

Introduction

Our ITSP project, BB8 is actually a bot which moves forward and backward, by rolling its body like a ball while the hemispherical head on the top remains upright.

The bot is driven by a mobile app (created using MIT App Inventor)

Motivation

This ultra swaggy bot was first seen in the latest edition of the Star Wars Saga, The Force Awakens. The fact that the head of the bot stays upright while the body rolls is amazing. Besides, some of the videos explaining most of the mechanisms involved, gave us the motivation to proceed with this idea.

- <https://www.youtube.com/watch?v=zljq5U5ybcU>
- <https://www.facebook.com/groups/BB8BuildersClub/>
- <https://www.youtube.com/watch?v=-QbFvDlly1k>

Components

Electronics

- Arduino Uno
- HC09 Bluetooth Module
- L293D motor driver
- Batteries
- Jumper Wires
- Breadboard

Mechanical

- Plywood
- Acrylic Sheet
- 2 Plastic dome-like spheres
- 2 wheels

- 6 caster wheels
- 2 motors(60 rpm)
- 4 Neodymium Magnets
- A steel rod
- L clamps
- Tapes and other adhesives

Structure

- The body was made by joining two hemispheres cut from two dome-like spheres made of plastic. The diameter of the body was 48.3 cm(19 inches).
- The head was made using acrylic bowl mounted over an acrylic base with the radius of 25cm. There were three caster wheels attached on the lower side of head base. Two magnets were also pasted to the lower side of acrylic base which were attracted to the the two magnets on the circular base inside the body. Hence, the head could be stable over the body due to magnetic attractions.
- The chassis was made using plywood of thickness 8 mm and circular in shape with radius of 19.7cm. Two wheels (radius 3 cm and thickness 2.1cm) connected to motors(placed on end points of a diameter) and six caster wheels were placed on the chassis such that there was a wheel touching inner body surface at each angle difference of 30 degrees.
- We used a steel rod to connect the wooden chassis inside the body to connect the circular base(made using wheel picked from scrap) which was near the top surface of the body to hold magnets.

Circuit and Coding Part

To be edited

Chassis

- We cut the circular piece of radius 19.7cm from the plywood of thickness 8mm and cut two rectangular pieces out of it diametrically opposite to each other for wheels by visiting Tata lab.
- To connect the steel rod to the main wooden chassis, we made a hole in it's center and used two bolts to attach it, one above the chassis and one below it. With this, mechanism, we could keep the length of steel rod above chassis and hence position of magnet base inside body under our control. Hence, we could increase the distance between magnets inside and outside the body and hence control their magnetic strength.
- The length of rod was smaller than required though. So, we placed a wooden piece between the upper end of rod and the base(made of wheel from scrap) for magnets and attached it using m-seal to rod and using DST to base. The base used for magnets was circular with around 3-5cm diameter. The magnets were attached to it symmetrically using a fevi quick. We also covered the base, rod, magnets and wooden piece with brown tape to give it more strength and avoid weakening of attachment because of magnets.
- The circuit except the batteries didn't make much of a difference in the mechanical working of the bot. We, initially placed two batteries under the chassis attached to the chassis with the help of U-clamp and DST. One battery being used to balance the weight of other and maintain symmetry. However, the motors were unable to operate as the center of gravity too low and weight of chassis too high. So, we shifted the batteries to the upper side of chassis.

Head of The Bot

- Head was made using an acrylic bowl mounted on an acrylic base attached using brown tape.

- Three caster wheels were attached to the lower side of the base on the end-points of an equilateral triangle of side 7.5cm with centroid the center of the base.
- Magnets were attached to the base exactly as the other two magnets were kept inside the sphere. The magnets were kept in a way that the inside magnets and the outside magnets always have their opposite poles facing each other.

Theory Involved

When the wheels attached to chassis start moving due to the command given by the mobile app to the bluetooth module to the arduino and hence to the motors, they make the body roll similar to the movement of a hamster wheel. The chassis inside is attached to a vertical shaft which has magnets placed on it. The head also has magnets attached to its base. The head, hence, stays in the orientation of chassis only i.e. upright, while the body of sphere keeps rolling from outside.

Week Wise Progress

First Week

- Bought most of the components we required except plywood and a sphere for body.
- Learnt Solidworks
- Completed the circuit

Second Week

- Bought plywood and spheres for body
- Cut the spheres into hemispheres and filed them to make them complementary of each other(though not exactly complementary).
- Made solidworks model by calculating the exact positions and dimensions of various parts.
- Cut out the chassis as required from plywood.
- Made the app for controlling the bot.

- Joined the chassis, circuit, one battery(kept on the center of chassis) and body to have our first successful test of moving body.

Third Week

- Joined the steel rod and magnets to the chassis and adjusted the battery(batteries).
- Made base for head with acrylic and attached caster wheels and magnets to it according to the calculations done earlier.
- Tested the complete bot and realised the problems that came.

Fourth Week

- Debugging of the old pains and the new.

Team

- Darshan Tank
- Aditya Mittal
- Videsh Suman

Problems

- It took us a lot of time to find a proper sphere of desired size.
- The material used for body lacked strength. We even increased the number of caster wheels we were using from four to six to give the body a better support.
- The two hemispheres cut out for the body were not complimentary to each other. The thickness of the hemispheres was also not uniform. It was very difficult to join them every time using tape for each experiment.
- It was also difficult for the wheels inside to move over the tape as the hemispheres had really deformed. We couldn't find a better way to join the hemispheres which could keep the sphere intact and smooth and was easy to revert.
- The motors found it difficult to move the wheels with presence of head because high friction between caster wheels of head and body

due to high magnetic strength. Also the magnetic strength decreased the normal reaction between the wheels of chassis and the inner body surface and hence, decreasing the friction there. So, we also decreased rpm of our motors from 200 to 60 to increase their torque.

- The arduino was found to be defective. Our two batteries also stopped working because of some extra current withdrawal.

References

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