Design of an interactive BB8-like Robot

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Abstract. Inspired by the famous Star Wars movie, we decide a moving and interactive robot which is similar to the BB8 character of the sequel. The proposed system is based on a low-cost set of components allowing to control the device wirelessly by means of a mobile app. The robot incorporates an mp2 module and a visual interactive system and it could be used for Human Robot Interactive applications.

Keywords: low-cost robotics, Human Robot Interaction, Hamster drive mechanism.

1 INTRODUCTION

BB8 is a very famous robotic device from the movie sequel "Star Wars" [1]. This robot is made up of a rolling ball-shaped trunk combined with a spherical head on its top.

In 2015, a miniature toy version of the character came out that replicated the characters movements and sounds [2]. Such a toy has an interesting design, since its main spherical body or trunk is equipped with a gyroscope, to detect the direction and movement of the robot trunk, and two wheels that are controlled by motors to cause the body of the robot to move from the inside [2-3]. There is also a base plate inside that is used as a counterweight to keep the wheels at the bottom of the sphere and there is a vertical bearing which keeps the wheels in contact with the floor. Finally, the head is connected on to the rolling body through magnets that are placed in the body and at the bottom of the head, the magnets keep a connection between the head and body so that the head stays on top while the body roles [2].

This robot represents an interesting opportunity to enhance the interaction of toys with the end-user of the toys, given it nice look and appealing [4]. However, such a

design needs to integrate further components which can enhance the interaction capability of the device, such as:

(i) wireless communication and control system
(ii) sensors integration for proper Human Robot Interaction
(iii) use of low-cost components and open-source software to decrement cost and increment use

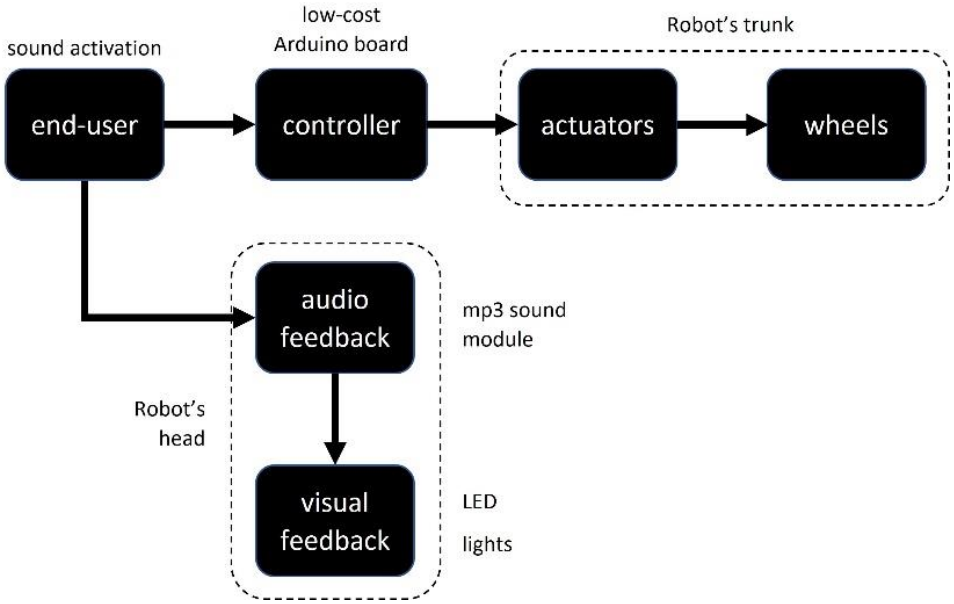

Fig. 1. Functional diagram of the proposed robotics' design

Here we propose to customize the BB8 robot with a novel design which allows the wireless control of the robot and the integration of low-cost components as well as low-cost sensors and devices for a better human robot interaction. The robot is made of 6 main functional elements which are shown in Figure 1.

2 Materials & Methods

A. Interaction Points

The project has two interaction points. The first point is the control of the movement. The project is controlled by an app called *Elegoo BLE tool*, the app connects to the Bluetooth module attached to the electronics inside the body of the project [5]. Once connected, the app allows the user to control the movements of the project by commanding it to move either forwards, backwards or turns. The wireless control allows the device to move freely of up to a 4-meter distance from the app and the user can also

determine how fast they want the project to move. The second interaction point is through the mp3 sound module. The module outputs sound through a speaker once commanded. There is a button connected to the top of the head of the project that can be pressed for the sound to play. This also switches the interactive lights on through the mic module that is connected to the end of the LED lights. The mic detects sounds nearby and outputs the lights to flash in time with the sound.

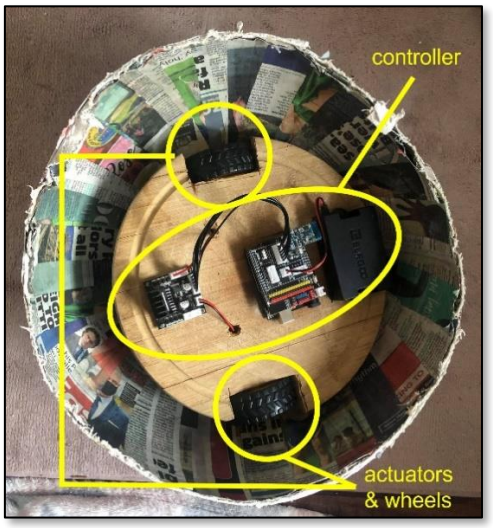

Fig. 2. An overview of the inner side of the robot trunk

B. Design, Assembly and Integration

The main part of the robot is made of 3 layers of paper *mache* newspaper. This one is placed on a 51 cm beach ball. A further layer of cotton canvas and all-purpose filler is positioned on the mache and sanded; then a further layer of varnish is deposited on top. Once the varnish had dried the body was then coated in black spray paint, and silver and gold spray paint were then added for detail. The head consists of a 20 cm polystyrene semi sphere that was cut down to 17 cm and the covered in all-purpose filler, sanded, and coated in layers of varnish. Once the varnish had dried the head was then coated in spray paint and the details and designs were then added. At the bottom of the head, there are 3 makeshift rollers that are used bearings for the head to allow the head to roll on the body. Three Neodymium magnets were attached onto the structure inside the body and another three were attached onto to the makeshift rollers at the bottom of the head.

C. Electronics

The main electronics in the robot's body combines a robotics car kit [6] which works with the mobile app. Wireless communication is provided by means of a Bluetooth

module and an Arduino Uno board [7]. This board manages the signals to a bridge driver connected to the Arduino, and the bridge driver will then command the motors which will move the wheels in the direction instructed. Arduino Uno embedded system was adopted because this board can be easily connected to another computer system via a USB port, which allows quick prototyping and the code to be constantly modified and updated accordingly [2]. However, it is also a way for power to be supplied to the board.

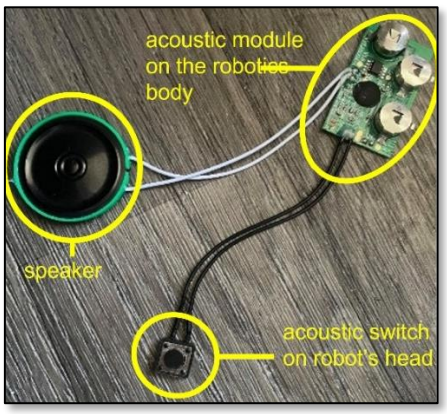

Fig. 3. The acoustic module with the switch, the speaker and the mp3 processing unit [8].

In order to actuate the device, *2 DC motors* and a *H-bridge driver* were attached onto a wooden circular board using screws. The wires from each of the dc motors were then connected to their corresponding spaces on the H-bridge driver. The Arduino uno was the connected onto the board along with the shield. Finally, the battery was then attached to the board and connected to the Arduino along with the H-Bridge drive.

Another electronic device that was implemented for this project was an *MP3 sound module*. This worked by pressing a button that was attached to the sound module containing a micro-SD card to play a different sound out of the speaker each time the button was pressed. The device was made by attaching a mini speaker with two small jumper cables and a button switch cable wire to the mp3 sound module [8]. A micro-SD card was then used to import 6 different sounds onto the mp3 module. To test, the button was pressed 12 different times to ensure each sound worked twice.

The final electronic device implemented in the project was sound reactive LED lights. These lights worked by using a mic module as a sound sensor to detect any audio nearby, and once the audio has been detected the sensor then transmits that audio to the lights. These were made using a BC547 Transistor. The C end of the transistor was attached to the BRG section on the yellow LED light strip.

A 68 kΩ was then attached to the B end of the transistor and the other end of the ohm was attached to the positive section of the LED lights. The positive end of the mic

module was then attached to the E end of the transistor and then the negative end was connected to a jumper cable that was attached to the negative end of a power supply. Another jumper cable was used to attach the positive end of the power supply to the transistor. The device was tested by placing a phone next to the mic module and playing sound at 3 different levels to see if the mic module was able to sense all the different sound levels.

Fig. 4. The LED lights inside the project

Table 1 - Preliminary testing of the LED light sensor

	Preliminary tests set-up	
light sensor test	***sound level***	***LED light display outcome subhead***
	High	Strong light display
	Medium	Strong light display
	Low	Weak light display

D. Software

The programming that has been develop in this project has been written in Arduino using an Arduino Uno. The code contains seven different sections. The first section of the code defines the pins for each of the sections, and the second section of the code is for the forward command that will move the card forward. The third section of the code is for the backwards command that will move the car backwards, and there are two sections for left and right commands as well. The final section is for the loop function that allows the command and movements to be repeated until the device has reached its required destination.

E. Wireless communication

The project works by an app wirelessly sending commands to an Arduino via IEEE 802.15.1 protocol, namely using a HC-08 Bluetooth 4.0 module. The HC-08 module uses the BLE protocol as it is suitable for transferring small amounts of data between nearby devices and allows the device to operate for a longer period.

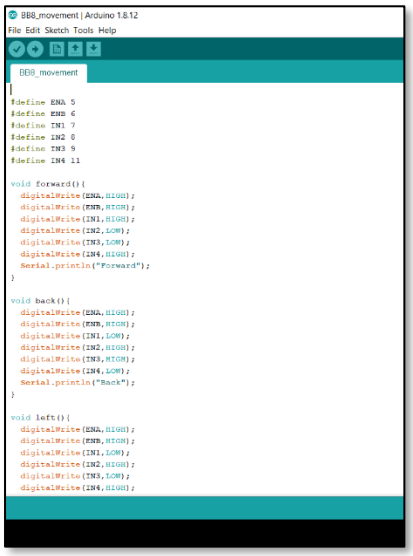

Fig. 5. An overview of the main function of the Arduino IDE program

3 Results & Discussion

When given a command, the project was capable of moving accordingly. The motors inside the body of the project will cause the body to roll across the floor. The Bluetooth module keeps connected to the device and app for up to 4 meters which gives the project a lot of distance tp move. The magnets placed inside both the head and body cause a pull that forces the head to remain on top of the body as the project moves. Table 1 shows the light display for the mic sensor based on the sound level of the audio, a seen the mic sensor has the strongest output on a high or medium level. To ensure the strongest light display, the mic sensor has been placed next to the speaker from the sound module in the project.

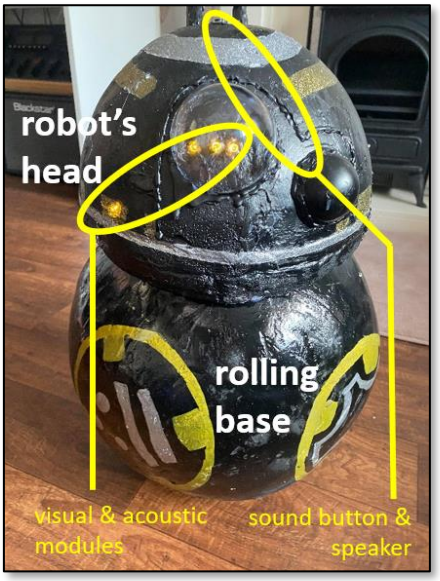

Fig. 6. The whole robot design with the low-cost controller, the wireless communication module and the visual and acoustic systems

4 Conclusion

While the project has been built successfully and met all its requirements, there are many ways in which it could be developed and imporved in the future. A future development for the project could be to add a sensor that would detect sound and automatically output sound as a response to create a human-robot interaction [9-12]. This could then be used as a companion for the elderly or lonely. A motion sensor could also be attached to the project to avoid the robot from crashing into any obstacles, this could be added with a self-drive alteration, in which a user could enter a specific location for the project to get to and the project will take itself to that location, much like the delivery robots that are used by some shops in the UK to deliver items to those who are unable to leave their house [12].

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