Air Mouse: *Wireless translation of hand gestures into two and three-dimensional mouse movements*

Summary of Progress

The goal of this project is to make a wearable glove that connects as a mouse to any computer, laptop or cell phone device that supports the Bluetooth 4.0 Low Energy Standard. The first step in the design process was to create a general layout of the components showing their connections to the microcontroller. Figure 1 shows the electrical schematic design. The team tested and studied the ordered hardware components to finalize the mechanisms of each feature on the Air Mouse. The scope of the project includes the wireless transmission of data which the Feather nRF52 Bluefruit LE board satisfies since it contains a Bluetooth transceiver.

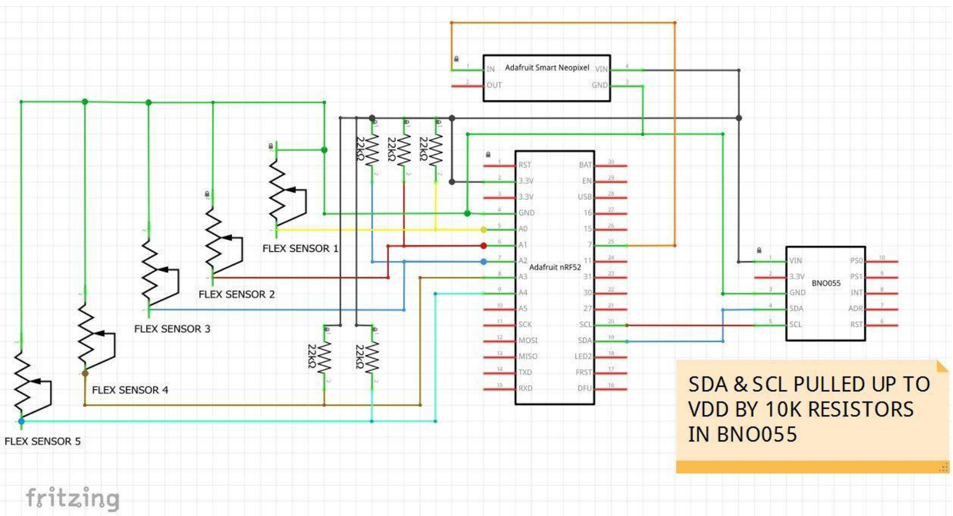


Figure 1 Electrical Schematic for Air Mouse

The BNO055 was mounted on a breadboard and tested to record the angular displacement due to movement away from the calibrated start position. It uses three triple-axis sensors: an accelerometer, a gyroscope, and a magnetometer. The BNO055 filters and synthesizes the sensor data on its built in microprocessor which runs a fusion algorithm to give the relative orientation as a vector of three Euler angles. We selected the return in the form of Euler angles, since it is the easiest to visualize and manipulate. The sensor interfaces with nRF52 over I^2C serial communication and the nRF52 streams the data to the computer over Bluetooth. The relative position is taken and converted to cursor speed and direction. For testing purposes, we used a flex sensor to set the start position of the breadboard. This was stored in the memory of the nRF52. Updated Euler angles are continually read from the BNO055 and the deviation of the updated angle from the starting angle returns the relative position of the breadboard. Figure 2 shows the resulting angles (+/-α) based on hand movements in the x-y plane.

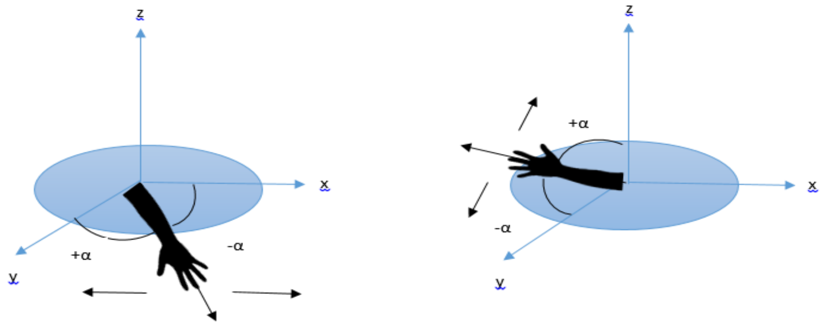


Figure 2 Movement of hand on x-y plane

The flex sensors allow for the mouse clicks by measuring the change in resistance due to bending the sensor. The sensors were measured by Hammed and Ibrahim using a digital multimeter. In their relaxed state, the sensors have a minimum resistance of 50 kΩ and a maximum flexion resistance of 224 kΩ. The change in resistance is communicated with the microcontroller in the form of voltage changes that are detected by the microcontroller on the analog pins 1 and 2. The measured voltages are divided into set thresholds to determine the level of flexion. This allows the flex sensors to aid in three dimensional applications as well such as a grabbing action. In addition to the flex sensors, the pressure sensitive sheets were also tested as an alternative mouse clicking action specifically designed for people with Carpal Tunnel syndrome. The sheets work on the same resistance change principle as the flex sensors. The relaxed state resistance of the sheets was measured on the multimeter to be 0.24 kΩ with a maximum of 8.4 kΩ depending on the pressure applied. .

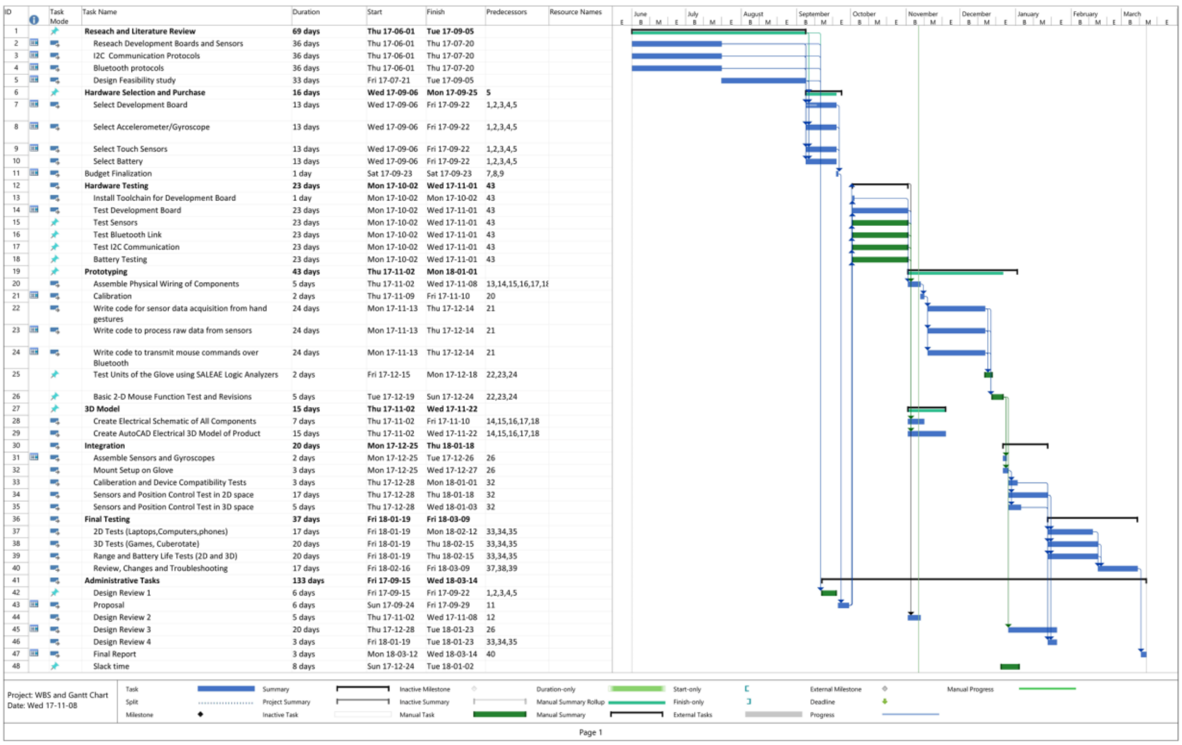
The portable power source requirement is fulfilled in the form of a 3.7V LiPo Battery Cell which connects to a RGB Smart Neopixel used to display the battery status. Using the current discharge curve of the battery specified on the data sheet, an arbitrary color code was developed by Simran to display the remaining battery life for the Airmouse. The internal vbat pin on the microcontroller is constantly read to get the ADC readings ranging from 0 to 300mV with a 12 bit resolution. The vbat pin also has a resistor voltage divider that is taken into account to get the LiPo voltage readings in mV. The readings are further divided into arbitrary levels. The neopixels change color to inform the user each time the voltage and, hence, the battery level drops below those thresholds. The battery life specifications and optimization can be further worked on as the prototype develops.

Summary of Changes

Our current design uses a flex sensor on the top and pressure sensitive sheets on the bottom of each finger. Because these sensors are enough to perform multiple tasks of clicking as well as scrolling, we decided to remove the joystick to stay within space/weight constraints. The joystick was initially supposed to allow scrolling action.

<u>Schedule and Updated Gantt Chart</u>

The team progress and the Gantt Chart tasks were largely in line with each other. The schedule was modified to include slack time in winter from December 24, 2017 to January 2, 2018 to account for winter holidays. This reduces the time for sensor data acquisition, processing of raw data and transmission code development from 31 to 24 days which we deem achievable. This also mandates the completion of basic two dimensional mouse features testing to be completed by December 24, 2017.



ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**Reseach and Literature Review**	**69 days**	**Thu 17-06-01**	**Tue 17-09-05**		
2	Reseach Development Boards and Sensors	36 days	Thu 17-06-01	Thu 17-07-20		
3	I2C Communication Protocols	36 days	Thu 17-06-01	Thu 17-07-20		
4	Bluetooth protocols	36 days	Thu 17-06-01	Thu 17-07-20		
5	Design Feasibility study	33 days	Fri 17-07-21	Tue 17-09-05		
6	**Hardware Selection and Purchase**	**16 days**	**Wed 17-09-06**	**Mon 17-09-25**	**5**	
7	Select Development Board	13 days	Wed 17-09-06	Fri 17-09-22	1,2,3,4,5	
8	Select Accelerometer/Gyroscope	13 days	Wed 17-09-06	Fri 17-09-22	1,2,3,4,5	
9	Select Touch Sensors	13 days	Wed 17-09-06	Fri 17-09-22	1,2,3,4,5	
10	Select Battery	13 days	Wed 17-09-06	Fri 17-09-22	1,2,3,4,5	
11	Budget Finalization	1 day	Sat 17-09-23	Sat 17-09-23	7,8,9	
12	**Hardware Testing**	**23 days**	**Mon 17-10-02**	**Wed 17-11-01**	**43**	
13	Install Toolchain for Development Board	1 day	Mon 17-10-02	Mon 17-10-02	43	
14	Test Development Board	23 days	Mon 17-10-02	Wed 17-11-01	43	
15	Test Sensors	23 days	Mon 17-10-02	Wed 17-11-01	43	
16	Test Bluetooth Link	23 days	Mon 17-10-02	Wed 17-11-01	43	
17	Test I2C Communication	23 days	Mon 17-10-02	Wed 17-11-01	43	
18	Battery Testing	23 days	Mon 17-10-02	Wed 17-11-01	43	
19	**Prototyping**	**43 days**	**Thu 17-11-02**	**Mon 18-01-01**		
20	Assemble Physical Wiring of Components	5 days	Thu 17-11-02	Wed 17-11-08	13,14,15,16,17,18	
21	Calibration	2 days	Thu 17-11-09	Fri 17-11-10	20	
22	Write code for sensor data acquisition from hand gestures	24 days	Mon 17-11-13	Thu 17-12-14	21	
23	Write code to process raw data from sensors	24 days	Mon 17-11-13	Thu 17-12-14	21	
24	Write code to transmit mouse commands over Bluetooth	24 days	Mon 17-11-13	Thu 17-12-14	21	
25	Test Units of the Glove using SALEAE Logic Analyzers	2 days	Fri 17-12-15	Mon 17-12-18	22,23,24	
26	Basic 2-D Mouse Function Test and Revisions	5 days	Tue 17-12-19	Sun 17-12-24	22,23,24	
27	**3D Model**	**15 days**	**Thu 17-11-02**	**Wed 17-11-22**		
28	Create Electrical Schematic of All Components	7 days	Thu 17-11-02	Fri 17-11-10	14,15,16,17,18	
29	Create AutoCAD Electrical 3D Model of Product	15 days	Thu 17-11-02	Wed 17-11-22	14,15,16,17,18	
30	**Integration**	**20 days**	**Mon 17-12-25**	**Thu 18-01-18**		
31	Assemble Sensors and Gyroscopes	2 days	Mon 17-12-25	Tue 17-12-26	26	
32	Mount Setup on Glove	3 days	Mon 17-12-25	Wed 17-12-27	26	
33	Caliberation and Device Compatibility Tests	3 days	Thu 17-12-28	Mon 18-01-01	32	
34	Sensors and Position Control Test in 2D space	17 days	Thu 17-12-28	Thu 18-01-18	32	
35	Sensors and Position Control Test in 3D space	5 days	Thu 17-12-28	Wed 18-01-03	32	
36	**Final Testing**	**37 days**	**Fri 18-01-19**	**Fri 18-03-09**		
37	2D Tests (Laptops,Computers,phones)	17 days	Fri 18-01-19	Mon 18-02-12	33,34,35	
38	3D Tests (Games, Cuberotate)	20 days	Fri 18-01-19	Thu 18-02-15	33,34,35	
39	Range and Battery Life Tests (2D and 3D)	20 days	Fri 18-01-19	Thu 18-02-15	33,34,35	
40	Review, Changes and Troubleshooting	17 days	Fri 18-02-16	Fri 18-03-09	37,38,39	
41	**Administrative Tasks**	**133 days**	**Fri 17-09-15**	**Wed 18-03-14**		
42	Design Review 1	6 days	Fri 17-09-15	Fri 17-09-22	1,2,3,4,5	
43	Proposal	6 days	Sun 17-09-24	Fri 17-09-29	11	
44	Design Review 2	5 days	Thu 17-11-02	Wed 17-11-08	12	
45	Design Review 3	20 days	Thu 17-12-28	Tue 18-01-23	26	
46	Design Review 4	3 days	Fri 18-01-19	Tue 18-01-23	33,34,35	
47	Final Report	3 days	Mon 18-03-12	Wed 18-03-14	40	
48	Slack time	8 days	Sun 17-12-24	Tue 18-01-02		