Pilot Health Monitoring System

Project Closeout

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I. Design Impact Statement

Public Health, Safety and Welfare Impacts: In terms of public health, safety and welfare this project can be looked at with multiple angles. A positive effect of this project would be seen in the public safety category. This technology is all about the safety of the pilot and ensuring that the plane continues to be in control in the case of a pilot health issue. An article on *The General Aviation News* Website describes an accident that was caused by a pilot's preexisting medical condition [1]. The FAA holds pilots to high standards of health, but there are still underlying medical conditions that people do not know about and that routine medical exams cannot uncover. Once implemented this technology could help to predict pilot medical issues, giving the rest of the crew, both on the ground and on board the plane, more time to respond and ensure the safety of those onboard. This technology will increase the overall safety of aviation across all fields, commercial and private.

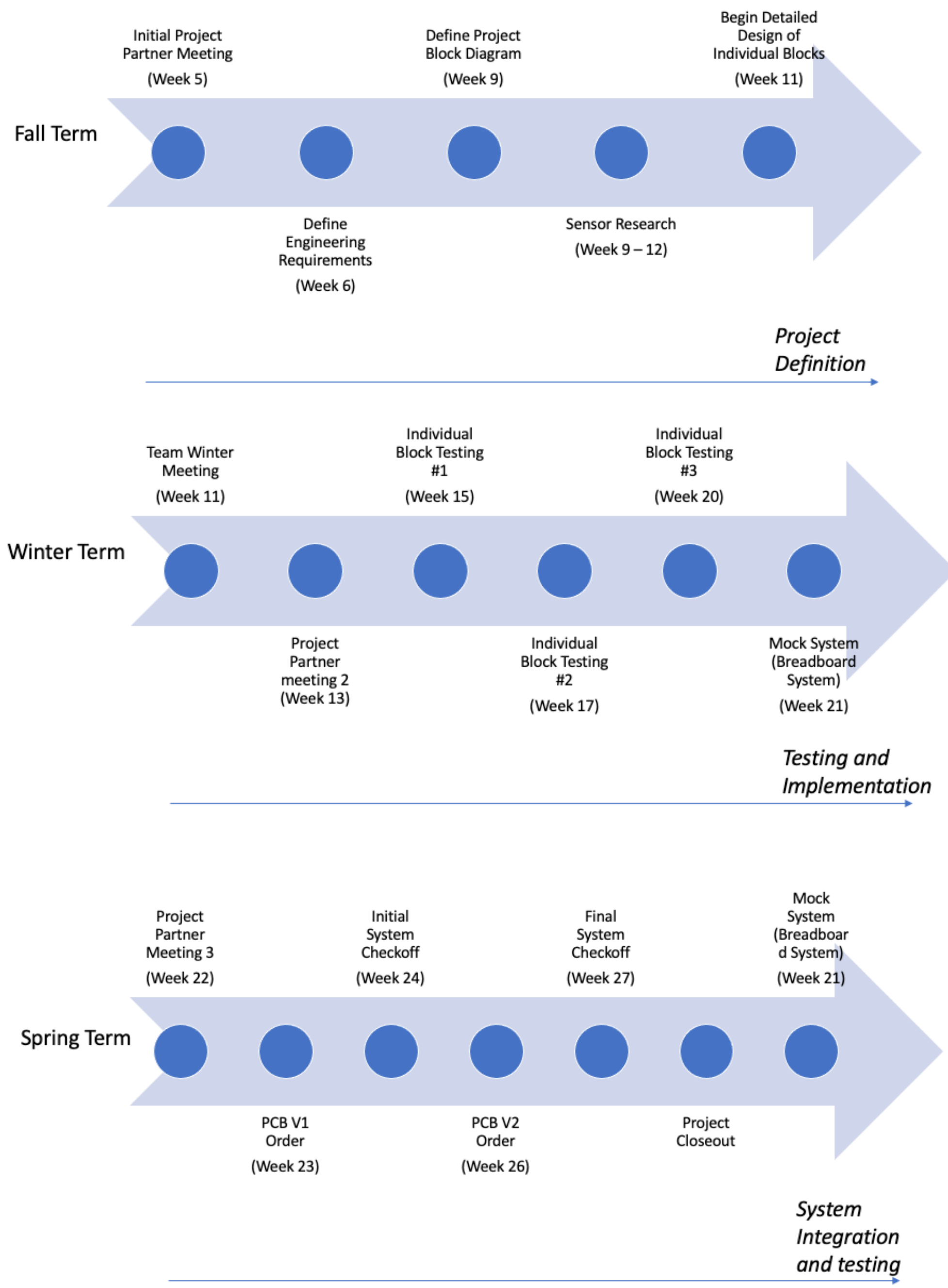
***Cultural and Social Impacts*:** When looking at aviation in general there appears to be some social benefits and social costs. When looking at the social benefits you can see that aviation brings people together. Aviation connects people and cultures from all over the world [2]. Aviation eliminates a lot of travel time allowing people to travel farther and more often. With this increase in traveling around the world tourism will also increase. Tourism around the world is a large industry, aviation allows more people to visit destinations allowing the economy and in turn the people in those areas to thrive. This technology could help boost these small economies even more.

Some negative effects on aviation include the cost. It is still fairly expensive to fly but an increase in flying throughout the public could help offset the prices of commercial aviation allowing flying to be more easily accessible for people who could not afford to fly in the past.

Environmental Impacts: Aviation has a large impact on the environment, according to the FAA aircraft engines produce large amounts of carbon dioxide as a result of the combustion process used in air transportation [3]. Overall aviation accounts for 12% of all transportation emissions. Aviation is not extremely efficient when you are looking at the emissions that it accounts for. Flying is more efficient then driving because of the large number of passengers that can fit in a plane [4], but there is still a large environmental impact which is hurting in the form of climate change. The technology developed through this project may increase the number of passengers seen in air travel, which in turn could boost climate change and cause a large environmental impact.

Economic Factor: The technology developed through this project will make flying even safer, in turn this will create even more trust in people for flying – causing more people to choose to fly instead of other variations of transportation. This increased confidence in commercial aviation could lead to a much larger number of people choosing to travel in general. Around one third of all people have some form of anxiety surrounding flying [5]. This technology could possibly give these individuals more confidence in aviation, causing them to either start flying, or start flying more often. Aviation generates 13.5 million jobs and contributes 880 billion dollars a year to the world GDP [6]. Increasing this industry will create thousands of jobs and contribute even more the world GDP, it will also boost tourism around the world helping thousands of communities.

II. Project Timeline



III. Scope and Engineering Requirements Summary

1. Alert System (Haptic Feedback)

-Project Partner Requirement: The system needs to alert when a sensed value is out of range.

-Engineering Requirement: 9 out of 10 users will report that they were alerted by the system when their heart rate is at or above 140 BPM.

2. Battery Powered

-Project Partner Requirement: System must be battery powered.

-Engineering Requirement: The wearable sub-system must operate for at least 4 hours on a single charge and the wearable will have an integrated battery.

3. Blood Oxygen Sensor

-Project Partner Requirement: The pilots blood oxygen levels should be sensed accurately.

-Engineering Requirement: The ECE system will measure and calculate Blood Oxygen Levels within 5% of actual values.

4. Form Factor (Wearable)

-Project Partner Requirement: System must be applicable pilot's body (wrist or head) without affecting their ability to operate the plane

-Engineering Requirement: The ECE system must be attachable to a wristband or inside of the pilot's helmet and must weigh less than 125 grams.

5. Heart Rate Sensor

-Project Partner Requirement: The pilot's heart rate will be sensed accurately.

-Engineering Requirement: The ECE system will measure and calculate Heart Rate within 10% of actual values.

6. Sampling Rate

-Project Partner Requirement: The system must collect biometric data at a high resolution.

-Engineering Requirement: The ECE system will sample data from the sensors at a minimum of 64 samples per second.

7. Store Sensor Data

-Project Partner Requirement: Software system stores data in real time

-Engineering Requirement: The ECE system must be capable of storing 24-48 hours (multiple flights) of sensor data in an on-board database. Storage Solution must be accessible (Removable from the system) and must be capable of maintaining a data transfer rate of at least 200 bytes per second.

8. Wireless Connection

-Project Partner Requirement: Wireless data transfer

-Engineering Requirement: The wearable sub-system will communicate data wirelessly over a distance of at least 2M when a 2.4GHz WiFi router is streaming Netflix with in 2M as well.

IV. Risk Register

Risk ID	Risk Description	Risk Category	Risk Probability	Risk Impact	Risk Indicator	Responsible Party	Action Plan
R1	Vendor Delay - Necessary parts may experience shipping delays	Timeline	20%	L	Vendor Location	Jack Larson	Retain
R2	Testing Logistics - Our team lacks the resources to test our system under the specific conditions of a fighter pilot	Technical	50%	M	Physical condition of subjects	Zachary Rabin	Retain
R3	Remote Learning - Could be faced with communication/ development issues with limited access to teammates	Technical/ Team Chemistry	25%	M	Lack of communication/ clarity amongst teammates. Team member confusion/ conflicting objectives	Max Altenhofen	Reduce
R4	Limited Lab Access - May face challenges finding a location with adequate equipment where assembly/ testing can take place	Technical/ Timeline/ Cost	30%	H	Any plans that require equipment that we do not have immediate access to	Jack Larson	Reduce
R5	Breaking outside of initial project scope - Our project partner gave us baseline requirements and stretch goals	Project Objective	20%	L	Any account for stretch goals before baseline goals are met (jumping the gun)	Zachary Rabin	Retain

R6	Software - Hardware incompatibility - Since our team is made up of 3 ECE and 3 CS students (divided into sub-teams), incompatibility/ conflicting objectives may come into play	Technical	5%	H	Lack of communication between sub-teams, or limited cooperation between sub teams	Max Altenhofen	Avoid
R7	Faulty/ damaged parts - Necessary materials/ parts may come in the mail and delay assembly/ testing process	Technical/Timeline	15%	M	Website reliability, quality of product reviews, and quantity of products ordered	Jack Larson	Retain
R8	Project plan is not concise or requires enough from team members	Timeline	15%	H	Lack of deadlines, long stretches of time without progress	Zachary Rabin	Avoid

After the completion of this project the risks that our team had as the highest probability ended up not being our downfall. Our biggest problem throughout the course of this project was the timeline. From the start of the project some important dates were not set on the timeline such as the ordering of the PCB. From the start of the project R8 should have had a higher probability. We also did not include a risk about debugging and testing, this process took longer than expected and should have been taken into account from the start of the project, this would be a good risk to take into account at the start of another project.

V. Future Recommendations

Recommendation:	Reason:	Solution:
Select a stronger optical sensor	The sensors used in this project worked, but they could be more accurate.	An optical sensor with a larger light source, or with a green light source may work better for reading biometric data from the wrist or the temple. These parts are harder for light to penetrate compared to fingers, brighter lights and green lights do a better job at penetrating the skin here. The BH1790GLC sensor may be a good place to start, this sensor allows you to select the lights you would like to use with it.
Use multiple optical sensors	A single sensor worked well, but having multiple would allow for even more accurate data, and would allow for more movement of the system on the wrist or temple.	A possible solution would be to use multiple BH1790GLC sensors in an array along with several powerful lights.
Place optical sensors on their own PCB	The final PCB design for this system had all components on the same PCB, this led to a lack of space on the top side of the PCB, causing some components to be placed on the bottom half of the PCB. This did not allow the sensor to fully protrude through the opening. Sensor data is more accurate when there is solid contact to the skin.	Use multiple PCBs in the system, have a dedicated sensor module where all components are on top and the sensors and lights are on bottom, this will allow the board to be mounted flat to the bottom of the enclosure, and the sensors and lights will be able to have solid contact with the skin, allowing more accurate biometric data collection.
Include PCB as a block	This group did not have the PCB as a block, meaning no one individual had the full responsibility to design it. Because of this there was no hard deadline for the time the PCB must be designed. This led to a late design of the PCB and many debugging problems.	From the start of the project include the PCB as a block, this will force someone to be thinking about the design from the start of the project and will lead to earlier testing and a more proficient system.
Keep up with team members block progress	During the duration some of the blocks passed the block checkoffs but were not ready for implementation.	Assign an individual to keep up with the development of others blocks, this person should be checking that the blocks will work in the final system

		including both hardware and software.
Lower the weight requirement of the system to 60 grams	The weight requirement for this system was 125 grams, this was achieved with our final system which weighed in at around 100 grams, but it was very large and clunky to wear.	Weight could be reduced by using smaller battery's and possibly even just one battery. Our final system met our battery requirement easily so it would have been possible to slim that aspect of the system down.
Include an onboard data visualization module	During use of our final system, it was difficult to analyze the data that we had been recording, this is because the only way we could see it was after the fact through a micro-SD card, or through a BT serial monitor.	It may be possible to include a small LCD display on the top of the system. This will allow you to easily see what data is being collected while working to test the system. It will also allow the user to quickly see their data as they wear the system during normal use.
Have required dedicated time each week where group members work on the project together	During the course of this project, it was difficult to gauge how much work had been completed by each team member. Sometimes it was assumed that some things had been completed even if they had not actually been completed.	From the start of the project (or the start of each academic term) assign a time span of around 2 or 3 hours where the members of the group will work together on the project. This could be people working individually in the same call or in the same room, as long as everyone is easily reachable at the same time. This will allow the project to flow much easier as it works to completion.

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