Sorting Hat

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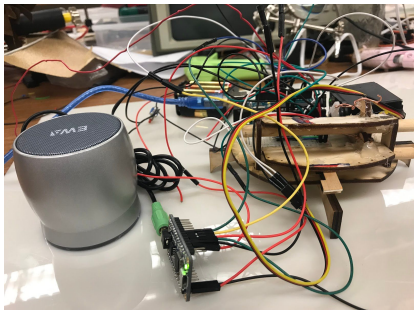
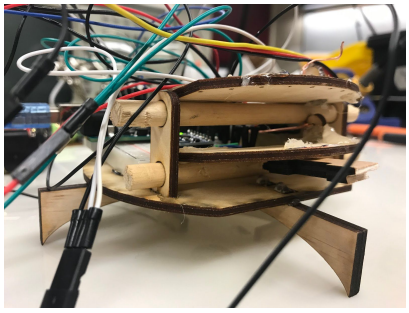
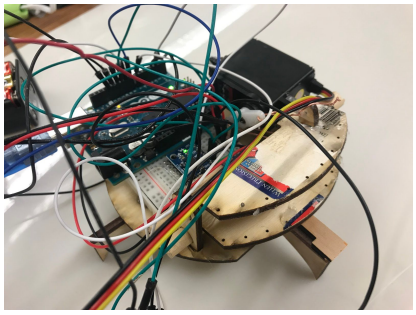
Description

The interactive sorting hat imitates the Harry Potter lifestyle. Get a first hand experience of what house you would have been placed in after finally receiving that letter to Hogwarts you've always been waiting for. The sorting hat intelligently sorts you into different Hogwarts houses based on your yes or no responses to a series of questions.



Parts

1. Harry Potter Sorting Hat
2. Wooden Boards
3. Servos
4. Accelerometer
5. Adafruit SFX Board
6. Sparkfun Protoshield
7. Mini Speaker

Features

a) Incorporates head nod responses to questions when sorting

b) Intelligently sorts into right house
c) Animatronic hat gives the feeling that it's the actual sorting hat
d) Sorting Hat Voice

How to activate

Step 1: Flip the power switch
Step 2: Push the button when you're ready to start
Step 3: Listen to the question and nod yes or no to answer
Step 4: Answer all 15 questions and receive your house!

How does the project work

We used an accelerometer to receive head nod feedback from the user. We then used these "yes" or "no" responses as part of the sorting algorithm to help the hat correctly identify the user's destiny. The questionnaire is specified further in this write up. Lastly, in order to give the hat a life like feeling, we embedded mouth movement technology using servos, and Adafruit FX board and a mini speaker. While the questions are being asked to the user, the hat simultaneously moves its mouth and talks out loud.

Schematics

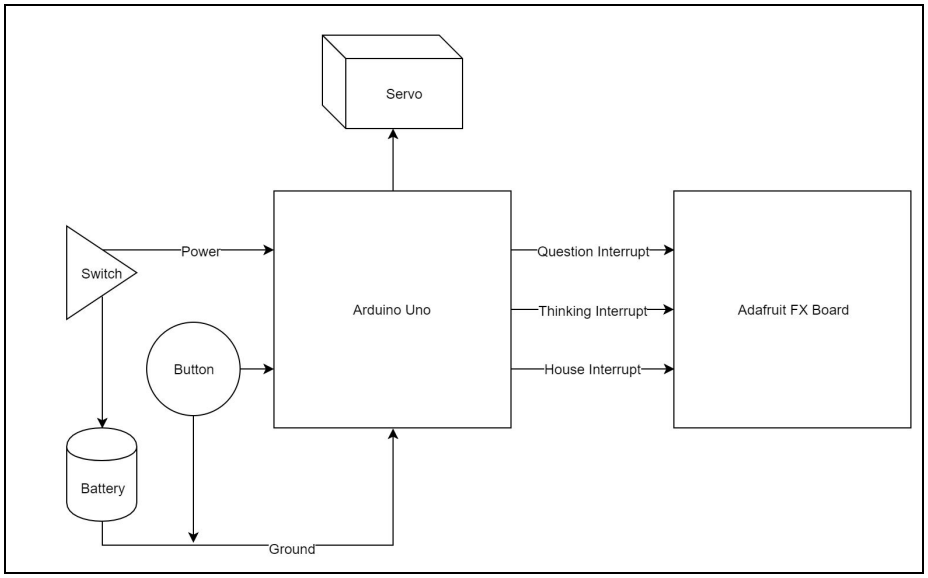


Figure 1. Project Schematic

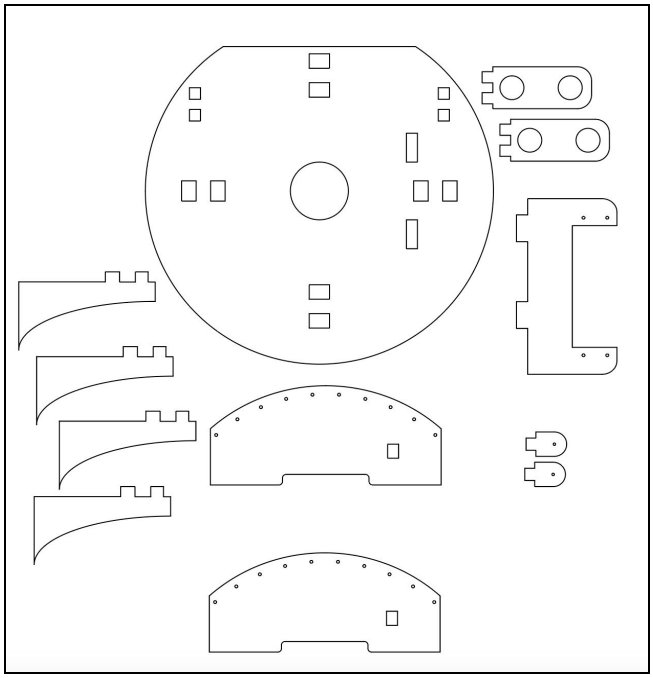


Figure 2. Mouth Frame Illustrations

Diagrams

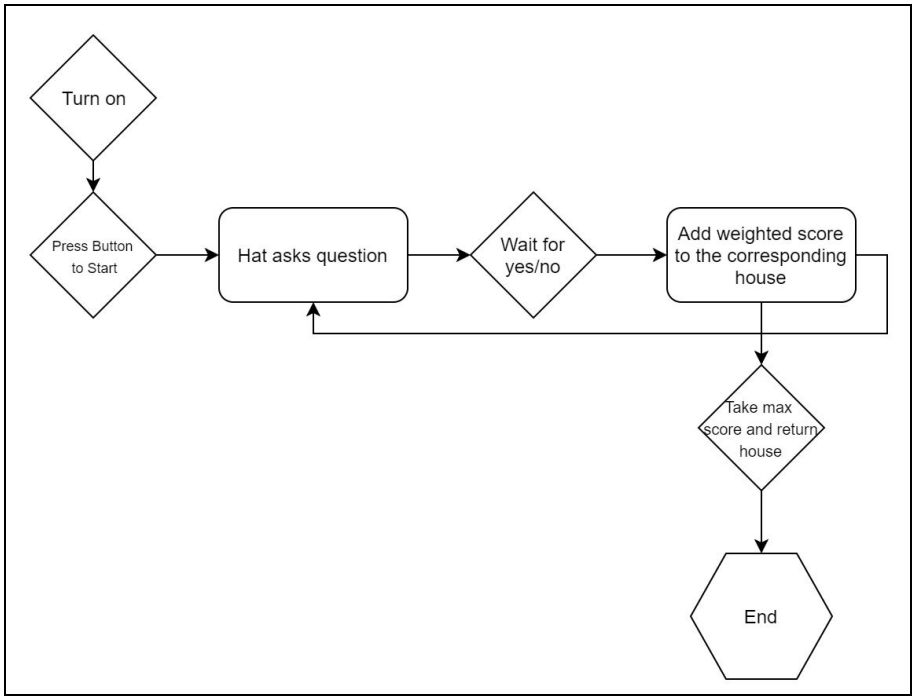


Figure 3. Flow diagram for program

Code

Head Nods

Did someone say sensor fusion?

We combined the accelerometer and gyroscope in the chip we acquired and used a digital motion library to calculate Roll, Pitch, and Yaw. Once we had these numbers we were able to detect the yes and no nods of the wearer by finding max and min values and then waiting until the difference between the two was above a certain threshold.

Our code was made possible by Servo.h, I2Cdev.h, MPU6050_6Axis_MotionApps20.h, and Wire.h. The MPU6050 communicated with the Arduino Uno via I2C and the Adafruit FX board was triggered using digital pin outputs.

```
#ifdef OUTPUT_READABLE_YAWPITCHROLL
    // display Euler angles in degrees
    mpu.dmpGetQuaternion(&q, fifoBuffer);
    mpu.dmpGetGravity(&gravity, &q);
    mpu.dmpGetYawPitchRoll(ypr, &q, &gravity);
    if ((ypr[0] * 180/M_PI) <= yawMin){
      yawMin = (ypr[0] * 180/M_PI);
    } else if ((ypr[0] * 180/M_PI) >= yawMax) {
      yawMax = (ypr[0] * 180/M_PI);
    }

    if ((yawMin != 200) && (yawMax != -200)) {
      if (yawMax - yawMin > 75) {
        output = "no";
        Serial.print("NONONONONONONONONONONONONONONONONONONONONONONONONON\n");
        //return;
        //return output;
        yawMin = 200;
        yawMax = -200;
      }
    }
```

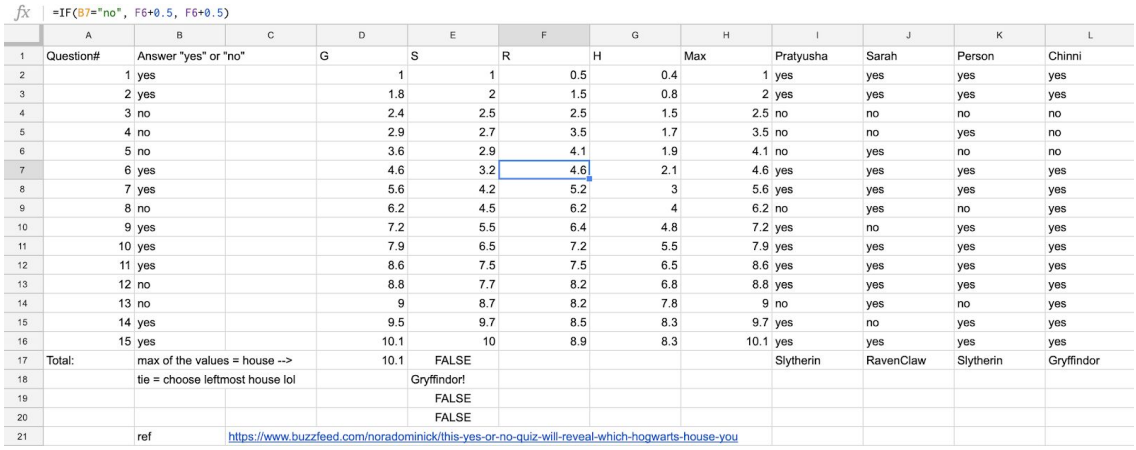
Code Snippet 1. Calculating Head Nods

Intelligent Sorting

Our hat ensures that you don't get randomly sorted!

Our sorting algorithm was based on distributing different weights to each of our questions. For example, if the question "Was Harry a good wizard?" was to appear and the user responds "yes", then their slytherin weight to that question would be a

lot lower than their gryffindor weight. Using this idea, after every question each house collects more points according to the user's response and at the very end, the house with the max amount of points becomes the user's sorted house. We first tested our theory in an excel spreadsheet and even got some of our friends to try it out to make sure we were weighting all the questions as correctly as possible. Then, we transferred this logic into code!



`fx` =IF(B7="no", F6+0.5, F6+0.5)

	A	B	C	D	E	F	G	H	I	J	K	L
1	Question#	Answer "yes" or "no"		G	S	R	H	Max	Pratyusha	Sarah	Person	Chinni
2	1	yes		1	1	0.5	0.4	1	yes	yes	yes	yes
3	2	yes		1.8	2	1.5	0.8	2	yes	yes	yes	yes
4	3	no		2.4	2.5	2.5	1.5	2.5	no	no	no	no
5	4	no		2.9	2.7	3.5	1.7	3.5	no	no	yes	no
6	5	no		3.6	2.9	4.1	1.9	4.1	no	yes	no	no
7	6	yes		4.6	3.2	4.6	2.1	4.6	yes	yes	yes	yes
8	7	yes		5.6	4.2	5.2	3	5.6	yes	yes	yes	yes
9	8	no		6.2	4.5	6.2	4	6.2	no	yes	no	yes
10	9	yes		7.2	5.5	6.4	4.8	7.2	yes	no	yes	yes
11	10	yes		7.9	6.5	7.2	5.5	7.9	yes	yes	yes	yes
12	11	yes		8.6	7.5	7.5	6.5	8.6	yes	yes	yes	yes
13	12	no		8.8	7.7	8.2	6.8	8.8	yes	yes	yes	yes
14	13	no		9	8.7	8.2	7.8	9	no	yes	no	yes
15	14	yes		9.5	9.7	8.5	8.3	9.7	yes	no	yes	yes
16	15	yes		10.1	10	8.9	8.3	10.1	yes	yes	yes	yes
17	Total:	max of the values = house -->		10.1	FALSE				Slytherin	RavenClaw	Slytherin	Gryffindor
18		tie = choose leftmost house lol			Gryffindor!							
19					FALSE							
20					FALSE							
21		ref	https://www.buzzfeed.com/noradominick/this-yes-or-no-quiz-will-reveal-which-hogwarts-house-you									

Figure 4. Testing our Sorting Algorithm

```
void question1(String input) {
  if (input == "yes") {
      gryffindor += 1;
      slytherin += 1;
      ravenclaw += 0.5;
      hufflepuff += 0.4;
    } else {
      gryffindor += 0.2;
      slytherin += 0.2;
      ravenclaw += 1;
      hufflepuff += 1;
    }
}
```

Code Snippet 2. Intelligent Sorting

Animatronic Movements

We kept the hat movement pretty simple by creating a mouth frame and adding a servo to it that allowed that hat to emulate a talking animation. This code snippet was intertwined with interrupts to help with simultaneous actions of mouth movements as well as speech.

```
void talkPlease() {
  for (int i = 0; i < 5; i++) {
     for(angle = 0; angle<90; angle+=1)
    {
      servo_test.write(angle);
      delay(5);
    }
    angle = 180;
    delay(10);
  }
}
```

Code Snippet 3. Animatronic Movement

Questionnaire

Responses were considered on a weighing scale where yes's and "no's were worth a different amount for each question and each house. We took the maximum of those values and directed that information to the sorting hat to break it to the user.

1. Would you play Quidditch at Hogwarts?
2. Would you excel in Defense Against the Dark Arts
3. Are you any good at playing Wizard's Chess?
4. You catch a classmate cheating on their exams. Do you tell on them?
5. Would you ever receive a Howler from your parents?
6. Would you have a pet while at Hogwarts?
7. Would you ever go exploring in the Forbidden Forest?
8. Would you ever want to work at the Ministry of Magic?
9. Would you want to have the Elder Wand?
10. Would you ever go snooping in the forbidden section of the library?
11. Is Moaning Myrtle annoying?
12. Would you ever participate in a duel?
13. Was Harry actually a good wizard?
14. Do you prefer the books over the movies?
15. Will Scott give this project an A?

External Supporting Documentation

We got the basic guideline for the mouth orientation for our hat from William Osman's H3 Beanie idea:
https://www.youtube.com/watch?v=0Q0_xFYpYL4&feature=youtu.be

Attached Files

SortingHat.ino
Lasercut.ai

Successes

Throughout the whole process, we knew we would have all the separate pieces working, but it was nice to be able to throw everything together in order to make a complete prototype. Also, we finally got the voice we wanted in order to make the experience feel even more real and less animatronic!

One of the most exciting things in the project was how easy it was to get the yes/no detection working. It actually worked the first time! The only time we spent on that was adjusting sensitivity and making sure we picked the correct axes to watch.

We'd also like to thank Amazon Prime for shipping things in two days because that saved us A LOT of time.

Failures

One of the biggest problems we had was finding a speaker that had AUX input. We were able to test using a pair of headphones (which were difficult to find because everyone uses Bluetooth these days) until a speaker finally came in via Amazon Prime. This definitely slowed us down in the early stages.

Using the Adafruit FX Board and the MPU6050 at the same time presented some weird compatibility issues. We found that the code would work with one or the other but not both. Our working theory is that the two boards used some of the same registers and the overwrite one when the other is initialized. Thankfully the Adafruit FX Board comes with pins to trigger sound files. We pivoted from triggering sound via software to triggering sound with hardware. There is a feature that allows us to triggerNext by naming files in a certain way and only asserting a certain pin HIGH (which we used for the sequence of questions). We then used the file naming scheme to assign thinking sounds and the house declarations to other pins.

How to make it better

With more time, we would have liked to implement an mobile application to stand as the interface of the hat. This would allow for greater user experience because they would be able to control the hat from their phone rather than having to directly interact with the hardware.

We also believe that with more time, we could've reached out to the actual Leslie Phillips in order for him to voice the rest of our questions in order to allow users to feel even more immersed in the Harry Potter environment.