G07 - Air Mouse: *Wireless translation of hand gestures into two and three-dimensional mouse movements*

1.0 Summary of Progress towards Integration

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. In line with the pre-established Gantt chart schedule, the project is in the integration stage.

A diagram was created to show the position of each component on a right-hand glove, and then the tested sub-systems were transferred from the breadboard onto the glove. The glove material was chosen using the following criterion:

- Lightweight (< 50g) to allow for unstrained hand movements.
- Antistatic Fabric to ensure against static electricity buildup.
- Air-permeable to reduce sweating or related discomfort.

A ready-to-wear right-hand glove made of cotton was chosen in standard unisex, medium size, for the prototype.

1.1 The layout of the glove was carefully planned and designed as follows:

The **BNO055 sensor** receives the hand orientation and tilt information based on Euler angle displacement from its initial position. To allow for maximum sensitivity to hand movements and gestures, it is mounted horizontally slightly before the knuckles area.

The **Flex sensors** are placed on the inner sides of the glove for more flexibility and to reduce the amount of pressure exerted on the fingers. A 33K Ohm resistor is attached in series with each flex sensor for this design, which gives a range of approximately 0.5V, from fully straight to fully flexed when tested. The threshold voltage for the pinky (A0), ring (A1), middle (A2) and index fingers (A3) were set to 1.8V, 2.5V, 2.0V, and 2.9V respectively. The numbers in brackets indicate which corresponding pin each sensor is connected to on the microcontroller. The state of each finger is read by the microcontroller, and flexing and relaxing certain fingers allows the user to perform mouse actions. This allows the microcontroller to distinguish between left and right mouse clicks depending on which finger is flexed. Flexing all fingers at once puts the mouse in scrolling mode.

The **Battery** is mounted between the thumb finger and wrist area. The Neopixel is placed beside it to indicate the battery life remaining with the intensity of the status indicator lamp. The brightness indicates the power level of the battery, with a green color light displaying a state of maximum charge and red for the minimum. A slider switch was placed close to the battery location for the ease turning the glove on or off. The Bluefruit nRF52 board was positioned such that the micro-USB connector is oriented towards the user for recharging the battery or connection of any external sources.

Circuit Interconnection - This design layout was wired using jumper cable connections among different components for flexibility while testing. The flex sensors are held in place using glue whereas the BNO055 was sewn onto the fabric. The final design circuit connections will be done with conducting thread 316L as specified in our proposal.

1.3 First Design Prototype

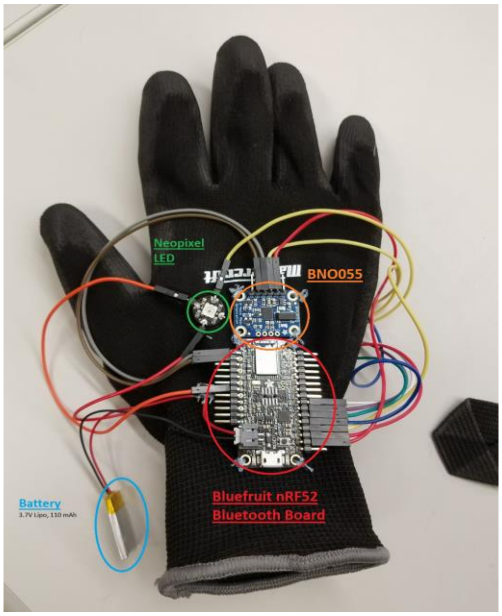


Figure 1 - Left image shows top view of glove. The image on the right is the bottom view of the glove.

2.0 Summary of Changes Made to Design

2.1 The pressure sensitive sheet, which was initially intended as an alternate method for providing mean of control, was removed from the design at this stage. The flex sensors provide better threshold values than the pressure sensitive sheet and was, hence, removed.

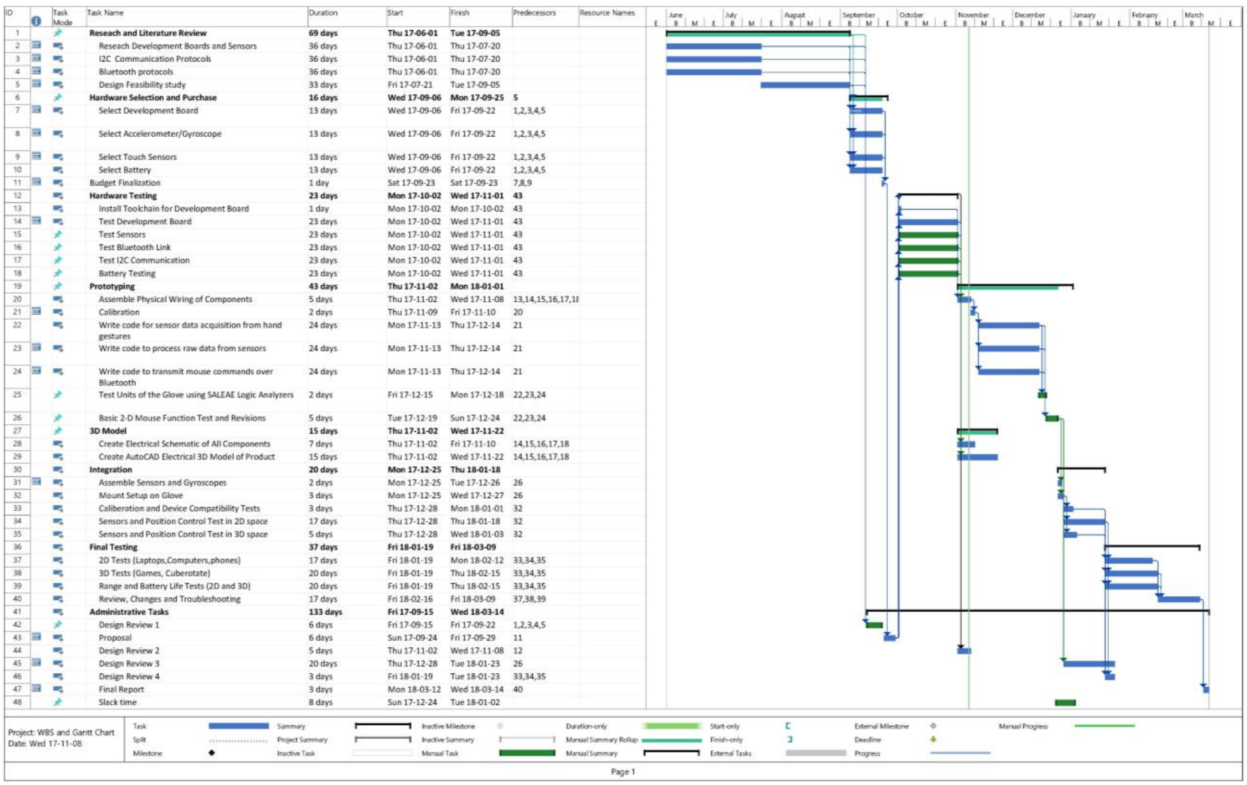
2.2 Our initial design was to display three colours that indicated fixed battery range, Green (100%-43%), Yellow (42%-7%), Red (6%-0%). A varying brightness scheme was implemented for each colour to indicate the charge in each range. The brighter the colour, the higher the charge in that range. This change was brought forth to provide the user with a better indication of the battery state of charge as it is visually more incremental than then semi-frequent level to level changes in colour.

2.3 A finite state machine code was implemented to read the state of the flex sensors. This method replaced the previously used polling method which involved polling each flex sensor until it is flexed to perform an action. The finite state method proved to be more efficient as it allowed for an increase in the number of possible functions from 4 to 16.

2.4 The glove design was changed from the initially proposed five flex sensors to four, omitting the thumb finger sensor. The removal was a result of weighing the added capabilities from adding one more flex sensor against the added power draw of the sensor, wires, and the resulting reduced mobility of the thumb. Thus, it was concluded that the minimal added capabilities of placing a flex sensor on the thumb did not outweigh the reduced performance.

3.0 Summary of Changes to GANTT Chart

The time allotted for 3D model testing and programming was removed from the Gantt chart to provide more time for the 2D model. The 3D feature was also proposed as optional so the team will look into implementing it once the basic mouse functions are successfully programmed.



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	13,14,15,16,17,1ɛ	
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		

Project: WBS and Gantt Chart
Date: Wed 17-11-08

Page 1