brain controlled drone

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Project leader	
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Inhalt

1.~~0~~ Introduction

The drone market is expanding continuously with an immense speed. There is a wide ranged variety of devices, supplying different features and therefore coming with a tremendous price range. But all that left aside, they all have something in common: They are controlled either by an extern controller or a smartphone. That is where Brone will take the next step, controlling our drone using solely one's brain and muscles. This opens up a new application area. The user is able to control the device while his or her arms are free. As a result, even people how are entirely paralyzed are offered the possibility to train their motor imagination.

2.0 Initial Situation

In the past few years the drone market experienced a rapid boom. Years ago, when drones where still in the fledgling state, high prices and non-matured technical features scared the consumers away. But over the years a lot of manufacturers entered the market. The competition between the companies resulted in a tremendous price drop and increased performance for their devices. At this point in time, semi-professional drones are affordable for most consumers as well as of high-grade quality. That's where we want to take the next step. Brone leaves aside the ordinary way of controlling a drone. We are using the Brain's electric impulses to make the drone move according to simple muscle movements or even the mere thought about moving the corresponding body parts. The matching technology is currently used in stroke rehabilitation therapy. The Company g.tec - which has been working on brain computer interface related soft- and hardware for a long time - supports us in realizing the project by providing us with the devices essential for the development as well as their far-reaching know-how.

3.0 General Conditions & Constraints

The proposed system has to the deal with the following constraints:

• The GUI must be intuitive and easy to use, even for people who are not that accustomed to modern devices.

• At launch, the app is supposed to support the languages English and German.

• Efficient use of hardware resources is required. Taking into consideration that the app runs on android, we are facing a huge variety of devices with different hardware specifications. Primarily we have to put focus on the data acquiring and classifying process since these two will need the most resources.

• Due to the variety of hardware the application should obviously support as many Android Versions as possible. Looking at the ratio of the technical features provided to the devices that are supported (~50%) Android Version 4.4 seems to be the best choice. 50% might not sound like that much, but lower versions mean less features and a worse user experience for modern devices. Also devices with Android Versions lower than 4.0 probably won't have sufficing hardware to begin with.

• The project's deadline is the end of the second term (summer 2017). By the end of that given time period, the project should be ready for release. Furthermore, the last month before the deadline should be primarily used for the final touch.

• The variety of different hardware we are going to use (gNautilus, Unicorn, Wifi Drone) must be handled properly, which means a clean and structured error Handling concerning unexpected disconnects, low batteries etc. is indispensable.

4.0 System Concept

- Stable connection tablet-nautilus
- Stable connection tablet-drone
- Different control types
    - Face muscles
    - Motor imaginary
    - Head moves
- Live video preview
- Fly log (route, duration etc.…)
- EEG plot

4.1 Overview

The Point **System Concept** is structured into the 4 paragraphs below. In these we'll show the general concepts of our features.

4.2 Video live stream

Since our application supports drones with built-in cameras, we have the possibility to give the user some information about his current position using a video live stream. The main advantage of an on-board camera is that it avoids confusion regarding the current drone's flying direction. Another nice feature is that we can save some videos or pictures and add them to the flight log.

4.3 Flight Log

The flight log keeps a record of all passed flight-sessions including the flight duration, images, videos and the covered track. Furthermore, the flight log serves as a useful tool to analyze flights and keep an eye on the drone's status. For example, we have the opportunity to monitor the battery's abrasion by checking the recorded battery information. Doing so, we are able to make more accurate forecasts concerning the remaining fly-time during a session.

4.4 EEG Plot

To get a good classification the nautilus electrodes need good scalp contact. To check if this is the case, we provide an EEG plot which plots the data in real-time. First, we will use an extern open-source library for plotting the data. If we have time at the end of our project we will add our own implemented plot.

4.4 Control types

We are going to provide different kind of control possibilities to find the best solution for every user. The methods contain a range of muscles which can be used for interacting with the drone. The following paragraphs will present the different possibilities we will provide.

4.4.1 Control type: face muscles

Muscle Movement	Drone Movement
Moving eyebrows up or down	Altering Altitude (Going up/down)
Moving lips left or right	Turn left/right (Rotation on z-axis)
Pressing together jaws	Flying along faced Direction

This control type concentrates on the use of the face muscles. The drone's movement is controlled as follows:

- By moving the eyebrows up and down the user is able to alter the drone's altitude.
- By moving the lips left or right, the user can rotate the drone along the z-axis, thus changing the faced direction
- To fly towards the faced Direction, the user has to press his or her jaws together

4.4.2 Control type: head movements

Muscle Movement	Drone Movement
Tilting head on sideways (Rotation on x-axis)	Tilting Drone on x-axis
Rotate head on z-axis	Turn left/right (Rotation on z-axis)
Tilting head back and forth (Rotation on y-axis)	Turning on y-axis
Moving eyebrows up or down	Altering Altitude (Going up/down)

This control type concentrates on the use of the neck and face muscles. The drone's movement is controlled as follows:

• To tilt the drone sideways (rotating it on the x-axis) - thus resulting in the drone moving left or right - one has to move the head left or right on the x-axis as well.

• To rotate the drone on its z-axis the user also has to rotate his or her head on that axis.

• To rotate the drone on its y-axis, the user has to move his or her head back or forth on the y-axis as well.

• By moving the eyebrows up and down the user is able to alter the drone's altitude.

4.4.3 Control type: motor imaginary

The concept of motor imaginary drone control slightly differs from the other to control types. While the preceding two methods used actual muscle movement to control the drone, using the motor imaginary control type the user only thinks of moving specific body parts – obviously without actually doing so.

On one hand that opens up various possibilities – especially for handicapped people - but on the other hand controlling the drone by just thinking about certain movements requires quite a bit of training and as a result is not as precise when used by inexperienced users.

4.4.4 Control type: Individual movement

We are going to provide a feature which allows the user to define personal control patterns. He or She is able to combine the different control types, like using parts of **head movement** and parts **of face muscles** at the same time. This function will make the application more flexible and fitted to the user.

5.0 Opportunities & Risks

Chiefly our target group consists of people who want to try something new and are interested in flying drones. In view of that we can assume the average age of our targeted users to be 14+ years. Also we want to try to immerse as many people as possible into the world of drones.

Our collaboration with G-Tec – a company specialized on 'Brain Computer Interface' related Soft- and Hardware – opens up several opportunities and advantages such as the following:

- We are allowed to use very expensive hardware and software that's crucial for the development.
- Furthermore, we have the possibility to inquire after possible Solutions for the occurring problems we have using their libraries, devices and such, and as a result learn many things from the company's developers.
- The whole project is 'pre-structured' and organized by the company. Therefore, the Development Process is way less complicated to begin with.

Since Brone can increase the brain function – offering a great opportunity for people with a mental disability – it is way more than an ordinary gimmick. Furthermore, the app makes flying a drone become possible for people suffering from various kinds of paralysis or physical disabilities.

6.0 Planning

6.1 Milestones

1st Semester

[06.12.2016] – Stable Connection with Nautilus-Device

- No crashes when disconnected unexpectedly
- No crashes when device is not connected properly
- No crashes when device is not connected to headset

[20.12.2016] – Establish connection with Drone, testing library features

- supported by the Parrot Library

[17.01.2017] – General app layout

2nd Semester

[20.02.2017] – process nautilus data

- filter, classify

- supported by the company g.tec

[21.03.2017] – First control mode finished

[04.04.2017] – Video live stream [4.2]

[09.05.2017] – EEG Plot [4.4]

[20.06.2017] – Flight log [4.3]

3rd Semester

[01.12.2017] – Bug fixing, release