|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Software Requirement Specifications**  Drone Navigation Using Brain Computer Interface (BCI)  Version: 1.0   |  |  | | --- | --- | | Project Code | 19S-16 | | Supervisor | Dr. Ahsanullah Abro | | Co-Supervisor | Dr. Ahmed Ali Shah | | Project Manager | Muhammad Raheal Safdar | | Project Team | Naneeta  Madiha | | Submission Date | 20th September 2022 | |

Document History

|  |  |  |  |
| --- | --- | --- | --- |
| **Version** | **Name of Person** | **Date** | **Description of change** |
| 0.1 | Muhammad Raheal Safdar | 10-08-2022 | Document Created |
| 0.2 | Naneeta | 16-08-2022 | Added Non-functional requirements |
| 0.3 | Madiha | 02-09-2022 | Added Functional Requirements |
| 0.4 | Muhammad Raheal Safdar | 15-09-2022 | Added External Interface  Requirements |
| 0.5 | Muhammad Raheal Safdar | 20-09-2022 | Review the whole document |
|  |  |  |  |
|  |  |  |  |

Distribution List

|  |  |  |
| --- | --- | --- |
| **Name** | **Role** | |
| Dr. Ahsanullah Abro | | Supervisor |
| Dr. Ahmed Ali Shah | | Co-Supervisor |
| Muhammad Raheal Safdar | | Project Lead |
| Naneeta | | Project Member |
| Madiha | | Project Member |
| Mam Faryal Shamsi | | Evaluation Committee Lead |
| Sir Saif Hassan | | Evaluation Committee Member |

Document Sign-Off

|  |  |  |  |
| --- | --- | --- | --- |
| **Version** | **Sign-off Authority** | **Project Role** | **Sign-off Date** |
| 0.1 | Muhammad Raheal Safdar | Project Lead | 10-08-2022 |
| 0.2 | Muhammad Raheal Safdar | Project Lead | 16-08-2022 |
| 0.3 | Muhammad Raheal Safdar | Project Lead | 02-09-2022 |
| 0.4 | Muhammad Raheal Safdar | Project Lead | 15-09-2022 |
| 0.5 | Muhammad Raheal Safdar | Project Lead | 20-09-2022 |
| 0.6 | Dr. Ahsanullah Abro | Supervisor | 22-09-2022 |

**Table of Contents**

[1. Introduction 6](#_Toc114612701)

[1.1. Purpose of Document 6](#_Toc114612702)

[1.2. Intended Audience 6](#_Toc114612703)

[1.3. Document Convention 6](#_Toc114612704)

[2. Overall System Description 7](#_Toc114612705)

[2.1. Project Background 7](#_Toc114612706)

[2.2. Project Objectives 7](#_Toc114612707)

[2.3. Stakeholders 7](#_Toc114612708)

[2.4. Operating Environment 7](#_Toc114612709)

[2.5. System Constraints 7](#_Toc114612710)

[2.6. Assumptions & Dependencies 8](#_Toc114612711)

[3. External Interface Requirements 9](#_Toc114612712)

[3.1. Hardware Interfaces 9](#_Toc114612713)

[3.2. Software Interfaces 9](#_Toc114612714)

[3.3. Communications Interfaces 9](#_Toc114612715)

[4. Functional Requirements 10](#_Toc114612716)

[4.1. Functional Hierarchy 10](#_Toc114612717)

[4.2. Use Cases 11](#_Toc114612718)

[4.2.1. Drone Navigation with OpenBCI 11](#_Toc114612719)

[5. Non-functional Requirements 12](#_Toc114612720)

[5.1. Performance Requirements 12](#_Toc114612721)

[5.2. Safety Requirements 12](#_Toc114612722)

[5.3. Security Requirements 12](#_Toc114612723)

[5.4. User Documentation 12](#_Toc114612724)

1. Introduction

* 1. Purpose of Document

The document is developed to go deep inside the requirements of the project. When we talk about software development, Software Requirement Specification (SRS) is the document on which our whole software depends upon. Simply, we can say this as the base of entire project. SRS is the detailed description of the system to be developed. This document includes functional and non-functional requirements of the system being developed. SRS help developers to reduce time and cost to achieve desired goals for a particular software system. An SRS defines how a system software will interact with system hardware, with other software programs and with humans in different varying real-life situations. The main purpose of this document is to define each possible functional and non-functional requirements of the project “Drone Navigation Using Brain Computer Interface (BCI)”. Using this SRS, we can develop our system later on, to meet the desired system goal. This document will also help to reduce time and effort for the development of the project.

* 1. Intended Audience

The development team, supervisor and evaluation committee of the project Drone Navigation Using Brain Computer Interface (BCI) will use this document. This document would also be helpful for testers and any evaluators to quickly understand the requirements of the system. The supervisor and FYP evaluation committee will use SRS document to test and verify the system requirements. If this project is deployed as a product, then this document will be a detailed description of system and will help them to understand the entire system being developed.

* 1. Document Convention

This document will be using Times New Roman fonts and font size 12pt for text and 14pt for sub-headings and 18pt for headings.

1. Overall System Description
   1. Project Background

As per the year 2011, World Health Organization (WHO) global report on disability says that one out of every five individuals on the planet Earth is disabled. This worldwide estimate is rising due to the aged people and the rapid spread of deadly disease. They do not have the capability of moving their muscles or cannot move anywhere they want. They have significant obstacles in modern society because of their limits and disability to perform basic activities such as playing games with others or conversing with the people. The proposed BCI will provide a new horizon for drone navigation. People may control a drone with their minds alone, and will require less physical action.

* 1. Project Objectives

The main goal of our project is to design and develop BCI system that will:

1. Establish one-way communication from brain signals to desktop application running on our laptop.
2. Open up the communication between the desktop application and the Drone.
3. Control drone navigation in 3D space.
   1. Stakeholders

The stakeholder of the system is Sukkur IBA University Management.

* 1. Operating Environment

This software will run on Windows operating system 8+. Any version of windows later than 8 is needed to use this app. The whole backend will depend on Machine learning model that will be called for each respective signal. The desktop application will be developed in Visual Studio using C# and machine-learning model will back up overall project.

* 1. System Constraints
* **Software constraints**

1. Operating System of laptop or PC can terminate software due to any failure.
2. Devices (headset and drone) are needed to be in range for interacting with the system from laptop or PC.

* **Hardware constraints**

1. Devices should have fully charged and working properly.

* **Cultural constraints**

1. User should be trained on how to focus to be able to generate specific brain thought like left or right direction.

* **Environmental constraints**

1. The system is safe to fly indoors and outdoors but it is only recommended to do so in windless conditions.

* **User constraints**

1. The users or stakeholders will be provided proper training for using the system.

For Example, how to wear headset, how to sit to control the drone etc.

* 1. Assumptions & Dependencies

Following are the assumptions & dependencies of our system:

1. User should have properly placed headset over their head.

2 The connection of headset and the laptop or PC is established using the Bluetooth dongle.

3. The connection between the application and the drone is established.

1. External Interface Requirements
   1. Hardware Interfaces

The system will use the following Hardware interfaces:

1. OpenBCI Headset

2. Tello EDU Drone

* 1. Software Interfaces

The desktop application will act as an intermediate between the OpenBCI headset and the Tello EDU drone. The application will access the human brain signals from the OpenBCI open-source software running on the laptop or PC. Those signals are acquired using the Bluetooth dongle connected to that laptop or PC. The signals acquired through open-BCI GUI will be transferred to C# application which then at the backend uses ML model t classify signal. The application then sends the signal output to the Tello EDU drone using the Wi-Fi with the help of integrated circuit of the drone.

* 1. Communications Interfaces

The whole communication process takes place using two different technologies. The first technology is used for the communication of the headset to the laptop or PC and this technology is known as Bluetooth while the second technology that we are going to use is the Wi-Fi. It will be used to communicate with drone to control its navigation.

1. Functional Requirements
   1. Functional Hierarchy
2. User will wear the Open BCI headset.
3. Turn on the OpenBCI cyton board.
4. OpenBCI GUI should be connected with the headset through USB dongle.
5. Drone setup will be done like turning it on and other required settings for the drone to fly smoothly.
6. User will think of take-off command for the drone to start flying (for the next command user may think of any of the five remaining commands/directions).
7. Signal acquisition from scalp through OpenBCI headset.
8. Signal will be routed to computer via Bluetooth.
9. Signal preprocessing.
10. Signal classification via ML model (at backend in Python).
11. Command generation for drone from received classified signal (at backend).
12. Generated command will be routed to drone via Wi-Fi.
13. Drone will start navigating in the desired direction.
    1. Use Cases
       1. Drone Navigation with OpenBCI

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **TEST CASE OF PROJECT** | | | | |
| Drone Navigation with OpenBCI | | | | |
| **Test case Id:** | | 01 | | |
| **Actors**: Primary Users: Drone Controller (who has worn the headset) | | | | |
| **Feature:** System allows drone controller (user) to think of any six commands/directions to navigate the drone i.e., take-off (up), right, left, forward, backward, land (down). However, first direction input must be of take-off. | | | | |
| **Pre-condition:** | | OpenBCI headset must be connected with the OpenBCI GUI, Wi-Fi and Bluetooth must be available, Tello EDU drone must be switched on. | | |
| **Scenarios** | | | | |
| **Step#** | **Action** | | | **BCI System Reaction** |
| **1.** | User thinks of any of the six directions. | | | Drone will navigate to that direction. |
| **Alternate Scenarios:** | | | | |
| **1a:** Drone will not be navigating correctly due to misclassification of the direction from ML model, the user will think again of the previous direction until the drone is navigated to the desired direction.  **2a:** Drone will not be navigating due to some system or hardware error or Wi-Fi unavailability, after the error removal, the user will think again of the previous direction. | | | | |
| **Post Conditions** | | | | |
| **Step#** | **Description** | | | |
| **1.** | Drone has successfully navigated to the specified direction that user had thought of. | | | |
| **Test Case Cross referenced** | | | NA | |

1. Non-functional Requirements
   1. Performance Requirements

System will perform efficiently in indoors and outdoors and its response time depends on the speed of Wi-Fi of drone and its range.

* 1. Safety Requirements

User wearing headset needs to be concentrated all the time because thought diversion may result in the crash of drone.

* 1. Security Requirements

Not applicable.

* 1. User Documentation

User manual will be provided for understanding the usage of the system.