is pressed, the robot stop and stands by until next command. By using Linear Interpolation, collected sensor data was used to calculate the parameter which was passed to function that drives motors. Certain threshold was used decide to which distance robot will stop to avoid crash to any obstacle. Figure 5. The interface of the mobile application of the robot is shown.

This mobile application which was made in the MIT App Inventor 2 software, sends the signals to microprocessor to activate the software that was embedded in the Arduino UNO by the numbers pre-defined in the mobile application after establishing the connection with the written Arduino UNO. The "Next" button is coded as "1" in the block diagram. When the "next" button is pressed, the value of "1" will be delivered to our microprocessor. Then, after obtaining the value "1" in our microprocessor,

Fig. 8. Interface of the Robot Android Application

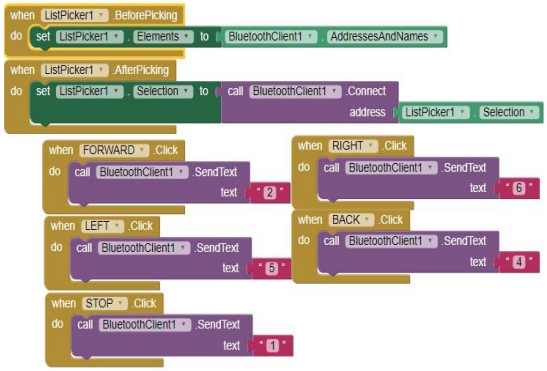

Fig. 9. Interface of the Robot Android Application Block Diagram

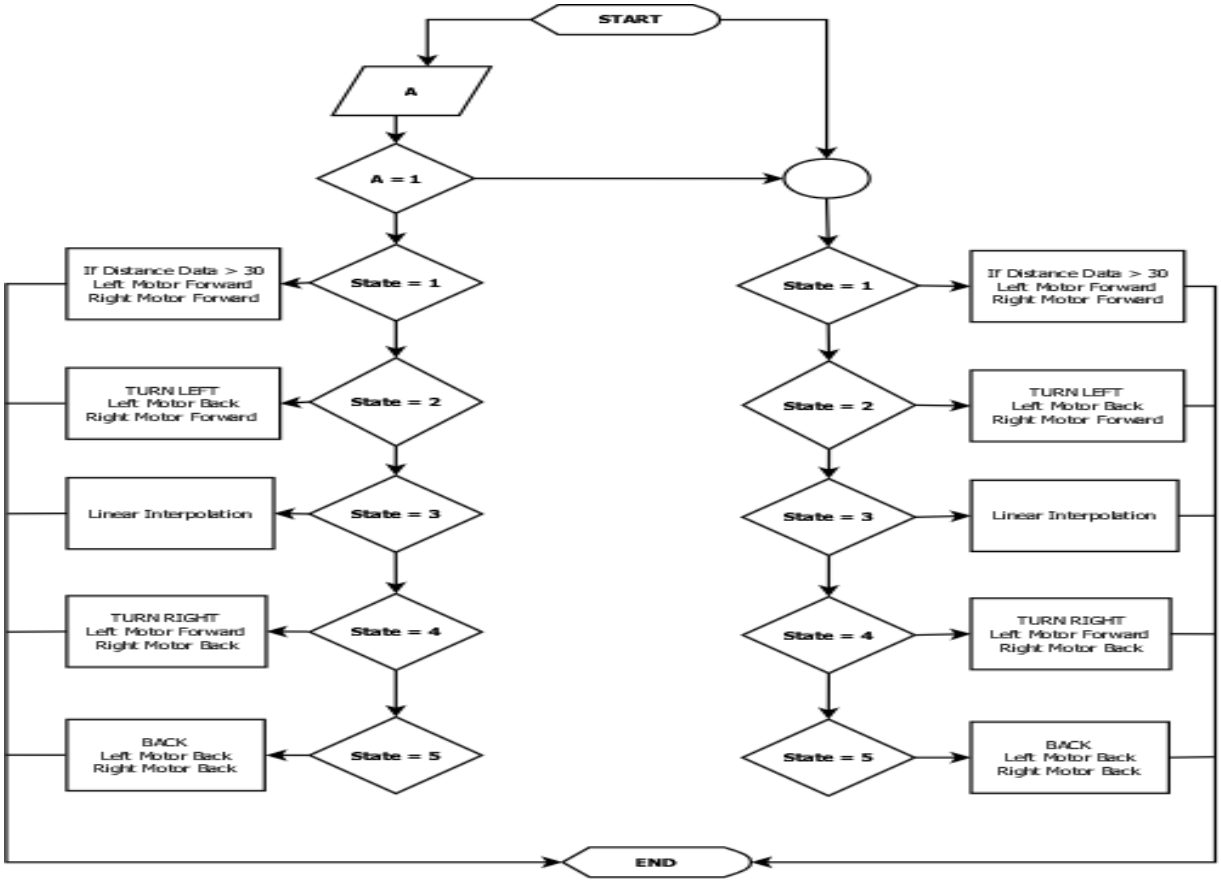

Fig. 10. Flowchart of Tank Robot Android Application

2.4. Lineer Interpolation

As known, in the mathematical field, interpolation is the method of acquiring unknown values of any data, by using its known values. Most common interpolation methods are:

- Linear Interpolation
- Bilinear Interpolation
- Spline Interpolation
- Polynomial Interpolation

Due to its easy to apply and low computational nature, Linear Interpolation was chosen to acquire the motor speed control parameter that was used in Arduino motor speed control function. Linear Interpolation may simply be formulated and illustrated as follows.

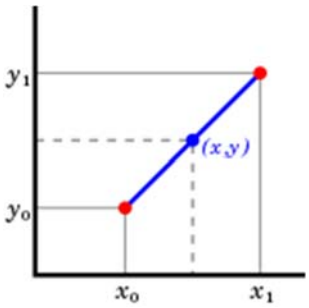

Fig. 11. Lineer Interpolation

Where (x_0, y_0) and (x_1, y_1) are known data and (x, y) is the data to be calculated which lies between (x_0, y_0) and (x_1, y_1).

$$\frac{y-y_0}{x-x_0} = \frac{y_1-y_0}{x_1-x_0}$$

This method was implemented to acquire speed ontrol parameter for known proximity sensor value which lies between maximum – minimum sensor values.

3. Results

Distance that was sensed and motor speed control parameter which was calculated by Linear Interpolation were visualized as a graph in the MATLAB which was shown in Fig.12 respectively. Negative relation between detected distance and motor speed was easily seen at given graph.

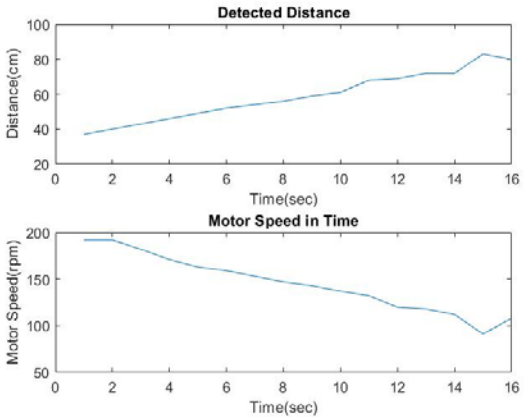

Fig.12. Change of the speed and distance of the motor

4.Conclusion

In this paper, Linear Interpolation was used to calculate the unknown function paramet by using data received by an analog sensor and generated control signal was used to make robot move. In addition to this, the system is supported by a mobile application. Inspired by these studies, it is possible to provide an autonomous motion by using microcontroller and mobile application. It is important to keep in mind that the noise that was generated by sensor is an important factor which can't be avoided and has impact at this kind of control systems. At future works various digital or analog filters will be used to filter the sensor noise and provide a better control.

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