Mind Controlled Quadcopter

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Abstract –*We humans are always looking for new ways to communicate with our environment. For example, through touch, through speech, through gestures. It is for the first time that it is possible in human history to communicate directly using our brain. This technology is called EEG or electroencephalography. Here we are able to map the human brain activity and it can be used to communicate with technology around us. To make use of this technology to the fullest we controlled a quadcopter using this our brain, it was made possible by this bleeding edge technology.*

Key Words: EEG, Quadcopter, brain activity, flight controller, BLDC motor.

1.INTRODUCTION

According to forecasts, the emerging global market for business services using drones is valued at over $127B. As more commercial businesses aim at growing market the investment by major companies and venture capitalists continues to grow. Quadcopters and drones are used in any place which poses danger to human life. They are generally controlled using remotes however, using our design they can be controlled by mere though which is much more intuitive to human brain and precise.

We made the drone from scratch. The design and calculations of force and weight for the drone were done. The other half of the project was the mind activity sensor. We chose the sensor carefully and with a lot of thought behind it. Sensing technique, practicality and affordability were all considered, after a lot of thought we landed on Mindwave Mobile 2 sensor. This sensor maps mind activity using EEG technology. The data from the sensor can be used by the developer to impale different activities that we desire. The drone will ascend and descend according to the user's wish just using his mind.

Many more generalized and applications are now possible, thanks to the latest technological advances made in this field. It is now possible for people to make use of this technology in day-to-day lives and it is possible for us to make new devices using this technology to cater for various customer needs.

2. LITERATURE SURVEY

History of EEG

Although the electrical impulses of mammalian brains were not observed until the late 1800s, you could say that EEG got its start in the 1700s. It was then that Italian biologist Luigi Galvani noticed a dissected frog's legs appeared to come to life when electricity was applied to its muscles. He first theorized that electrical currents cause muscles to contract.

Nearly a century later, English scientist Richard Caton used electrodes to record electrical signals in the brains of various animals, including cats and monkeys. Since his method required the brain to be exposed, he could not experiment on humans. Although his measuring device was rudimentary (not to mention painfully invasive) by today's standards, he was the first to record differences in EEG signals which were associated with sleep, alertness, sedation, and death.

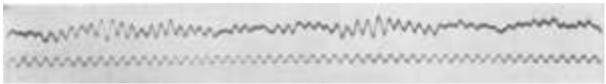

Fig -1: EEG Waveform

In 1924, German psychiatrist Hans Berger became the first researcher to record a human EEG. His subject was a 17-year-old boy who already had a hole drilled in his skull in order to treat a suspected tumor. Following this experiment, he devised methods of recording the electrical signals without drilling holes in anyone's head—he used non-invasive electrodes attached to his son's scalp, and tried silver needles on himself. Berger's work was either ignored or` ridiculed by his peers until 1934, when a pair of British electrophysiologists confirmed his findings, and Berger became widely known as the father of EEG.

Modern EEG Applications

Medical Uses of EEG

EEG testing is used to diagnose and evaluate various neurological conditions, such as epilepsy. The monitoring of a patient's brain waves can give their doctor insight into any abnormalities in brain function. Other conditions

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which may be tested for using EEG include Alzheimer's disease.

Fig -2: EEG practical

EEG is also used to monitor brain activity when a patient is in a coma. If the coma is natural and the patient is on complete life support, EEG can detect brain death. If a patient is in a medically induced coma, EEG is used to determine the appropriate amount of sedation needed to keep the patient in the coma.

If extensive brain damage is suspected due to physical trauma, drug abuse, or any other factor, EEG testing can help determine the actual extent of the damage.

EEG cannot measure the performance of the brain beyond its electrical activity, and cannot be used to determine intelligence or to diagnose most mental health conditions (with the exception of certain kinds of psychoses which affect electrical activity in the brain).

Modern EEG tests, unlike the invasive procedures of the 18th and 19th centuries, are completely painless and safe. No electricity is actually administered to the patient—it is simply measured.

EEG Technology and Research

EEG technology enables research in a variety of fields, from medicine to marketing. Recent research into sports-related concussions has used EEG testing to determine the short- and long-term results of sustaining multiple concussions or other head traumas. EEG has also played an important role in recent sleep studies, helping researchers learn the true effects of various lengths and qualities of sleep on the human brain.

EEG testing is also being used in advertising. Researchers who observe eye movement, facial expressions, and brain waves to determine the effectiveness of various pieces of media are pioneering a field called neuromarketing, which seeks to use biometrics to better the odds of advertising success in a world already oversaturated by media.

These are just a few examples of new and growing fields of research enabled by EEG technology—the measuring of human engagement and brain activity has nearly universal applications.

EEG-Enabled Communication Devices

Most people are familiar with the story of theoretical physicist Stephen Hawking, who lost the ability to speak after gradually becoming paralyzed due to ALS. His speech deteriorated rapidly in the late 70s, at which point he required a translator of sorts to communicate clearly with others. In the 80s, a serious bout of pneumonia necessitated a tracheotomy, which rendered him completely unable to speak.

Fig -3: Stephen Hawking using EEG

Hawking used a computer program to help him speak for several years, which was fairly high-tech for the late 1980s and early 90s. In 2005 he began using a program which allowed him to communicate via computer using only the movement of his cheek muscles, and in 2012 he began experimenting with brainwave-powered communication devices.

A communication device powered by brain activity alone would restore speech to patients even with complete paralysis. The technology has yet to be perfected, but new research is promising, and may one day lead to perfect technology-enabled communication for patients with ALS and other degenerative illnesses.

NeuroSky's MindWave Mobile 2 Headset

We're passionate about the development of new EEG-enabled technologies—that's why we engineer biosensors which are both affordable and easy to use.

The MindWave Mobile 2 EEG Headset is accessible to start-up game devas and advanced researchers alike, and provides data which is precise enough for either application (and any application in between).

Fig -4: Neurosky Headset

The MindWave Mobile 2 safely measures EEG power spectrums, NeuroSky eSense meters (mediation and attention), and eye blinks. MindWave Mobile 2 physically consists of a headset, a sensor arm, and an ear clip. The headset's reference and ground electrodes are located on the ear clip, and the EEG electrode is on the sensor arm where it rests on the forehead just above the eye (FP1 position). It is powered by a single AAA battery, which provides 8 hours of battery life. [1]

How Quadcopters Fly

Here are some important concepts that we need to define – pitch, yaw and roll. These terms refer to the three dimensions that an aircraft in flight is free to move it.

Pitch – Pitch refers to the nose of the aircraft going up or down. You could think of it as climbing or diving

Yaw – Yaw on the other hand refers to the nose of the aircraft turning left or right. You could simply think of this as turning.

Roll – To understand roll think of an axis running from the front to the back of the aircraft. When an aircraft rolls it is turning on this access. You can also think of roll as a tilt.

Quadcopters make use of 4 Motors. Two of these motor spins clockwise while the other two spin counter clockwise.[2]

3. METHODOLOGY

The system uses Mindwave mobile 2 as its main sensor to map brain activity and provide data to the microcontroller.

Microcontroller used is Arduino nano V3.0. The microcontroller has two functions, to take input from the sensor and give mapped output to the quadcopter. Microcontroller is responsible for varying speed and direction.

To establish Bluetooth communication between Mindwave and Arduino we used HC-05 Bluetooth module.

To establish RF communication between the transmitter and receiver module of the quadcopter we used nRF24L01 RF communication module.

To have safe and stable flight patterns, we used KK 2.1.5 flight controller module.

For the quadcopter we used a 250 mm quadcopter frame fiber, 2300kV BLDC motors, Blheli ESCs, Lithium polymer battery and fiber propellers.

3.1 MICROCONTROLLER

Arduino nano V3 is a compact, compatible, flexible and breadboard friendly microcontroller board, developed by Arduino.cc in Italy, based on ATmega328p. Arduino nano pinout contains 14 digital, 8 analog, 2 reset and 6 power pins. Each of the digital and analog pins have multiple functionalities but its main function is as input or output pin. Analog pins have a 10-bit resolution which measures voltage from 0 to5 V. Its tiny size and compatibility make it a popular choice for robotics projects.

Fig -5: Mindwave mobile 2

3.2 SENSOR

The Mindwave mobile 2 sensor is an EEG headset based on patented technology and using a proprietary processor

TGAM. It has a BLE module which makes it bluetooth compatible. The Mindwave has 3 leads that are used by the inbuilt processor to map brain activity and the results can be sent to another bluetooth compatible device. It is easy to use and connect as well as being reasonably priced.

3.3 COMMUNICATION MODULES

3.3.1 HC-05 BLUETOOTH MODULE

Mindwave mobile 2 headset has only Bluetooth support. It supports Bluetooth 2.0 and BLE (Bluetooth Low Energy)4.0. HC 05 works using Bluetooth 2.0, and so we use HC 05 to communicate with Mindwave. It takes data from the sensor and gives data to the microcontroller.

Fig -6: HC-05 module

3.3.1 nRF24L01 RF MODULE

For long distance, reliable RF connection between quadcopter's receiver and transmitter, we use nRF24L01 module to establish RF link. It has a range of 1km and is compatible with the microcontroller hence, we chose this module.

Fig -7: nRF24L01 module

3.4 QUADCOPTER

3.4.1 QUADCOPTER FRAME

The frame size of a quadcopter is specified in millimetres, this is the distance between the motors on your quad. Common sizes are 180, 250 and 400 millimetres. Our quadcopter is of the 250-millimetre variety.

Fig -8: Quadcopter frame

3.4.2 BR2205 2300KV BLDC MOTOR

As a general rule of thumb quadcopters that weigh more than 1 kilogram will use a motor in the range of 700 to 900 KV. Copters that weigh between a half and 1-kilogram use motors rated between 900 and 1300 KV. Craft under 500 grams make use of motors between 1300 and 2200 KV. The motor and propeller combination should be able to generate twice the weight of the craft in thrust. So, with a quadcopter having four Motors this means that each individual motor should be able to provide thrust equal to half the weight of the entire quadcopter. In other words, a 1-kilogram quadcopter requires four motors, each capable of at least half a kilogram of thrust.[2]

Fig -9: BLDC motors

3.4.3 KK 2.1.5 FLIGHT CONTROLLER

The Flight Controller is the brains of your quadcopter. This is the device that controls the speed of your motors by sending signals to your ESCs. The flight controller will accept the signals from the onboard radio receiver so that you can control your quadcopter remotely. It then does its magic and sends signals to the ESC's to control the motor speeds. We used KK 2.1.5 flight controller for our quadcopter, it is cheap, is very fast and has many features.

Fig -10: KK 2.1.5 flight controller

3.4.4 RS30A 30A Blheli ESCs

The device that controls the Brushless DC motors is called an Electronic Speed Controller or ESC. You need one for each motor. The ESC will have three sets of wires. There are three heavy-gauge wires that connect to the three wires on your brushless motor. Two other heavy-gauge wires connect to your power distribution board, this supplies voltage to the ESC and motors. There will also be three smaller wires that connect to your flight controller.

BLDC motors at peak speed require around 20A current. Hence, we are using ESCs having a rating of 30A to for safety factor of 10A.

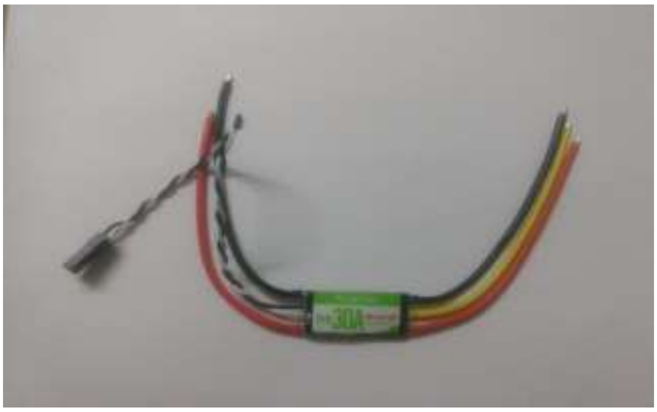

Fig -11: ESC

3.4.5 3S 35C 4000mAH LIPO BATTERY

Without a battery your quadcopter isn't going anywhere. The selection of the battery is one of the most important decisions you will make when designing and building your quadcopter. Larger batteries will have larger capacities and will therefore allow for a longer flight time. However, as the capacity of the battery goes up so does its weight, and adding weight to your quadcopter will reduce the flight time as more current will be required from your motors to lift the payload. Bear in mind that a heavier quadcopter is also less agile. ESC and motors are capable of supporting that voltage.[2] The motor requires minimum 3A supply. One motor at peak speed takes approximately 20A current, so 4 motors will require 80 Amp current at peak speed. The remaining systems takes approximately 1 Amp current. Hence for the selected battery, maximum current that our battery can provide is (35*4) Amp, i.e. 157.5 Amp.

Fig -12: LIPO Battery

3.5 SYSTEM DESIGN

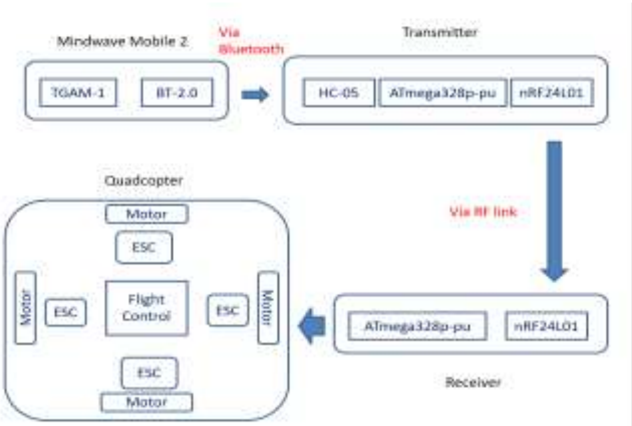

Fig -13: Block diagram

4. RESULTS

The drone took a lot of work for it to be able to have a smooth and safe flight pattern. The mind sensor data was sent to the microcontroller. According to the parameters set in the program, quad copter flight was controlled. The quad copter will ascend when the higher frequency components of brain map is dominant which is in an agitated or a focused state. Similarly, it will descend when the low frequency components of brain map are dominant which is in a calm or a meditated state. Rigorous flight testing was done, and it was found to be greatly accurate and consistent. The testing was done in open fields and safely.

Fig -14: Brain activity diagram

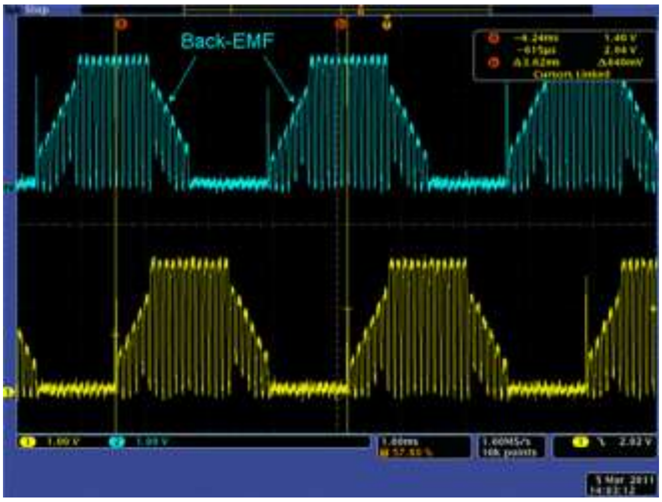

Fig -15: BLDC motor waveform

5. CONCLUSIONS

We had a vision of making something new, challenging and intuitive for a generation that loves and adores technology. In the process of trying to realize this, we had many confidence boosting accomplishments which gave us the courage to overcome the gut-wrenching failures. The quadcopter is fully functional and is pretty accurate. We wanted to dabble in new upcoming technology and apply it to a real-world problem. In the process, we were able to realize the dream of a mind-controlled device that we have had, in the form of a mind-controlled quadcopter.

The same design can be very easily applied to different forms of drones like UAVs, rovers, spy bots, bomb diffusing bots and much more. The EEG Technology has enormous potential, however it requires lots of investment and research to be able to use it in day to day activities.

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BIOGRAPHIES

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