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MINDGEAR - A gear change mechanism controlled by the mind

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Abstract - *In this paper, we have researched about the idea of introducing a gear change mechanism for automobiles completely driven by the human brain by using brain-computer interface (BCI). The main aim of this technology is to keep the driver completely focused on the road and not take his hands off the wheel. This technology can be beneficial for people who wish to drive but are restrained because of some disabilities. This can mainly be achieved using motor imagery. The process is carried out using Electroencephalography (EEG).*

Keywords: **Brain-Computer Interface (BCI), Electroencephalography (EEG), Semi-automatic transmission, Motor Imagery.**

1. INTRODUCTION

Every moving vehicle requires a transmission system to achieve change in speeds. Transmission is basically a gearbox that comprises of gears and gear trains to provide speed and torque conversions from a rotating input power source or the driving gear to the output or the driven gear. There are different types of transmission systems like the Automatic, Manual and Semi-Automatic.

A semi-automatic transmission does not change gears automatically, but rather has manual gear change without the need of clutch engagement. The gear change can be triggered by the information relayed by the computer or by the driver using paddle shifts.

Many die-hard car enthusiasts love the manual transmission over the automatic mainly because of how much fun they are to drive. There is a level of control and involvement with manuals that makes shifting so much more engaging than automatic transmissions. For drivers who are comfortable with driving a manual, many have a hard time going back to an automatic. They trust their instincts more than the sudden untimely shifts handled by the computer.

The manual transmission requires the driver to take their hands off the wheel hence diverting their attention for a couple of seconds. This can be avoided if the driver is able to change gears without using his hands.

What if we could execute gear change just by putting that thought in our mind. This requires a concept that connects the human brain and a computer. This concept is known as the Brain- Computer Interface (BCIs) [1].

BCI measures brain activity associated with the user's intent and translates this recorded activity into corresponding signals for the respective BCI application. This signal is then interpreted by a computer and carries out the function. BCIs provide non-muscular interaction hence making it a significant aid to those with disabilities.

Sensors present on the BCI device detect different types of electrical and magnetic signals from the brain over different areas. Electroencephalography (EEG) records electrical activity from the scalp with the help of electrodes [2].

There are two commonly used types of BCIs. The Partially invasive BCIs are implanted on the inside of the skull but outside the brain. This requires surgery to be done on the user. Whereas the non-invasive BCIs are in the form of headsets or wearable devices which have sensors that measure brain activity from the outside. The non-invasive ones are preferred since they don't require a surgery, though they have relatively poor strength due to the signals being damped by the skull.

Moving something as big as a limb or as small as a muscle causes brain activity. In fact, even the thought of movement or imagination of movement causes change in the sensorimotor rhythms. Sensorimotor rhythms refer to oscillations in brain activity. These oscillations are categorized according to frequency bands (delta: < 4 Hz, theta: 4-7 Hz, alpha: 8-12 Hz, beta: 12-30 Hz, gamma: >30 Hz) [3]. ERD/ERS patterns can be produced by motor imagery, which is the imagination of the movement without actually performing the movement. Thus, even the thought of moving a limb without even moving it causes signals to be produced in the brain.

Therefore, BCIs can be controlled by imagining the movement of the right hand, left hand, legs and other distinctive features.

A little initial training is required to control the BCIs using motor imagery as it may sound a little complicated. But as technology advances, the easier it becomes to handle and understand.

2. OBJECTIVE

The main aim of the paper is to design/construct a gear shift mechanism that upshifts/downshifts and is completely controlled by the brain, while still keeping both hands on the wheel and eyes on the road, hence the driver has his/her attention on the road all the time thus increasing safety.

3. WORKING

We have the driver seated in the driver seat. He puts on a headset that reads the signals from the brain. When it's time for the upshift of the gear, he just imagines movement of the right arm. This produces signals in the brain that is picked up by the BCI device and passed on to the computer. The computer then relays this information to the vehicle and causes the mechanical change to the next highest gear.

Same is the case for downshift, with the only change being, the driver now imagines movement of his left arm.

4. HARDWARE AND SOFTWARE

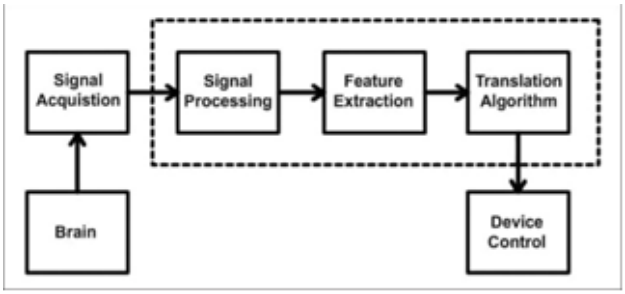

Fig -1: BCI Steps

4.1 Electroencephalography electrodes (EEG)

The Electroencephalography is the method used to record all of the electrical activity generated by the brain from electrodes placed on the scalp surface.

- It measures electrical activity generated by the synchronized activity of thousands of neurons.
- It provides excellent time resolution, allowing the analysis of which brain areas are active at a particular time.

Recent EEG Non-Invasive BCI devices have better temporal resolution due to the use of 256 electrodes occupying the whole area of the human scalp. Reusable EEG electrodes as shown in fig-2 are not as large as the disposable ones, and this gives them an advantage of being able to be placed a lot closer to the skin, even in areas with a lot of hair. These can be made of gold, silver or tin since they are all good conductors of electricity. They are used with headbands and can also be fixed to headsets.

They need to be cleaned carefully after every use. Their initial cost is higher than the disposable electrodes, however this tends to even out over time as they are durable and have an impressive lifetime.

Fig -2: Reusable EEG Electrodes [2]

4.2 Signal Amplifier

The signals received from the brain could be damped due to interference by the skull.

Hence the voltage fluctuations measured at the electrodes are very small, so the recorded data is digitized and sent to an amplifier. These signals are amplified for further processing.

4.3 Headset

Sample Since we are considering a non-invasive BCI, we are looking at wearable headsets.

EMOTIV EPOC+ as shown in fig.3 is a wireless headset. It has 14 saline sensors that offer optimal arrangement and collection of signals with effective strength [4].

Fig -3: EMOTIV Headset [4]

4.4 Software

There are many commercial softwares available that are designed for BCI applications. One among this is the Neurobci. It allows the user to develop their own Brain-Computer Interface based on biofeedback or neuro feedback as created in HTML, Jscript, C++, MATLAB and Fieldtrip.

4.5 Vehicle

A vehicle with semi-automatic transmission is used.
Semi-automatic transmission replaces the gear lever with a set of actuators, and the clutch pedal with a hydraulic motor.

A computer (sometimes referred to as "TCM", or "Transmission Control Unit") monitors various inputs, such as the vehicle speed, engine torque, accelerator pedal position, and more in order to determine when to change gear and in which direction.

When it decides a gear change is necessary, it will engage the clutch which in turn disengages the transmission from the engine, then activate the shift actuators to affect a gear change, then finally disengage the clutch so that engine is once again driving the transmission.

This computer can be so programmed to take the input coming in from the headset and trigger the gear change as and when the driver has the thought in his mind.

5. CONCLUSIONS

The MindGear in short receives signals from the brain on the required change of gear, which are transmitted through the EEG wirelessly to the computer, hence performing the action. This technology can prove to be effective for those who are differently abled. This concept can be further modified as per the user requirements/needs.

BCI is an interesting topic of research; it has the ability to solve many seemingly impossible issues. Currently, BCI and the use of EEGs are restricted mostly to gaming and entertainment. This idea takes the concept of BCI one step further.

REFERENCES

[1] Edited by Obermaier Bernhard, G.R. Muller and Gert Pfurtscheller, “Brain Computer Interfaces: Revolutionizing Human Computer Interaction”

[2] EEG Electrodes- http://www.greenteksensor.com/what-are-te-different-types-of-eeg-electrodes/

[3] Rabie A. Ramadan, S. Refat, Marwa A. Elshahed and Rasha A. Ali, “Basics of Brain Computer Interface.”

[4] EMOTIV Headset - https://www.emotiv.com/