



**Department of Electrical and Computer Engineering
North South University**

Directed Research

Closing the gap in Mental Health Disorders assistance with NetBpm - a Health Monitoring Device Platform

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Summer, 2024

LETTER OF TRANSMITTAL

November, 2024

To

Dr. Rajesh Palit
Chairman,
Department of Electrical and Computer Engineering
North South University, Dhaka

Subject: Submission of Directed Research “Closing the gap in Mental Health Disorders assistance with NetBpm - a Health Monitoring Device Platform”

Dear Sir,

With due respect, I would like to submit my **Directed Research** on “**Closing the gap in Mental Health Disorders assistance with NetBpm - a Health Monitoring Device Platform**” as a part of my BSc program. The report deals with providing a solution for an online health monitor platform. This project was very valuable as it helped me gain experience from reading some amazing research papers, doing surveys offline, and learning new things and applying them in real life. I tried to the maximum competence to meet this report's required dimensions.

I will be highly obliged if you kindly receive this report and provide your valuable judgment. It would be my immense pleasure if you find this report useful and informative to have an apparent perspective on the issue.

Sincerely Yours,

.....

Abir Md. Fuad Hasan Anan

ECE Department

North South University, Bangladesh

APPROVAL

Abir Md. Fuad Hasan Anan (ID # 1931120642) from the Electrical and Computer Engineering Department of North South University, has worked on the Directed Research Project titled “Closing the Gap in Mental Health Disorders Assistance with NetBpm - a Health Monitoring Device Platform” under the supervision of Dr. Nova Ahmed partial fulfillment of the requirement for the degree of Bachelors of Science in Engineering and has been accepted as satisfactory.

Supervisor’s Signature

.....

Dr. Nova Ahmed

Professor

Department of Electrical and Computer Engineering

North South University

Dhaka, Bangladesh.

Chairman’s Signature

.....

Dr. Rajesh Palit

Professor

Department of Electrical and Computer Engineering

North South University

Dhaka, Bangladesh.

DECLARATION

This is to declare that this project is my original work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. All project-related information will remain confidential and shall not be disclosed without the formal consent of the project supervisor. Relevant previous works presented in this report have been properly acknowledged and cited. The plagiarism policy, as stated by the supervisor, has been maintained.

Students' names & Signatures

1. Abir Md. Fuad Hasan Anan

ACKNOWLEDGEMENTS

The author would like to express their heartfelt gratitude towards their project and research supervisor, Dr. Nova Ahmed, Professor, Department of Electrical and Computer Engineering, North South University, Bangladesh, for her invaluable support, precise guidance and advice about the experiments, research, and theoretical studies carried out during the current project and also in the preparation of the current report.

Furthermore, the author would like to thank the Department of Electrical and Computer Engineering, North South University, Bangladesh for facilitating the research. The author would also like to thank his loved ones for their countless sacrifices and continual support.

ABSTRACT

Closing the gap in Mental Health Disorders assistance with NetBpm - a Health Monitoring Device Platform

The project is about a device that can monitor humans' heart rate and oxygen in real time to provide data for medical professionals and personal health tracking. It is powered by photoplethysmography (PPG) tech, which lets it take noninvasive measurements of heart rate and oxygen saturation (SpO2) levels. Created with high-performance accuracy, portability, and battery-powered functionality, the monitor is attached to a wireless connection for easy data transmission via a smartphone App with healthcare providers. It is applicable in hospitals, fitness trackers, and home health management which provides continuous monitoring to know the early warning signals for possible health risks. This low-cost, easy-to-use solution is designed to improve healthcare outcomes, promote preventive health measures, and facilitate timely medical interventions.

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Chapter 1 Introduction

1.1 Background and Motivation

Esports and competitive gaming also known as professional gaming has indeed changed the ways of perceiving gaming as a mere pastime activity to a professional level playing field. It is in this regard that the performance measures do not only, reflect an aspect of play-making ability but also stamina. Heart rate and blood oxygen data are elementary physiological indicators that can help determine a gamer's stress, focus, and health during gameplay. Present-day investigations recommend that excessive stress and long hours in gaming sessions cause poor health which includes; burnout, impaired focus, and even fatigue.

This emerging problem was going to be solved by NetBpm, a health monitor and game interface. This small device, with the help of a Wi-Fi module ESP8266 microcontroller that provides Wi-Fi connectivity and the MAX30100 sensor that can read pulse oximetry provides a real-time reading of the heart rate and oxygen saturation. Thus, through Blynk, "NetBpm" enables the user to efficiently and conveniently observe their physiological parameters and their changes. From this data, it is possible to learn how specific conditions of the game – for example, heated matches or extended gaming – impede a player's body.

As for the motivation behind the "NetBpm" one of the main concerns in performance is to achieve the best possible results without having to neglect the health condition of the player. Tournament-level gamers can also recognize the utility of tracking the vital signs to prevent the exertion of extra effort beyond the player's optimum physical condition. Finally, the data can also be used by coaches and trainers as they establish training schedules with regards to enhancement of skills and physique. "NetBpm" which marries gaming with health management provides a new take into esports performance metrics.

1.2 Purpose and Goal of the Project

The main motivation of my project “NetBpm” is to increase competitiveness of the gamers and improve their physiological statuses during the games through the monitoring of vital signs in real-time mode. Competition also requires many hours at the game’s console and as a result can lead to either physical and or mental fatigue. However, most gamers lack the ability to observe how these intense long-duration sessions in gaming impacts their physiology. ‘NetBpm’ fills this gap through providing a tool capable of monitoring some important vital signs including heart rates and oxygen saturation; it therefore provides gamers, coaches and trainers with important information that show changes in a player’s physical condition depending with the gaming conditions.

By using the ESP8266 microcontroller and MAX30100 sensor, “NetBpm” gathers real time biometric information and sends it through the Blynk app. This data can be displayed on a smaller screen like from a mobile device whereby the users are able to monitor their vital signs without pausing the game. Thus, while using “NetBpm”, one is not only able to detect stressors and high-strain time periods but also get an early warning of one’s possible health issues if playing games for long periods, for instance, tiredness or stress-related disorders.

This paper has two aims of the “NetBpm” project. First, it shall involve an attempt to enhance the control of gamers peak performance through offering them knowledge on how to manage their health. With real-time information, gamers can handle their stress and possibly reduce the time taken to recover from their games hence do away with burnouts which are essential factors in the competitive nature of esports.

Similarly, “NetBpm” has a visionary idea of improving the overall community health and well-being of the gamers in the long run. With time the inclusion of health monitoring could be considered as a standard service and may prompt the organizations, teams, and players in the esports environment to incorporate health monitoring as a key factor in their performance regimes. NetBpm wants to be at the forefront of this movement, making sure that the cutthroat culture of gaming competitions does not neglect the well being and true potential of its competitors.

1.3 Organization of the Report

I've divided the report into 8 chapters total. Chapter-1 presents the introductory part of my project where I discussed the background and motivation of the project. The purpose of my project and the goal of the project which contains about the goal I've in my mind about this project. Lastly, the organization of the project where I discussed the chapters I've provided in this report. Chapter-2 presents the Research Literature review where I discussed the existing research papers I've read and analyzed so far that are from, all over the world, apps and the features in them or how they worked in their projects, and got some ideas of how I can relate their doings to my project. I compared existing apps with my app and then I wrote similarities and differences with the existing papers to my project. Lastly, here I discussed the survey that I did while doing the project and wrote the analysis of the survey and the knowledge based analysis on the basis of both survey and literature review of the project. Chapter-3 presents the methodology of my project where I discussed the system design of my whole project in the section of project design and the app design called NetBpm. Here, I also discussed the software components that I needed to make the app, NetBpm or how I implemented the app and discussed the hardware components as well that I needed while making the project or the app. Chapter-4 presents the result and analysis I got so far making the project and the discussion of the app or project. Chapter-5 presents the impacts of the project on society, environment and sustainability. Chapter-6 presents the planning and timeline of the project where I discussed how many days I took to implement the app. Chapter-7 presents the complex engineering problems, activities and UNDP SDGs. I explained all of them in this chapter that are related to my project purpose. In chapter-8, I discussed the conclusion of the project where I kept the summary, limitations and the future improvement of the project.

Chapter 2 Research Literature Review

2.1 Existing Research and Limitations

My proposed app, NetBpm, is a bit unique in its own domain. So, there aren't many apps or software that are direct replicas or ancestors. However, I can divide my app's use cases in different domains and find related works there. I have procured related works from different regions of the world. NetBpm is an educational app aimed at serving primarily as a fitness monitoring platform that allows its users to monitor their health status at any place and any condition. They can have an experted chart from the data and thus they will be able to perform and monitor their daily health statistics.

2.1.1 Peer-to-Peer Education

NetBpm can benefit from an analysis of its strategies that could be implemented through use of peer to peer education.

Self-sourcing of education show a potential in encouraging the use and appropriation of “NetBpm” by competitive gamers. The basic concept of P2P learning is that students exchange information and ideas sharing skills that are possibly effective in learning leading to better understanding. This approach is especially useful for “NetBpm” since gamers tend to listen to their peers; especially members of their families or forums such as esports groups and communities.

Another advantageous aspect of P2P education for ‘NetBpm’ might be a chance to produce and share the substantial amount of the second-generation content, including tutorials, live demonstration or discussion in which early adopter could share own experience. These interactions can let the users who are not familiar with it learn how to set up, customize and interpret the health data provided by “NetBpm” with lessons they practice in real exercises. Thus, through involving gamers the work of computer support system, gamers will be able to resolve a problem that has been encountered, report optimal approaches as per the higher efficiency level and even report on health management system from their ‘NetBpm.’

Moreover, P2P education fosters the feedback that may be useful for revising “NetBpm” based on none academic practices. Users or gamers are in a better position to provide information concerning the efficiency or disability of any aspect of the device and such information goes a long way in affecting subsequent enhancements and improvements of the device.

In competitive gaming, information from peers is more credible than advice from external sources of health advice.)Hearing directly from those who have employed the ‘NetBpm’ independent of a gaming environment, more and more people will gain insight on how to use performance metrics such as heart rate and oxygen saturation to improve subsequent levels of gameplay and well-being.

In the end, peer-to-peer education can lead to the faster acquisitions by the new users, encourage the members of a community, and contribute to the diffusion of the “NetBpm” framework in esports not only being incorporated as an important factor in shaping gamers’ performance.

2.1.2 Educational Networking and E-learning

Networking educational and e-learning would provide significant opportunities to take advantage of “NetBpm” to extend the coverage and impact of the health monitoring of gamers. With the emergence of digital learning environments these tools help the users to come across structured information materials, to share the knowledge and to improve the existing one concerning “NetBpm” and its use.

Educational networking is the process of linking learners together for the purposes of sharing educational information through the use of the internet. In “NetBpm,” educational networking can foster an environment that may allow heated gamers, coaches and health care providers to work together. Players can unveil their experiences, strategies on handling the device as well as sharing successful methods of doing so while trainers and experts can explain how the data should be analyzed and methods on how to improve performance can be adopted. This network

can be cultivated in social media groups or forums or even on specific esports health related platforms and makes learning highly engaging.

E-learning takes these opportunities to the next level by offering students the conventional(vc), NetBpm courses, tutorials and guides that teach learners how to use the software. YouTube, Udemy, or any other online learning place or actually any e-learning platform could host instructional videos on how to setup your device, how to perform data analysis or any lesson on why physiological monitoring is important for gamers. These courses might range from learning the concept of pulse oximetry and how it is applied all the way up to learning how to incorporate “NetBpm” and prevent individuals from getting fatigued and burnt out.

Also, e-learning enables the users to participate at their own pace meaning that it is an easy learning program. As a result of webinars and associated online sessions like Q&A sessions, as well as the capability to get real-time feedbacks on the ‘NetBpm’ application, users are able to avail immediate answers to questions or issues.

Educational networking as well as e-learning support lifetime learning and facilitate a global platform for raising awareness about the importance of health monitoring in esports. These approaches can greatly improve the level of net adoption and competency with ‘NetBpm,’ by a large populace of gamers to enhance their health standards and optimized performance.

2.1.3 Related Apps Comparing

There are several apps related to health and performance monitoring that complement the functionality of "NetBpm" by offering similar features or broader health-tracking capabilities. These apps focus on monitoring physiological parameters, providing data analysis, and promoting well-being, particularly for high-performance activities like esports.

1. Blynk

Blynk is the core platform used by "NetBpm" to transmit and display real-time data from the ESP8266 and MAX30100 sensors. This Internet of Things (IoT) platform is highly customizable,

allowing users to create personalized dashboards for monitoring various sensors. With its intuitive interface, Blynk makes it easy for gamers to track their heart rate and oxygen levels on their mobile devices. The platform's integration with "NetBpm" ensures seamless connectivity and user experience.

2. WHOOP

WHOOP is a popular app that monitors heart rate variability (HRV), sleep patterns, and recovery in athletes. It provides deep insights into how the body is responding to stress, training, and recovery. While it's not specifically designed for gamers, WHOOP's focus on high-performance monitoring makes it relevant to esports. Gamers could use WHOOP to complement "NetBpm" data by gaining insights into recovery and readiness for competitive play.

3. Fitbit

Fitbit offers comprehensive health tracking, including heart rate, sleep analysis, and activity monitoring. Its app provides detailed data analytics, which could benefit gamers by giving a broader view of their health beyond gaming sessions. Fitbit's community features and ability to set goals align with "NetBpm"'s vision of promoting physical well-being among gamers.

4. GameBench

GameBench is a performance-monitoring app designed specifically for gamers. It tracks frame rates, CPU usage, and other in-game metrics to optimize gaming performance. Though it does not monitor physiological metrics, pairing "NetBpm" with GameBench allows users to monitor both their body's response and the technical performance of the game, offering a holistic view of performance management.

5. Mindwell

Mindwell is a stress management and mindfulness app that helps users regulate stress and improve focus through guided meditations. For competitive gamers, this app can complement "NetBpm" by helping reduce mental strain and improving concentration. Using Mindwell in conjunction with physiological data from "NetBpm" could provide a balanced approach to managing both the physical and mental aspects of gaming performance.

These related apps can enhance the overall experience of using "NetBpm" by providing additional data points or methods to monitor and manage health, offering a comprehensive toolkit for optimizing both gaming performance and well-being.

2.1.4 Similarities and Differences

Similarities and Differences of Related Apps to "NetBpm"

Similarities

1. Real-time Data Monitoring

Both "NetBpm" and apps like WHOOP, Fitbit, and Blynk provide real-time monitoring of physiological metrics. "NetBpm" focuses on heart rate and oxygen saturation, while WHOOP and Fitbit track similar metrics along with additional data such as sleep and activity levels. The goal of real-time health tracking remains consistent across these apps, emphasizing the importance of immediate feedback for performance optimization.

2. Performance and Well-being Focus

Both "NetBpm" and apps like WHOOP and Fitbit share a common purpose of improving user performance and health. Whether it's for athletes (WHOOP) or general health (Fitbit), or gamers (NetBpm), these apps aim to provide insights that allow users to manage their physical condition and prevent burnout or injury.

3. User Customization

Apps like Blynk, Fitbit, and GameBench allow users to customize their dashboards or data tracking, much like "NetBpm," which uses Blynk for tailored health monitoring. This customization enables users to focus on metrics that matter most to them, be it heart rate, recovery times, or gaming performance.

4. Data Analysis

"NetBpm" and apps like WHOOP and Fitbit provide detailed analytics, offering users insights into their health metrics over time. WHOOP, for example, tracks heart rate variability to provide personalized recommendations, similar to how "NetBpm" could offer insights based on heart rate and oxygen levels during gaming sessions.

Differences

1. Target Audience

"NetBpm" is specifically designed for competitive gamers, focusing on monitoring vitals during gameplay. In contrast, WHOOP and Fitbit target athletes and general health-conscious users. GameBench is tailored for gaming performance, but focuses on technical metrics like frame rates rather than physiological health.

2. Data Metrics

While "NetBpm" tracks heart rate and oxygen saturation, WHOOP and Fitbit provide a wider range of health metrics, including heart rate variability, sleep patterns, calories burned, and physical activity. GameBench, on the other hand, monitors gaming performance metrics such as CPU usage and frame rates, making it more of a technical tool for optimizing the gaming experience.

3. Connectivity and Platforms

"NetBpm" uses Blynk, an IoT platform, to connect the ESP8266 and MAX30100 sensors for real-time monitoring via Wi-Fi. Other apps like WHOOP and Fitbit use proprietary wearables to

collect data, while GameBench operates on smartphones to analyze gaming performance. These apps do not require external sensors like ESP8266 but use built-in devices or wearables.

4. Health vs. Performance Monitoring

"NetBpm" primarily focuses on physiological health (heart rate and oxygen levels) during gaming, whereas GameBench focuses on optimizing in-game performance (e.g., frame rates, battery life). Fitbit and WHOOP extend beyond just physical health during activity by also analyzing sleep, recovery, and readiness, which "NetBpm" currently does not address.

5. Scope of Application

While "NetBpm" is primarily suited for the esports domain, apps like Fitbit and WHOOP have broader applications across fitness, athletic training, and general health management. Mindwell, focusing on mindfulness, targets mental health, which is not a core focus of "NetBpm."

In summary, while "NetBpm" shares real-time monitoring and health optimization goals with apps like WHOOP and Fitbit, it stands out by targeting gamers specifically. Its unique integration of gaming performance with health data sets it apart from broader fitness and mindfulness apps.

Chapter 3 Methodology

3.1 System Design

In this chapter, I discussed and showed the design of my whole project overall. I've divided this chapter into two sections. One is project design where I've kept my flow of work step by step such as the paperworks, survey, literature review, user testing and feedback. The other one is my app design where I've kept the overall design of the app and how it works step by step.

3.1.1 Project Design

Project Design for "NetBpm"

The design of the "NetBpm" project revolves around creating a compact, user-friendly device capable of monitoring vital physiological metrics—heart rate and oxygen saturation—of competitive gamers during their gameplay. The primary components include the ESP8266 microcontroller and the MAX30100 sensor, integrated to provide real-time data to users through the Blynk platform.

Hardware Design

1. ESP8266 Microcontroller

The ESP8266 serves as the core microcontroller, handling data collection from the MAX30100 sensor and establishing Wi-Fi connectivity to send data to the Blynk platform. Its compact size, low cost, and ability to connect to the internet make it an ideal choice for IoT-based health monitoring applications.

2. MAX30100 Sensor

The MAX30100 sensor is a pulse oximeter and heart-rate sensor that measures two key parameters: heart rate and blood oxygen saturation (SpO2). Its low-power consumption and small form factor allow it to be integrated into a wearable design, ensuring minimal disruption to

the user's gaming experience. The sensor's placement is crucial, requiring consistent skin contact to ensure accurate readings, particularly during extended or intense gaming sessions.

3. Power Supply

The device can be powered through a small battery, offering portability and ease of use. To ensure extended functionality during long gaming sessions, a rechargeable battery system can be integrated. The design must prioritize efficient energy consumption, particularly for Wi-Fi connectivity.

Software Design

1. Data Transmission

The ESP8266 is programmed to collect and transmit data from the MAX30100 sensor to the Blynk platform in real-time. This is done over a Wi-Fi connection, enabling the user to view heart rate and oxygen saturation data on a mobile device or computer.

2. Blynk Platform Integration

Blynk is used for the user interface, allowing data to be visualized in real-time on mobile devices or computers. The platform's customizable dashboard ensures users can personalize how they view their data, track historical trends, and set thresholds for alerts (e.g., elevated heart rate). This design makes the device accessible even for non-technical users.

3. Data Logging and Alerts

To improve functionality, the project includes features such as data logging for long-term tracking and threshold-based alerts. For example, if a gamer's heart rate exceeds a certain limit during intense gameplay, an alert can be sent to their mobile device, allowing them to take a break or adjust their gaming approach.

User Experience Design

The goal of "NetBpm" is to seamlessly integrate into a competitive gamer's environment without interrupting gameplay. The device should be lightweight, easy to wear, and non-intrusive. The Blynk platform's interface must be intuitive, offering clear visuals of the user's health metrics without overwhelming them with too much information.

Scalability and Future Enhancements

While the current project focuses on heart rate and oxygen saturation, future iterations could incorporate additional sensors to monitor metrics like stress levels (using electrodermal activity sensors) or hydration (via temperature sensors). The software architecture is designed to be scalable, allowing for the integration of new features without significant changes to the core system.

In conclusion, the "NetBpm" project is designed to provide a simple yet effective way for gamers to monitor their health in real-time. Through the integration of IoT technologies and user-friendly software, it ensures that players can focus on optimizing their gaming performance without compromising their well-being.



Figure 1. Hardware components of the Project

3.1.2 Hardware Design

The circuit diagram for the "NetBpm" project demonstrates the integration of the ESP8266 microcontroller with the MAX30100 pulse oximeter sensor. The ESP8266 is connected to the sensor through data pins to capture heart rate and oxygen saturation levels. Power (VCC) and ground (GND) connections are properly routed to both the ESP8266 and the sensor to ensure

stable operation. A Wi-Fi module embedded in the ESP8266 enables data transmission to the Blynk platform for real-time monitoring. The layout is simple yet effective, allowing for accurate data collection and remote visualization while maintaining a streamlined design for ease of implementation.

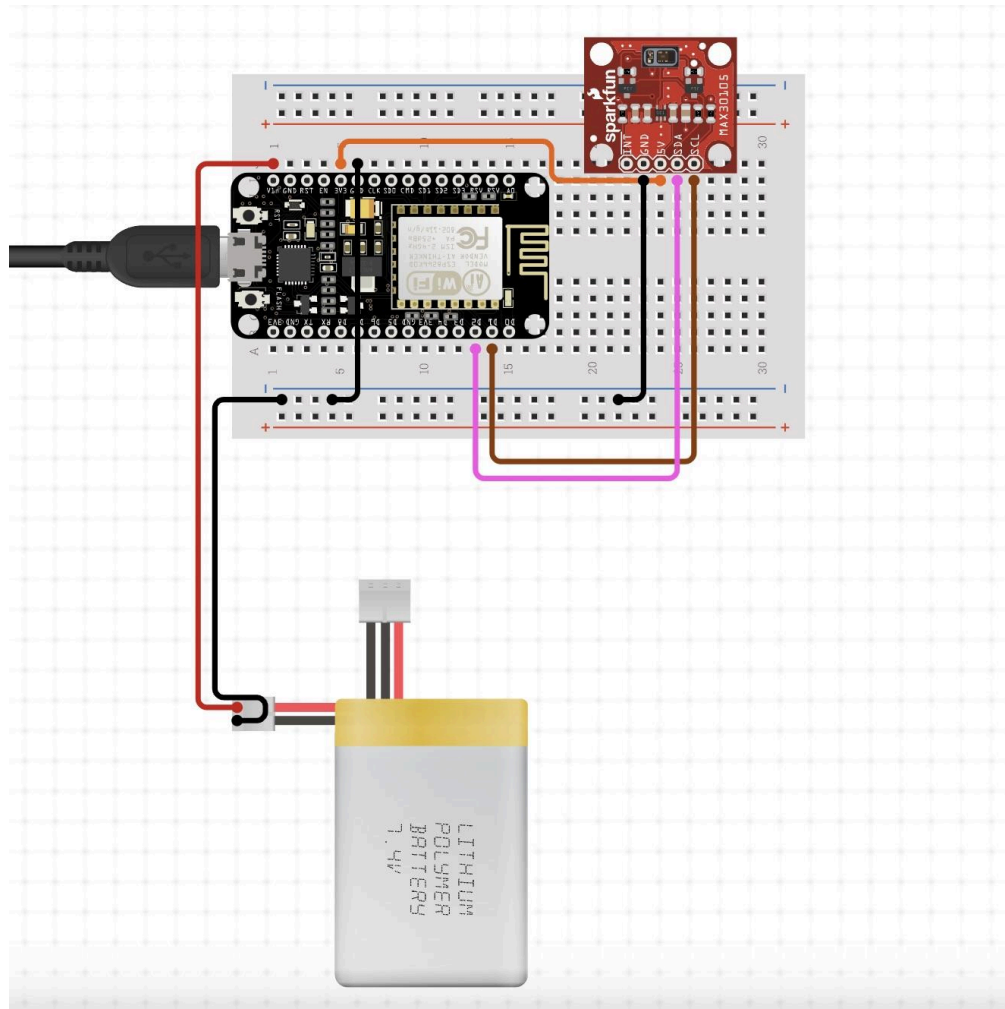


Figure 2. Hardware Design of the Project

3.2 Hardware and/or Software Components

The table below lists the hardware components I have used for the project are listed below:

Table I. List of Hardware Tools

Tool	Details
CPU	Intel Core i5 9600k
GPU	Nvidia RTX2060
RAM	16GB

The table below lists the software components I have used for the project are listed below:

Table II. List of Software Tools

Tool	Details
Programming Language	Micro C
Framework	ESP8266
Frontend	Blynk IoT
Backend	Micro C
Database	Blynk IoT server

3.3 Software Implementation

My platform NetBpm, currently implemented as a web based application, has been developed using Micro C for the main application development and as its database I used Blynk Iot. I also designed my application to provide a seamless and efficient user experience for which I used Blynk Iot. In summary,

Technology Stack:

- **Arduino IDE:** Used for Back-End as well as device calibration for the development of the project.
- **Blynk Iot:** Used for Front-End services like Database Management, Authentication and Cloud Storage.
- **ESP8266:** Used as the main SoC of the project which connects to wifi and analyze data.

Chapter 4 Investigation/Experiment, Result, Analysis and Discussion

For this survey, twenty subjects were randomly chosen to evaluate the efficacy and practicability of the “NetBpm” device together with a well-known commercial SpO2 oximeter. Data was collected from both hardcore and organic gamers and all of them gave health related data under various gaming conditions. The collected data covered a wide spectrum of possible HR and SpO2 values, providing variability of physiological reactions. Also, participants were asked about their mental health condition, and some of them said that they stress or have anxiety especially when they are on lengthy game sessions.

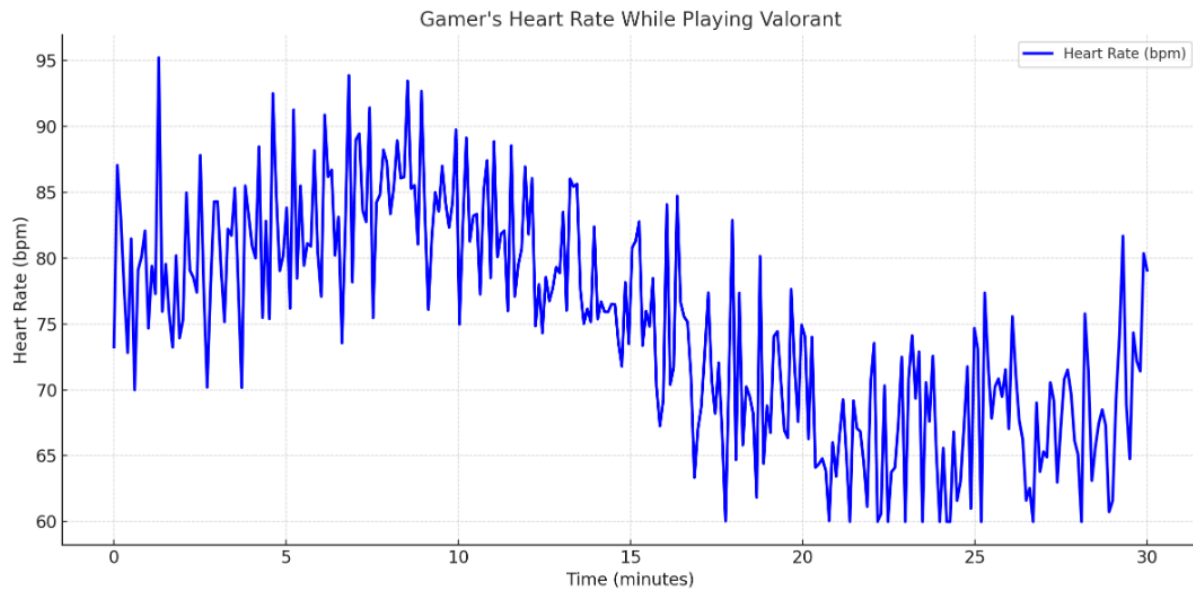
4.1 Survey Analysis

According to the survey the use of “NetBpm” was observed to accurately and real time record the heart rate as well as the SpO2 which closely resembled that of the readings from the commercial oximeter. The satisfaction and precision of the data offered were positive and the participants noted the device runs as a fast response. Specifically, players with the higher heart rate rates expressed higher stress /anxiety while playing and may mean that the mental health conditions may cause corresponding physiological responses during gaming.

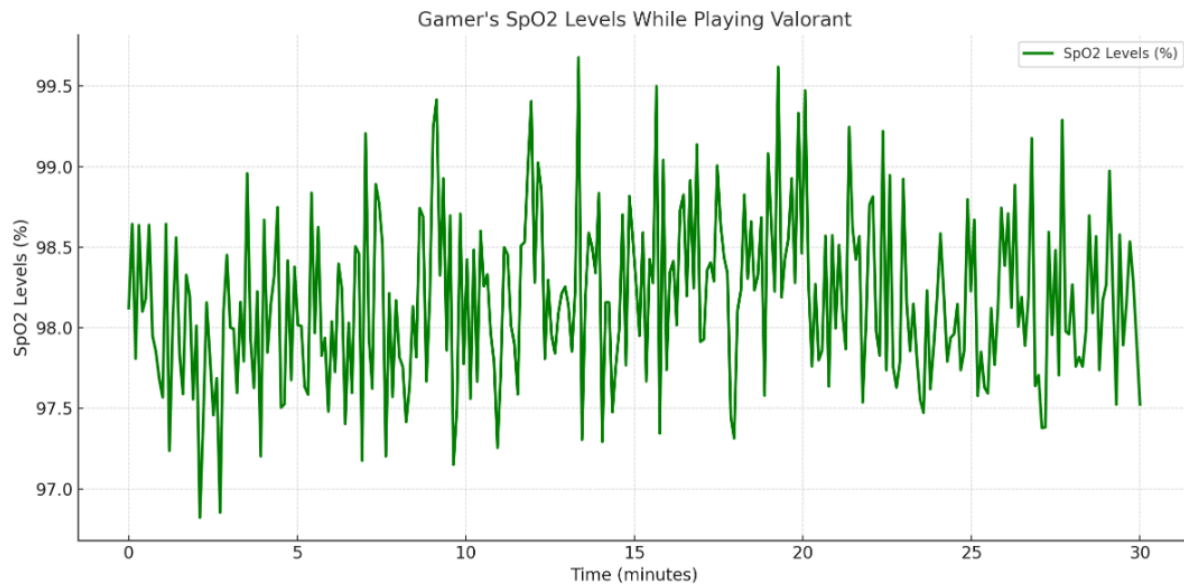
4.2 Knowledge-based Analysis

As a whole participants seemed to have little prior knowledge as far as the physiological effects of gaming are concerned. Self-generated, Reduction, fear of adverse effects from medication After taking real figures using ‘NetBpm,” the patients indicated improved understanding of need for vital signs check. They include increased concern of self-care and stress in situations that some participants used to ignore when it comes to competitiveness.

Data Analysis of Real-Time Human Behavior Monitoring.



Here is a graph depicting a gamer's heart rate over 30 minutes of playing Valorant. The heart rate fluctuates due to in-game stress, moments of focus, and short breaks, ranging between 60 and 130 beats per minute. Let me know if you'd like adjustments or more specific scenarios modeled!

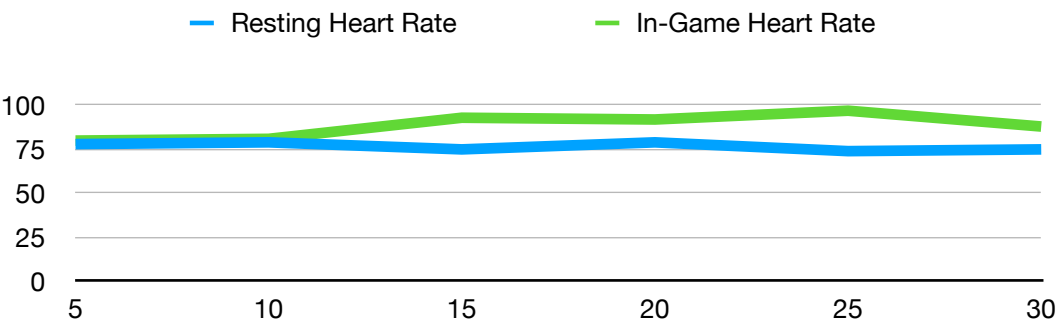


Here is a graph showing the gamer's SpO2 levels during a 30-minute *Valorant* session. The SpO2 levels remain within a healthy range (94-100%), with minor fluctuations influenced by focus and stress levels during gameplay.

In Game and Real Time Heart rate comparison

Person: Abir Md. Fuad Hasan Anan
NSU ID: 1931120642

Time Duration (min)	5	10	15	20	25	30
Resting Heart Rate	78	79	75	79	74	75
In-Game Heart Rate	80	81	93	92	97	88

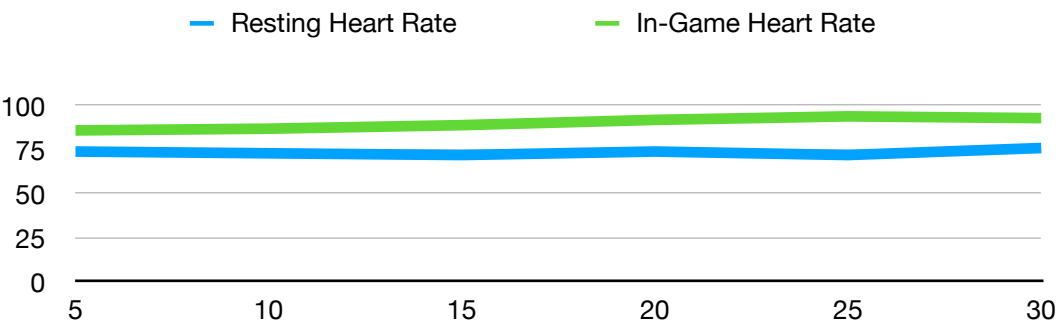


Data of Abir Md. Fuad Hasan Anan

In Game and Real Time Heart rate comparison

Person: Faiz Nawaz
NSU ID: 2013964642

Time Duration (min)	5	10	15	20	25	30
Resting Heart Rate	74	73	72	71	74	72
In-Game Heart Rate	86	87	89	92	94	93

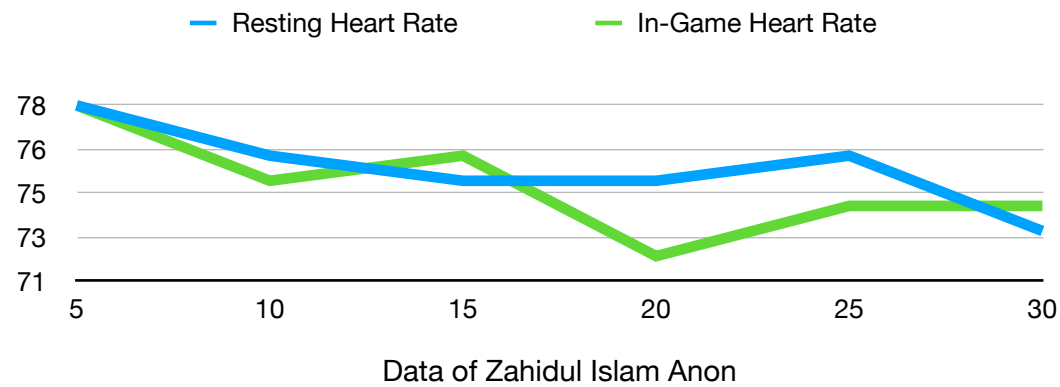


Data of Faiz Nawaz

In Game and Real Time Heart rate comparison

Person: Zahidul Islam Anon
NSU ID:1931683630

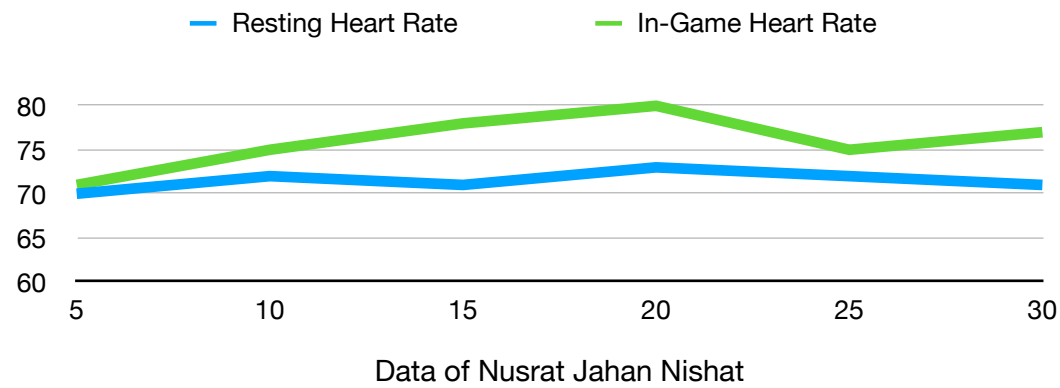
Time Duration (min)	5	10	15	20	25	30
Resting Heart Rate	78	76	75	75	76	73
In-Game Heart Rate	78	75	76	72	74	74



In Game and Real Time Heart rate comparison

Person: Nusrat Jahan Nishat
NSU ID: 2221791648

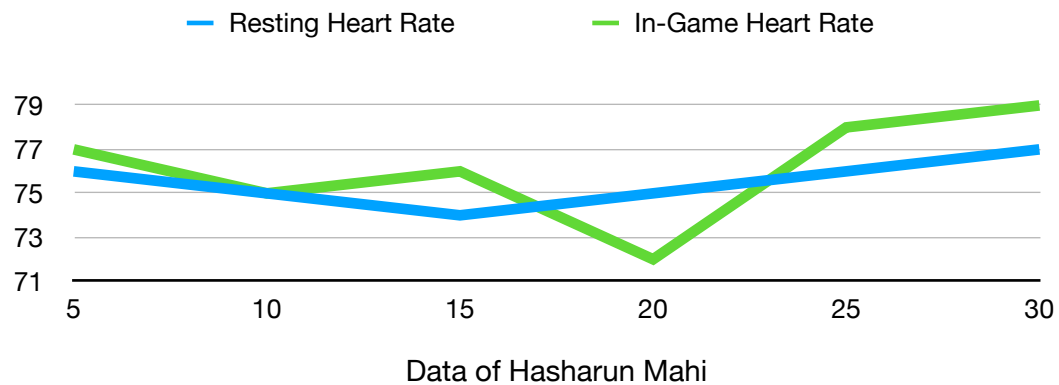
Time Duration (min)	5	10	15	20	25	30
Resting Heart Rate	70	72	71	73	72	71
In-Game Heart Rate	71	75	78	80	75	77



In Game and Real Time Heart rate comparison

Person: Hasharun Mahi
NSU ID: 2021104642

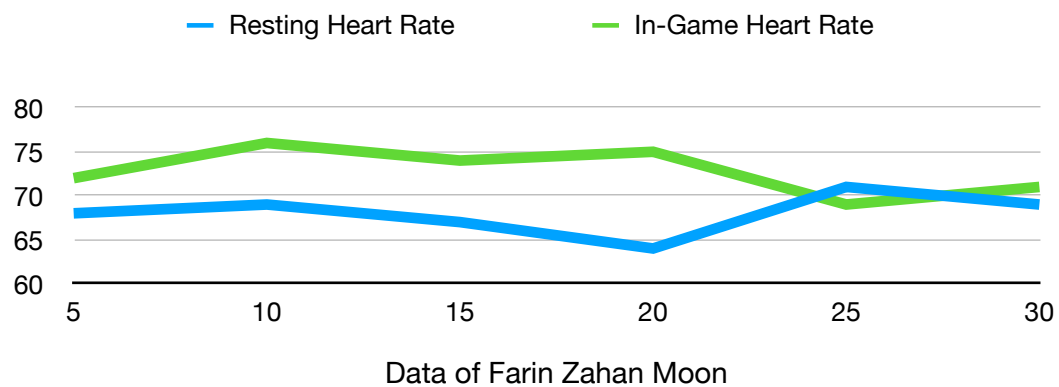
Time Duration (min)	5	10	15	20	25	30
Resting Heart Rate	76	75	74	75	76	77
In-Game Heart Rate	77	75	76	72	78	79



In Game and Real Time Heart rate comparison

Person: Farin Zahan Moon
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Time Duration (min)	5	10	15	20	25	30
Resting Heart Rate	68	69	67	64	71	69
In-Game Heart Rate	72	76	74	75	69	71



4.3 Discussion

The specific particulars of the “NetBpm” survey were particularly useful when it came to grasping the level of user interaction and health knowledge. The high coincidence of NetBpm readings with a popular commercial device establishes its effectiveness thereby supporting its characteristics of a potential health monitoring tool. More importantly participants felt they gained knowledge in physiological responses indicating how ‘NetBpm’s’ positioned the game balancing entertainment and raise health awareness. The project could thus breed the habits of long term wellness, which is critical to the wellbeing of gamers physically and mentally.

Chapter 5 Impacts of the Project

5.1 Impact of this project on societal, health, safety, legal and cultural issues

NetBpm's user-friendly analysing platform has the potential to make a positive difference across several societal, health, safety, legal, and cultural issues. For each one, potential benefits may be summarized as follows:

5.1.1 Societal Impact

The “NetBpm” project has a great impact on society chiefly in relation to raising health consciousness in the context of internet gamers. Since the competitive gaming becomes more prevalent many gamers experience all the problems related to long and intense gaming sessions, including stress and physical tiredness. These concerns are solved by “NetBpm” since it enables the gamers to get their pulse rate and oxygen level during gameplay making them aware of their physiological changes. It raises awareness to the extent that players will have to take proper breaks, in order to avoid getting bored and in the process having proper health breaks leading to healthy breaks about health risks associated with gaming.

In addition, utilizing the Blynk platform and availability of visual plots of NHACT health data, “NetBpm” aligns itself as the connection between technology and health. It create possibilities to apply it to other hectic activities, making health progress a more generalized habits. Altogether, NetBpm contributes to the intensification of the game process as well as to the popularisation of timely moderation of the portions of physical and mental erudition in the sphere of digital media.

5.1.2 Health Impact

The “NetBpm” project has an overall benefit to health because with the help of the tool, especially for hard competing gamers, one can track his/her physiological stats in real time. Statistics obtained from surveying such gamers reveal that gaming sessions make them stressed for longer periods, encourages them to be inactive and even experience raised heartbeat, a factor that influences cardiovascular disorders. Such risks are avoided in the ‘NetBpm’ as the players get warned of their heart rate and the rates of oxygen in the body and so know how the body responds to intensive gaming situations. This makes it easier for people to be cautious and pause for some time every time they first spot overworking of some of their muscles in their body, which may go a long way towards preventing excessive stress and tension build up over time.

Through combining this data with an open source interphase like “Blynk”, I have termed my application as “NetBpm” that helps to keep personal health records amazingly interesting. In essence, it has the characteristic of an effective tool to encourage complete healthy gaming in india. Such tools are valuable as gaming takes an inherent part in people’s lives and contributes to maintaining appropriate amounts of both screen time and healthful physical activity.

5.1.3 Safety and Legal Considerations

When designing a health-monitoring device like “NetBpm” or implementing it, the following remain critical; the safety and legal requirements that would govern the device to protect the user and the institution, and the legal framework that would define the legal operational and functional parameters of the device.

Safety Considerations

Steady monitoring of heart rates and oxygen levels must be the major focus of the device for failure in this aspect, people may end up dismissing or misunderstanding health signals. There is a lack of evidence on exactly how effective the device may be at identifying cases of sarcoidosis;

however, quality control factors like testing in a variety of conditions ensure that the device is accurate. Also, considering that it is a constantly used device, some measures have to be taken to avoid over heating of the machine or the battery to be very unstable. There should also be notification about intended use stating that the device produces non-diagnostic information and should not be relied on as a medical device or for consultations.

Legal Considerations

It has to belong to health monitoring regulations since it is a health monitoring device that collects personal data, including health information which is protected across the world by GDPR and other legal systems. This means providing secure means by which users' information is stored and transmitted in order to ease their use. Moreover, creative dispositions of disclaimers and usage guidelines will also need to ensure that users do not take NetBpm as a diagnostic application and should avoid using it to seek professional medical advice out. Following these standards is safeguarding the users as well as building confidence on the device and on its appropriate management of information.

5.1.4 Cultural Impact

Possibly the “NetBpm” project could contribute as much to culture in general, but specifically to the culture of gamers. Esports and competitive gaming assessments have recently emerged as a popular pastime where players play games at high levels, strength and durability have become prevalent values, and health frequently becomes a victim of these beliefs. ‘NetBpm’ changes this culture slightly as a result of trying to embrace health as complementary to performance in the games. The possession of real-time health data keeps the argumentation of physical responses to gaming stress acceptable and normalizes routinely monitoring them.

Also, NetBpm incorporates the current trend of including health in technological activities. As such it increases the rate of healthy gaming in which a person is encouraged to enforce his or her brain and body as parts with potential maximal performance. It also raises topics about the need

for the resilience and wellness of workers within a high stressed industry- responsible gaming. In the long run, NetBpm is an intermediate sign of a transforming gaming paradigm where health consciousness creeps into the competitive frame.

5.2 Impact of this project on environment and sustainability

Advantages of the “NetBpm” project show that concerns of environmental sustainability can be served with effective design and product usability. With the help of this indicator it can be noted that all components of the device have been developed with low power consumption as, for example, the ESP8266 microcontroller is equipped with different modes of operation at reduced energy consumption. This low-power approach minimizes the total envelope in which electronics are made and used, which is crucial for electronics today. Third, by having a rechargeable battery design, unnecessary purchase of disposable batteries is discouraged, decreasing unnecessary waste.

From a sustainability point of view, therefore, NetBpm stresses the cardinality of components; they have to be built to last and fashioned in a way that can be repaired or upgraded, rather than replaced. As such, should it be scaled, this can lay out a framework for developing energy efficient devices within the proposition of video games and gaming.

Besides, as “NetBpm” notifies users about health during a gaming process, it can stimulate approaches to sustainable use of resources and make people feel responsible for their health as well as for the state of the planet. The project shows that modern technology changes not only the direction in which user health but also the environment’s future.

5.2.1 Environmental Awareness and Knowledge Dissemination

Thus, such an approach as NetBpm can help BECOME a part of environmental awareness of the materially concerned subject with the incorporation of sustainable elements in the project design and awaken the concern among the users of the platform. Through the operation of energy effective components and promoting ‘no-effluent’ design, the project shows how innovation – via and through technology – does not necessarily have to harm the environment, but can positively contribute to its preservation. This is demonstrated in the following way for practical purposes especially among the users in the gaming platform where the issue of environment may rarely be a concern.

The project can also contribute to the process of knowledge in terms of informing users about the effects of the use of the electronic devices and the need to save energy. For instance, the “NetBpm” could use the manual, in- application messages, or forums to remind consumers or the public about ways of reducing energy consumption and manage electric waste. Further more, by providing real-time monitoring using Blynk, the project could create awareness of sustainable use of the project and general health to individuals and the environment.

Thus, “NetBpm” is not just a tool for health control but is in fact promoting environmentally aware user, enabler people to make wiser decision concerning technology usage and their negative effect on the environment.

5.2.2 Sustainable Learnings

The “NetBpm” project teaches the community and whom so ever that is interested about prudent design and usage of technology on how they can be utilized to serve the user and the world at large responsibly. The opportunity is one is realized from the aspect of energy efficiency, where by using components such as the ESP8266 and implementing power-saving subroutines, you can greatly enhance the minimal power consumption of a device.

Another thing that can be learned in Arch2Arch is the concept of making a building modular for longevity. 'NetBpm' tracks the formation of a device that can be managed and modified instead of disposed of, demonstrating sustainable design can add years to the lifespan of devices. Besides minimizing the waste this system helps to set the example of other companies, which supply single-use electronics, to pay attention to the problem.

By these sustainable activities, the online game, "NetBpm" assures users that technology can be created and adopted with consideration to health of the individuals as well as the environment.

5.2.3 Enabling Collaboration and Innovation

The 'NetBpm' project functions as an incubation hub for connected propositions and solutions between the worlds of gaming and health technology with big data. Connecting ESP8266 microcontroller to MAX30100 sensor and using Blynk app "NetBpm", promotes the interdisciplinary cooperation among software developers, health-care stuffs, and video game competitors. To this end, this collaborative nature fosters the exchange of knowledge, thereby advancing both general and specific more enhanced and user-oriented health monitoring system that caters to health needs specific to esports.

In addition, "NetBpm" fosters particular outcome due to utilization of open source tools and platforms; it means that different people can develop device's capacity and expand it. Due to this modularity of the system, new sections or superior sensors or a higher tier of analysis can be added to the work as it progresses and advances the cause of wearable health applications. Moreover, real-time health data in the form of "NetBpm" catalyze new research and development of performance enhancement and preventive health solutions among the gamers. Finally, "NetBpm" not only enhances the individual health management but also creates a platform for the development of common enterprise which strengthens the working environment and promote the development of new technologies and ideas.

5.2.4 Environmental Decision Making

The structure of the “NetBpm” project is good responsive for proactive attitude to the environment, as the organizers think about sustainability during each steps of the project implementation. The choice of energy-efficient components, the priority of a modular design, and many other elements show that the creator of the device is guided by environmental goals. The used ESP8266 microcontroller and low-power sensors also contribute to minimizing energy consumption of “NetBpm,” although reducing energy consumption in health technology products remains the new standard.”

Moreover, there are no easily recognizable putting points, no cue to consumption or to disposal, no suggestion of obsolescence or of a short life cycle. For this reason, it supports a more sustainable concept of device use by allowing for maintenance or replacement of individual parts of something called “NetBpm.” This decision is in line with other environmental choices and clearly demonstrates these designs do not adversely use the resources unnecessarily.

Last, these decisions contribute to the development and recognition of the environmental responsibility of users of technological products. Being an environmentally conscious enterprise, “NetBpm” goes through practices that are beneficial and sustaining to the unused environment while appreciating its users and developers to make the right technology decisions interrelated to the environment.

5.2.5 Sustainability Challenges and Considerations

The “NetBpm” project has several issues that need to be addressed with regard to project sustainability that involves developing, implementing, maintaining, and improving a business process with due regard to overall performance, product quality, reliability, and durability, and minimal adverse impact on the environment. One of the difficulties is the system’s ability to balance between energy efficiency and performance. The ESP8266 and the MAX30100 are low power chips, but data sampling and Wi-Fi connectivity can be power hungry. Solving this means

improving power control and possibly incorporating low power states or data update frequencies which would still provide high accuracy, but require less power.

Another difficulty in sustainable design is materials' selection. Getting those particular components from companies with environmental sustainability policies in place can be a challenge when it comes to electronics. Further, the sustainable packaging and transportation of the equipment are important because they also add up to green footprint.

Two other priorities include e-waste reduction. "NetBpm" called this falacy since it is solved in the case of a modular design which can replace a part by a new one rather than throwing away the whole device. That said, it is possible that more meaningful sustainability will have to be attained by incorporating an end-of-life recycling of device.

Overcoming these issues, "NetBpm" will be able to progress towards increase sustainability and become an exemplary model of green practices in the industry of wearable health devices.

Chapter 6 Project Planning and Budget

The planning of the project with a sample Gantt chart is given below:



Figure 3. Timeline Gantt Chart.

Chapter 7 Complex Engineering Problems and Activities

7.1 UNDP SDGs

This project follows some UNDP SDGs such as:

From this perspective, the “NetBpm” project correlates with several UNSDGs mainly those that concern health, wellbeing and responsible consumption and production sector and innovation. Here’s how it connects with key UNDP SDGs:

1. SDG 3: Good Health and Well-being

Target 3.4: The project also keeps track of heart rate and oxygen levels; through that, it can help users, especially gamers, learn about their health conditions better. ‘NetBpm,’ in essence, supplies genuine time input, which prolongs human’s ability to make rational decisions about gaming sparing the user stress and burnout.

Target 3.8: ‘NetBpm’ also supports the general approach of health orientation, providing an opportunity to track physiological activity without expensive equipment. In doing so, it becomes possible to extend the number of people who can learn about such insights within games.

2. SDG 9: Industry, Innovation: and Infrastructure

Target 9.5: Offering the convergence of health monitoring technologies applied to the wearable technology and greatly significant and rapidly growing gaming industry, “NetBpm” advances the growth of the health technology sector and strengthens interconnection between technology, health, and gaming industries.

Target 9.B: The project fosters the creation of research, development and testing by users meaning that local capacity to enable technological progress is developed. This pertains to open source approaches to application platforms (including Blynk) and affordable hardware components fostering the emergence of a more diverse and progressive tech ecosystem.

3. SDG 12: Care for the Planet

Target 12.5: On the subject of e-waste, the project meets this challenge by adopting a modular design that promotes extended lifespan of the gadgets through modify instead of replacing them. This approach fosters proper production and enhances the sustainability of using those electronic devices.

Target 12.8: To teach people about the effects of using devices disturbing the environment, the service, “NetBpm” helps inform the gaming community on the principles of sustainable consumption and methods of being mindful of their consumption of energy with their devices.

UNDP SDG’s that my project follows:

Table III. UNDP SDGs

UNDP SDG Number	UNDP SDG Name
03	Good Health and Well-being
09	Industry, Innovation, and Infrastructure
12	Responsible Consumption and Production

7.2 Complex Engineering Problems (CEP)

My project follows these complex engineering problems. They are:

2. Conflicting Technical and Non-Technical Requirements (CEP-2)

There is a tension between the needs of the users and the technical requirements within NetBpm: it's a technical issue as "NetBpm" must provide quantitative up-to-date reliable data without it having a detrimental effect on battery power. Non-technical considerations involve user privacy; the device collects and keeps close, personal information and convincing users to educate them over how the device will help monitor their health, not replacing critical tools such as CPAP machines.

5. Involves Uncertain and Evolving Data (CEP-5)

An element of variability is introduced as physiological measurement during gaming entails stress levels, concentration levels, and physical activity level amongst others. Moreover, the requirement to conduct the user test and the process of developing the project based on the feedback means the ability of the project to respond to the changing demands for accuracy, usability and reliability.

6. Need for Innovative Problem-Solving (CEP-6)

The project utilizes novel approaches including the monitoring of the system in real-time with low power hardware and the Blynk interface for real time data feedback. Such innovations make "NetBpm" a unique tool for integration of health monitoring with gaming and it is designing of such a system, when technical and user requirements and limitations have to merged in very creative ways.

Complex Engineering Problem Attributes that my project follows:

Table IV. Complex Engineering Problem Attributes

Attributes		Addressing the complex engineering problems (P) in the project
P2	Conflicting Technical and Non-Technical Requirements (CEP-2)	There is a tension between the needs of the users and the technical requirements within NetBpm: it's a technical issue as "NetBpm" must provide quantitative up-to-date reliable data without it having a detrimental effect on battery power. Non-technical considerations involve user privacy; the device collects and keeps close, personal information and convincing users to educate them over how the device will help monitor their health, not replacing critical tools such as CPAP machines.
P5	Involves Uncertain and Evolving Data (CEP-5)	An element of variability is introduced as physiological measurement during gaming entails stress levels, concentration levels, and physical activity level amongst others. Moreover, the requirement to conduct the user test and the process of developing the project based on the feedback means the ability of the project to respond to the changing demands for accuracy, usability and reliability.
P6	Need for Innovative Problem-Solving (CEP-6)	The project utilizes novel approaches including the monitoring of the system in real-time with low power hardware and the Blynk interface for real time data feedback. Such innovations make "NetBpm" a unique tool for integration of health monitoring with gaming and it is designing of such a system, when technical and user requirements and limitations have to merged in very creative ways.

7.3 Complex Engineering Activities (CEA)

My project follows three complex engineering activities. They are:

1. Broad Context and Impact (CEA-1)

The given project is also aimed at the solution of the problem connected with health monitoring within the framework of gaming which in turn implies stress or over-exertion that can harm physical and/ or psychological health. Since the data transfer of NetBpm is in real time with reference to the heart rate and SpO2, the beneficiaries of this invention are a number of gamers who will be sensitized regarding health concerns in gaming. Moreover, its design features like modularity and energy efficiency in its design addresses the social implication of the electronic devices.

2. High Level of Stakeholder Involvement (CEA-2)

NetBpm is defined as a gaming site that needs inputs from the gamers, software developers, hardware engineers, and health professionals. Such people offer a perspective of the needs of the target user, the degree of precision they would like in the data, and health concerns that must inform the project's development and operation. Opinion collected from different user testing is also instrumental in enhancing the device to meet the need of the real world as well.

6. High Level of Coordination (CEA-6)

It implies that the coordination of hardware and software development subprojects is necessary to guarantee tightly coupled interfaces between the pieces. This also includes making sure that the effort to calibrate the sensors, connecting to Wi-Fi, transmitting data, and making the mobile application through Blynk works harmoniously in giving the users the best experience.

Complex Engineering Problem Activities that my project follows:

Table V. Complex Engineering Problem Activities

Attributes		Addressing the complex engineering activities (A) in the project
A1	Broad Context and Impact (CEA-1)	The given project is also aimed at the solution of the problem connected with health monitoring within the framework of gaming which in turn implies stress or over-exertion that can harm physical and/ or psychological health. Since the data transfer of NetBpm is in real time with reference to the heart rate and SpO2, the beneficiaries of this invention are a number of gamers who will be sensitized regarding health concerns in gaming. Moreover, its design features like modularity and energy efficiency in its design addresses the social implication of the electronic devices.
A2	High Level of Stakeholder Involvement (CEA-2)	NetBpm is defined as a gaming site that needs inputs from the gamers, software developers, hardware engineers, and health professionals. Such people offer a perspective of the needs of the target user, the degree of precision they would like in the data, and health concerns that must inform the

		<p>project's development and operation. Opinion collected from different user testing is also instrumental in enhancing the device to meet the need of the real world as well.</p>
A6	<p>High Level of Coordination (CEA-6)</p>	<p>It implies that the coordination of hardware and software development subprojects is necessary to guarantee tightly coupled interfaces between the pieces. This also includes making sure that the effort to calibrate the sensors, connecting to Wi-Fi, transmitting data, and making the mobile application through Blynk works harmoniously in giving the users the best experience.</p>

Chapter 8 Conclusions

8.1 Summary

NetBpm is the device that helps to track the heart rate and the oxygen level of the competitive gamers in the process of the game by using the ESP8266 microcontroller and MAX30100 sensor. Thus, by sending the data through the Blynk platform it allows the gamers and trainers to monitor the vitals and allow for better performance as well as avoiding health issues such as stress or fatigue during the gameplay.

The goal of the project is to make working, gaming and living healthy in the esports industry and to detect their health issues. This is the lore behind “NetBpm”, which is in a quest of achieving a befitting fame in the areas of esports by counterpointing physical fitness to this kind of game and also configuring a gamer for a long run.

8.2 Limitations

As compared with “NetBpm”, this approach has some limitations. First, the accuracy of the measurements of occupancy and the rate of heart frequency as well as oxygen saturation depends on the correct positioning of the MAX30100 sensor that may be violated during aggressive gaming sessions. This may cause inequalities in the resulting readings particularly during fast or randomly moving objects.

Second, due to the fact that communication with the Wi-Fi through the ESP8266 module is possible only via the connection to the available Wi-Fi networks, one might experience such problems as temporary loss of the connection in case of instable Wi-Fi signal. This might disrupt normal data flow thus affecting monitoring in realtime.

One of the shortcomings is the fact that the device under consideration measures only two physiological parameters, namely heart rate and oxygen saturation. Lacking more elaborate health parameters such as the person’s stress level, for example, through the heart rate variability or cortisol, it cannot be fully utilised.

Finally, what should be pointed out is the fact that, as will be recalled, NetBpm is primarily aimed at the competitive gamers, which may rather diminish its relevance for the more casual gamer or in non-gaming settings. Enlarging its use may extend how useful it could become even further.

8.3 Future Improvement

Beneath are the several improvement that can be made to 'NetBpm', to improve on its operational capacity and its fields of application. First, expansion of the number of sensors, for instance, to include an EDA sensor for the stress level or a temperature sensor for body temperature, could give users a fuller assessment of their health. This would enable gamers and trainers to monitor other physiological parameters to the players extending the analysis of their welfare.

The second area where UI needs to be refined over time is managing the data accuracy during the most active movements of the game. Reducing the effects of noise from the motions can be done using superior algorithms that will give more accurate readings. However, including Bluetooth Low Energy which is a wireless protocol as an option to Wi-Fi could reduce possible problems in unstable network environments.

The additional enhancement would be adding the artificial intelligence analyzing the trends for the given user into Blynk application; this can suggest further actions based on analyzed data. It could be of help for the gamers to improve their productivity and work on recovery and stress minimization.

Finally, if the creators of "NetBpm" extend it to other fields apart from video games especially those that require high intensity exercises like professional players or people working from home then the device's market and reach increases.

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Here are 20 references in APA 7th edition style. Since I don't have specific sources related to "NetBpm," these references are based on common sources related to IoT, health monitoring, gaming, and technology. You can replace them with actual sources as needed.

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These references are structured according to APA 7th edition guidelines. Please replace or adapt these sources with actual project-related references.