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Mind Controlled Assistive Quadrotor Drone

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Abstract: Brain Computer Interfaces (BCI), also referred to as Mind Machine Interface (MMI) are devices capable of capturing brain activity. EEG based brain-controlled systems had initially found applications in military surveillance and biomedical services. Further research and work in this domain has enabled paralyzed people to control prosthetic arm with the help of their brain signals. Recent advancement in BCI Technology has seen a meteoric growth with contributions in additional fields such as security, lifestyle and entertainment. With the ever-increasing usability of drones in this era, we have tried to incorporate BCI with Unmanned Aerial Vehicles (UAVs). In this paper, we discuss the utilization of EEG signals to manoeuvre a quadrotor drone using a brain-wave-enabled biosensor. One of the crucial tasks performed by this sensor is to assimilate incoming stimuli and analyse the cerebral signals to determine accurate results.

Keywords: BCI(Brain Computer Interface), EEG, brain signals, drone, BCI (Brain computer interface), EEG, brain signals, drone.

I. INTRODUCTION

The primary objective of this paper is to render patterns of brain waves created by the user into commensurate commands using Brain Controlled Interface (BCI). The common BCI system comprises of features like signal acquisition, data processing, feature extraction etc[1]. Present devices that have been developed and being used in the industry record electrical impulses generated from the cerebrum. These impulses are acquired by placing an EEG Sensor on the scalp of the user. The Neurosky EEG sensor collects the electrical signals and not actual thoughts to translate brain activity into action. This sensor digitizes and amplifies raw analog brain signals to deliver concise inputs to devices running health and wellness, educational and research applications. This paper explains the interfacing of Neurosky EEG sensor with a quadrotor drone and how it can be used for various applications[2].

II. PROPOSED METHOD

A. System Design

The BCI (Brain Computer Interface) interprets graphicalrecord signals into commands to maneuver a quadrotor drone.The explanation of the system design is as follows:

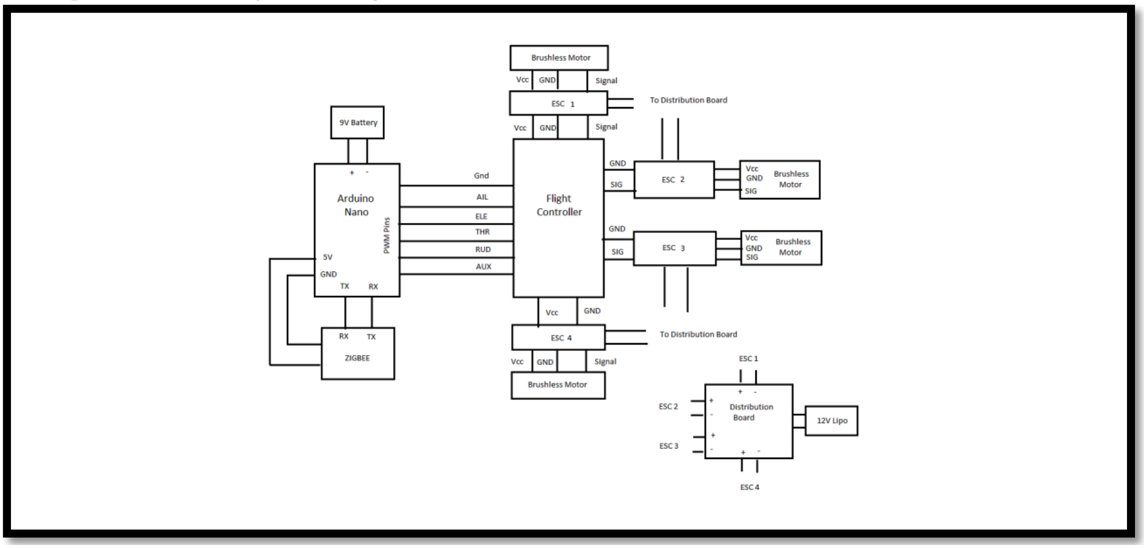

Fig. 1. System Design

Fig. 1. shows a basic schematic representation of all the interconnections of various elements on the drone. The elements being used are task specific and perform a particular role. The integration of all these tasks results in the overall functioning of the system.

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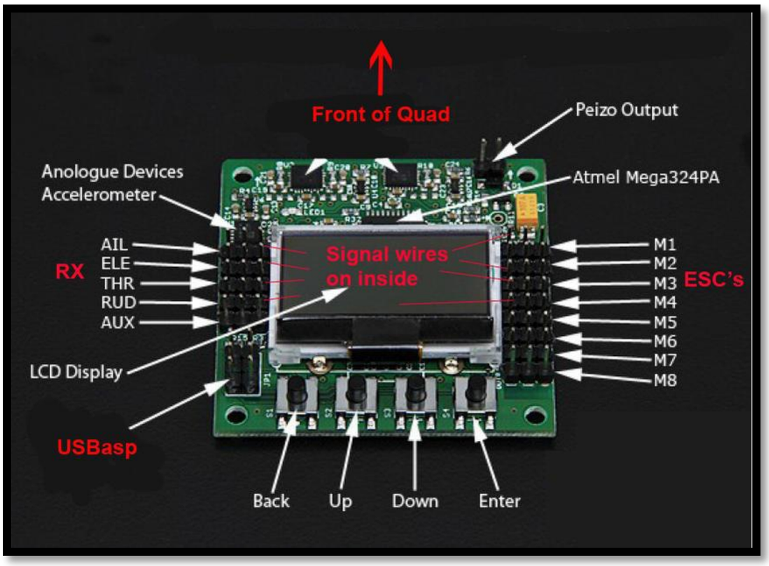

Fig. 2. Hobbyking KK 2.1.5

In Fig. 2., an image of a KK2.1.5 flight controller is shown which is provided by hobbyking.The KK2.1.5 has a built-in software,preinstalled craft types and an automatic calibration function of ESCs.This flight controller has various advantages over the other flight controllers in terms of the costsetup and configuration.This enables easier configuration and setup of the drone.Boards like the KK 2x models have an on board user interface that makes tuning simple,eliminating the constant use of personal computers for every small parametric changes.

Fig. 3. Mindwave Headset by Neurosky

Fig. 3. shows an EEG(electroencephalogram)sensor, manufactured by neurosky technologies that records signals generated by the human brain and transfers it by usinga Bluetooth embedded in the headset. The sensor ispoweredby using a AAA battery. The headset comprises of a powerswitch, a sensor tip,flexible ear arm and a ground connectionear clip.An LED indicator is provided on the headset in orderto specify the status of sensor.The data transmitted by thisEEG sensor will be received by the computer via a Bluetooth connection.All these data can be then used in order to controlthe motion of the quadrotor drone.

B. System Hardware

1) Motors:A quadrotor, as the name suggests, requires fourmotors to fly. It is advisable to use brushless motors as theyare lighter on the battery in terms of load. Apart from thata major advantage of using a brushless motors is the lackof brushes and physical commutator. The presence of fewerparts means less chance of wearing out.1400Kv r.p.m brushlessmotors were used having a stator diameter of 22mm.

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2) Electronic Speed Controller :These components are incharge of delivering power to the brushless motors. The number of ESCs will depend upon the number of motors being used.The ESCs are powered by using a 2200mah LiPo battery.All the ESCs receive a motor control signal from the KK flight controller through the signal pin.These signals are responsible for controlling the motor speed.

3) Zigbee Module :A zigbee module is used in order to achieve a wireless link between the sensor used by the user and the quadrotor drone.Zigbee is connected to the Arduino nano controller present on the receiving end, i.e the drone. It communicates wirelessly with the zigbee module connected to the PC.

C. **Design Flow**

Communication between the drone and the EEG sensor is facilitated using zigbee Modules and the sole reason for adopting this technology is to provide a good quality wireless transmission.Azigbee transmitter is connected to the PC which will send control signals to another zigbee which is placed on the drone.Firstly, the transmitter and receiver are supposed to be paired. This is done using the X-CTU software. The zigbee transmitter is interfaced with the PC with the help of a Python Script. Once the script is written, a command is sent through the zigbee transmitter to the receiver. Different commands are sent to the receiver present on the drone, depending upon the EEG sensor values. The Flight Controller present on the drone will be the recipient for the digitized sensor values. On receiving the dynamic values from the EEG sensor, the flight controller will execute the corresponding instructions for initiating the flight and controlling its movements.

III. PROPOSED ALGORITHM

The proposed algorithm mainly involves the procedure inwhich the drone is made to attain a stable flight.

1) Check if the zigbee is paired and connected to the PC.
2) Go to step if the above condition is satisfied else go to step 1.
3) ARM the drone.
4) Enable the EEG sensor.
5) Record the attention and meditation values on the console window in the PC.
6) Check if the attention and meditation values cross the threshold value.
7) Go to step 8 if the above scenario is satisfied,else go to step 6.
8) Enable serial port for zigbee.
9) Send take off control signals from zigbee to the drone.
10) Disable EEG sensor.
11) Enable the drone movement control.

IV. EXPERIMENTAL RESULTS

A. Zigbee Pairing

The 2 Zigbee modules which are being used as Transmitter and Receiver are paired in point-to-point communication mode using the X-CTU Software. Once the pairing is completed, the data can be sent in a bidirectional fashion from one Zigbee to another.The data transmission and reception between the two paired Zigbees can be observed in Fig. 4. and Fig. 5.

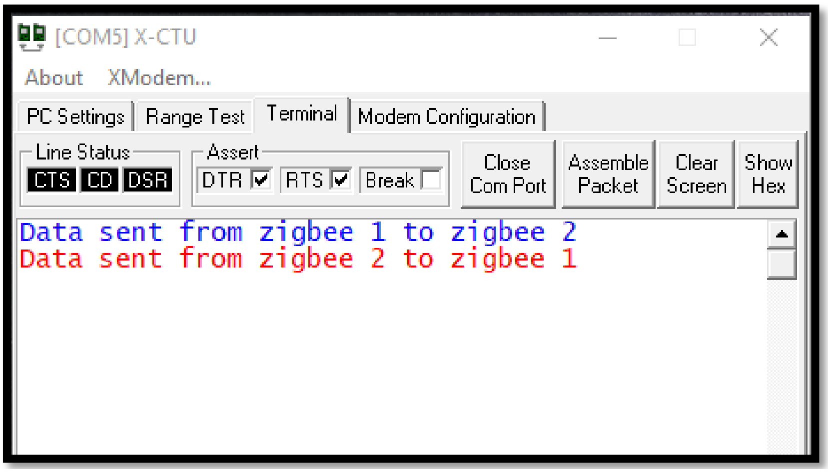

Fig. 4. Terminal window for Xbee1

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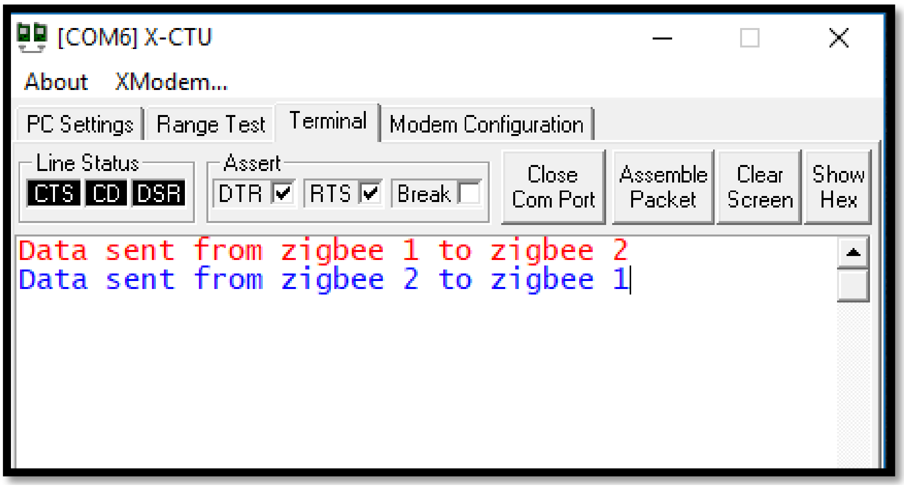

Fig. 5. Terminal window for Xbee2

B. Mindwave Signals

Fig. 6. Brainwave Visualizer Front Panel

C. EEG Readings

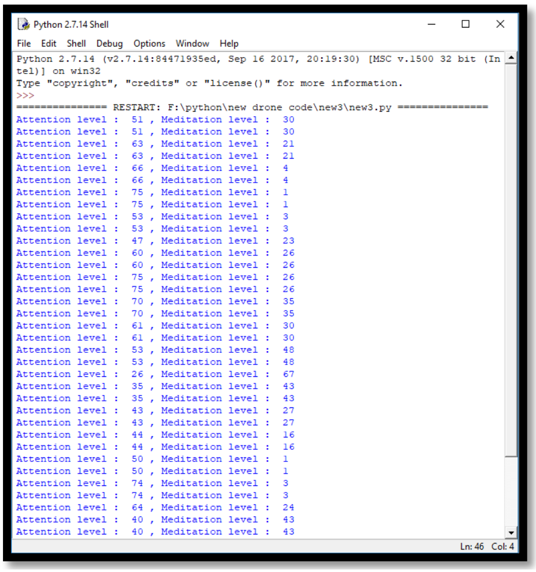

Fig. 7. EEG Readings

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D. Drone

Fig. 8. Final Prototype

V. CONCLUSION

The development of a Mind-Controlled Drone takes us astep further into the booming domain of Brain ComputerInterface technology. The implementation of this technologyin a basic drone provides assistance to people who are terminallyparalyzed and suffer from motor disabilities. It extendsthe platform for further research in UAVs and its practicalapplication in fields like military.

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