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Brain-Controlled Robotic Wheelchair System Using Embedded System

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ABSTRACT: Improving the quality of life for the elderly and disabled people and giving them the proper care at the right time is one the most important roles that are to be performed by us being a responsible member of the society. It's not easy for the disabled and elderly people to mobile a mechanical wheelchair, which many of them normally use for locomotion or movements. Hence there is a need for designing a wheelchair that is intelligent and provides easy mobility. In this thesis, an attempt has been made to propose a brain-controlled wheelchair, which uses the captured signals from the brain and processes it to control the wheelchair. Electroencephalography (EEG) technique deploys an electrode cap that is placed on the user's scalp for the acquisition of the EEG signals which are captured and translated into movement commands by the Arduino microcontroller which in turn move the wheelchair. After measuring brain waves it delivers to brain to computer interface unit which analysed and amplified and classify waves into alpha, beta, gamma, waves then Arduino microcontroller controls the movement of wheelchair

I.INTRODUCTION

1.1 GENERAL

The electric-powered wheelchair is a wheelchair acting by an electric motor controlled with a hand operated joystick. However, some people suffering from severe motor disabilities cannot use the joystick, such as paralysis and physically disable people and locked-in syndrome. So they have other special devices available (touchpad, head /speech control, eye, EEG, etc). With the objective of responding to numerous mobility problems, various intelligent wheelchair related research have been created in the last years. In this research try not only to give mobility to handicapped people but, more importantly, independently of third-party help. Despite these new types of control methods, can acquire users' intention to control the wheelchair. However, each type of alternative control has its limitations. Wheelchair users are among the most visible members of the disability community; they experience a very high level of activity and functional limitation and also have less of employment opportunities. Elderly people are the group with the highest rates of both manual and electric wheelchair use. Wheelchair users report difficulty in basic life activities, and perceived disability. It's not easy for the physically challenged and elderly people to move a mechanical or electric wheelchair. In recent times there have been a wide range of technologies that help aid the disabled physically challenged. These control systems are designed to help the physically challenged specifically. These competitive systems are replacing the conventional manual assistance systems. The wheelchair too has developed significantly with a variety of guidance systems alongside like using the joystick and a touch screen, and systems based on voice recognition. These systems however are of use to those with a certain amount of upper body mobility. Those suffering from a greater degree of paralysis may not be able to use these systems since they require accurate control. To help improve the lifestyle of the physically challenged further, this research work aims at developing a wheelchair system that moves in accordance with the signals obtained from the neurons in the brain through the electroencephalograph (EEG) electrode. EEG stands for electroencephalogram, a electrode commonly used to detect electrical activity in the brain. Detecting, recording, and interpreting brain waves began in the late 8 s with the discovery and exploration of electrical patterns in the brains and the technology has evolved to enable applications ranging from the medical detection of neurological disorders to playing games controlled entirely by the mind.

1.2 PROBLEM STATEMENT

Mobility impairments significantly impact the lives of individuals, limiting their ability to navigate their surroundings independently. Traditional assistive devices have provided valuable support, but there remains a critical gap in addressing the nuanced needs of those with severe mobility challenges. The problem lies in the limitations of existing technologies, which often require manual input or may not adequately cater to individuals with motor disabilities. As such, there is a pressing need for advanced assistive technologies that offer a higher degree of control and autonomy. The Brain-Controlled Wheelchair Project aims to address this gap by leveraging cutting-edge brain-computer interface (BCI) technology to create a wheelchair system that can be controlled seamlessly through neural signals, providing a novel solution to enhance the lives of those with profound mobility impairments.

II. LITERATURE SURVEY

2.1 Rebsamen, Brice, Cuntai Guan, Haihong Zhang, Chuanchu Wang, Cheeleong Teo, Marcelo H. Ang, and Etienne Burdet. "A brain controlled wheelchair to navigate in familiar environments." *IEEE Transactions on Neural Systems and Rehabilitation Engineering* 18, no. 6 (2010): 590-598. The Brain Controlled Wheelchair (BCW) is a simple robotic system designed for people, such as locked-in people, who are not able to use physical interfaces like joysticks or buttons. Our goal is to develop a system usable in hospitals and homes with minimal infrastructure modifications, which can help these people regain some mobility. The main challenge is to provide continuous and precise 2D control of the wheelchair from a Brain Computer Interface, which is typically characterized by a very low information transfer rate. Besides, as design constraints, we want our BCW to be safe, ergonomic and relatively low cost. The strategy we propose relies on 1) constraining the motion of the wheelchair along predefined guiding paths, and 2) a slow but accurate P300 EEG brain interface to select the destination in a menu. This strategy reduces control to the selection of the appropriate destination, thus requires little concentration effort from the user. Besides, the trajectory is predictable, which contributes to reduce stress, and eliminates frustration that may be associated with trajectories generated by an artificial agent. Two fast BCIs are proposed to allow stopping the wheelchair while in motion. A hybrid BCI was developed to combine the slow P300 BCI used for destination selection with a faster modality to stop the wheelchair while in motion. Experiments with healthy users were conducted to evaluate performances of the BCIs. We found that after a short calibration phase, the destination selection BCI allowed the choice of a destination within 15 seconds on average, with an error rate below 1%. The faster BCI used for stopping the wheelchair allowed a stop command to be issued within 5 seconds on average. Moreover, we investigated whether performance in the STOP interface would be affected during motion, and found no alteration relative to the static performance.

2.2 Fernández-Rodríguez, Álvaro, Francisco Velasco-Álvarez, and Ricardo Ron-Angevin. "Review of real brain-controlled wheelchairs." *Journal of neural engineering* 13, no. 6 (2016): 061001. This paper presents a review of the state of the art regarding wheelchairs driven by a brain-computer interface. Using a brain-controlled wheelchair (BCW), disabled users could handle a wheelchair through their brain activity, granting autonomy to move through an experimental environment. A classification is established, based on the characteristics of the BCW, such as the type of electroencephalographic signal used, the navigation system employed by the wheelchair, the task for the participants, or the metrics used to evaluate the performance. Furthermore, these factors are compared according to the type of signal used, in order to clarify the differences among them. Finally, the trend of current research in this field is discussed, as well as the challenges that should be solved in the future.

2.3 Khan, Mohammad Monirujjaman, Shamsun Nahar Safa, Minhazul Hoque Ashik, Mehedi Masud, and Mohammed A. AlZain. "Research and development of a brain-controlled wheelchair for paralyzed patients." *Intell. Autom. Soft Comput* 30 (2021): 49-64. Smart wheelchairs play a significant role in supporting disabled people. Individuals with motor function impairments due to some disorders such as strokes or multiple sclerosis face frequent moving difficulties. Hence, they need constant support from an assistant. This paper presents a brain-controlled wheelchair model to assist disabled and paralyzed patients. The wheelchair is controlled by interpreting Electroencephalogram (EEG) signals, also known as brain waves. In the EEG technique, an electrode cap is positioned on the user's scalp to receive EEG signals, which are detected and

transformed by the Arduino microcontroller into motion commands, which drive the wheelchair. The proposed wheelchair is implemented using an Arduino-based robot controlled by a human brain wave using a Brain-Computer Interface (BCI). The human brain wave is captured using a low-cost Neurosky MindWave headset. The proposed wheelchair has the potential to have an immense effect on the healthcare industry. The use of this braincontrolled wheelchair can improve the quality of life of a paralyzed patient

2.4 Carlson, T., Leeb, R., Chavarriaga, R. and Millán, J.D.R., 2012, October. The birth of the brain-controlled wheelchair. In 2012 IEEE/RSJ International Conference on Intelligent Robots and Systems (pp. 5444-5445). IEEE. — The prospect of controlling devices merely by the power of one's thoughts is compelling, especially for assistive technology applications. In the accompanying video, we show how we have strived to push brain-computer interface (BCI) technology out of the lab and into the real world, while simultaneously moving away from testing solely with healthy subjects to undertaking trials with patients and potential end-users. We describe the evolution of the motor imagery based BCI, which has resulted in a major milestone: the first patient trial of a motor imagery based BCI controlled wheelchair

2.5 Xin, Liqiang, Shang Gao, Jingyue Tang, and Xin Xu. "Design of a brain controlled wheelchair." In 2018 IEEE 4th International Conference on Control Science and Systems Engineering (ICCSSE), pp. 112-116. IEEE, 2018. The brain machine interface has a profound impact on paralysis or the life of the elderly. They can control all kinds of equipment without the need of both hands. The electric wheelchair has become very popular. This article introduces us to control the wheelchair by replacing traditional arms with EEG signals. We control the rotation of the wheelchair by the times of intentional blinking. The concentration of the signal in the EEG is taken as the signal to control the wheelchair, and the signal is transmitted to the STM32 to realize the forward control of the wheelchair. We have done a lot of tests to keep the error rate of the system at a lower level and the reliability of the system is high. In the future we will do adaptive threshold setting.

III.SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

A novel wireless dry EEG brain-controlled wheelchair with five steering behaviours is devised, which is based on two-stage control strategies combining sustained and brief motor imagery brain-computer interfaces (SB-MI-BCIs). Compared with the existing single modal brain-computer interface (S-BCI) controlled wheelchair, this new wheelchair has achieved more control commands and higher information transfer rate. Compared with their previous hybrid BCIs controlled wheelchair, subjects can control the wheelchair spontaneously and efficiently just by imagining the left hand, the right hand or both hands without any other visual attentions (e.g. P300 or SSVEP). The experimental results demonstrate that the SB-MI-BCIs can efficiently provide multiple independent control signals for wheelchair navigation.

Innovative Approach: The devised wireless dry EEG brain-controlled wheelchair represents a groundbreaking advancement in assistive technology, utilizing a novel two-stage control strategy. Unlike existing single-modal brain-computer interface (S-BCI) controlled wheelchairs, this innovative design incorporates sustained and brief motor imagery brain-computer interfaces (SB-MI-BCIs). This two-stage approach allows users to generate a diverse set of control commands, enabling a more nuanced and flexible steering experience. By combining sustained and brief motor imagery, users can seamlessly switch between five distinct steering behaviors, providing a level of control and adaptability that surpasses traditional systems. This represents a significant departure from conventional approaches, demonstrating the potential for enhanced user autonomy and improved wheelchair navigation.

underscores the transformative impact of combining advanced neurotechnology with innovative control strategies in the realm of assistive devices.

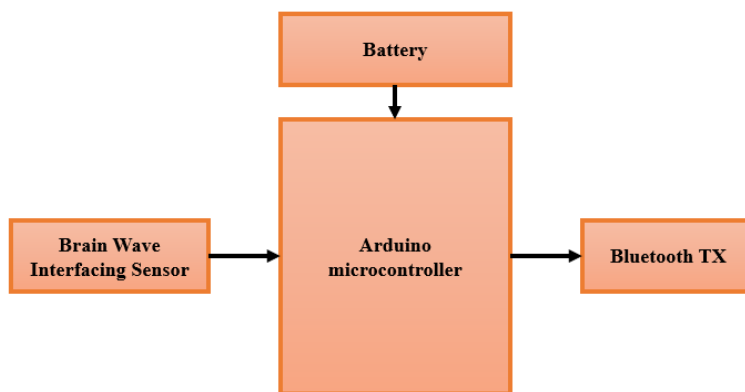
3.2 PROPOSED METHOD

This research introduces a revolutionary advancement in assistive technology through the development of a novel wireless dry EEG brain-controlled wheelchair. Leveraging a two-stage control strategy that integrates sustained and brief motor imagery brain-computer interfaces (SB-MI-BCIs), our wheelchair design pioneers a paradigm shift in user control and adaptability. In comparison to existing single-modal brain-computer interface (S-BCI) controlled wheelchairs, our innovation achieves a substantial increase in both control commands and information transfer rate, enhancing the user experience and real-time responsiveness. Furthermore, in contrast

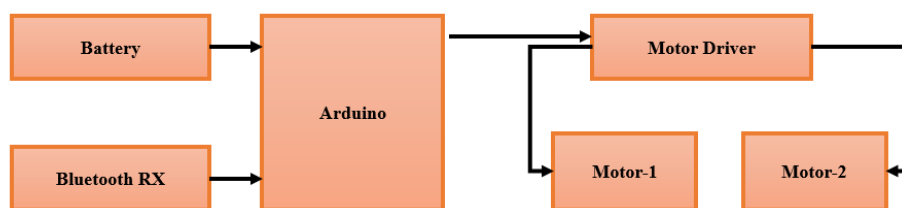
to our previous hybrid BCIs controlled wheelchair, this new design enables users to intuitively control the wheelchair by simply imagining the left hand, right hand, or both hands, eliminating the need for additional visual cues. Our experimental results affirm the efficacy of SB-MI-BCIs in providing multiple independent control signals, marking a significant stride towards spontaneous and efficient wheelchair navigation. This breakthrough promises to redefine the landscape of mobility assistance, offering newfound independence to individuals with severe motor impairments and paving the way for future advancements in brain-computer interface technology for assistive devices.

3.3 BLOCK DIAGRAM

TRANSMITTER SECTION



RECEIVER SECTION



3.4 WORKING PRINCIPLE

The Brain-Controlled Wheelchair operates based on a sophisticated integration of various components, including a battery, Arduino microcontroller, brain wave interfacing sensor, Bluetooth transmitter (TX), motor driver, and motors. The working principle involves a series of steps that enable the translation of the user's brain signals into actionable commands for wheelchair navigation.

Battery Power:

The wheelchair is powered by a rechargeable battery that supplies the necessary electrical energy to the entire system. The use of a battery allows for mobility without the constraint of external power sources.

Arduino Microcontroller:



The Arduino microcontroller serves as the central processing unit, responsible for coordinating and executing the control algorithms. It receives input signals from the brain wave interfacing sensor, processes these signals, and generates corresponding output commands to control the wheelchair's movement.

Brain Wave Interfacing Sensor:

The brain wave interfacing sensor is a crucial component that reads and interprets the user's brain signals. This sensor is typically based on electroencephalography (EEG) technology, which detects electrical activity in the brain. It captures specific patterns related to motor imagery, such as imagining left- or right-hand movements, and converts them into electrical signals.

Bluetooth Transmitter (TX):

The Bluetooth transmitter facilitates wireless communication between the Arduino microcontroller and external devices, such as a computer or a smartphone. This wireless connectivity allows for remote monitoring, configuration, and control of the wheelchair, enhancing its usability and versatility.

Motor Driver:

The motor driver is responsible for controlling the motors of the wheelchair based on the commands received from the Arduino microcontroller. It interprets the signals and regulates the power supplied to the motors, ensuring precise and responsive movement.

Motors:

The motors are the actuators responsible for propelling and steering the wheelchair. The number of motors may vary depending on the wheelchair's design; for simplicity, let's consider a wheelchair with two motors for basic forward, backward, and turning movements. The motor driver adjusts the speed and direction of these motors according to the user's brain signals, enabling intuitive control.

In summary, the working principle involves the brain wave interfacing sensor capturing the user's mental commands, the Arduino microcontroller processing these signals, and the motor driver translating them into precise movements of the wheelchair's motors.

IV.SYSTEM REQUIREMENTS

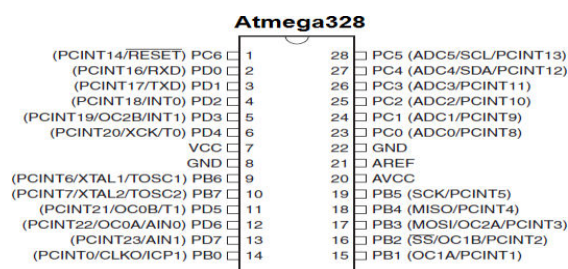
4.1 BATTERY

Introduction to Batteries: Batteries play a crucial role in powering a wide range of electronic devices, providing a portable and reliable source of electrical energy. They are essential components in our daily lives, from powering small gadgets like smartphones to larger systems like electric vehicles. A battery consists of one or more electrochemical cells that convert stored chemical energy into electrical energy through redox reactions. The most common types of batteries include alkaline, lithium-ion, lead-acid, and nickel-metal hydride, each offering unique characteristics suitable for different applications.

4.2 ARDUINO MICROCONTROLLER

Arduino microcontrollers are open-source, programmable hardware platforms widely used in electronics projects and prototyping. Developed to simplify the process of building interactive devices, Arduino boards feature a microcontroller unit (MCU) at their core, along with various input/output pins and a development environment that includes an integrated development environment (IDE). The platform is favored by hobbyists, students, and professionals for its user-friendly interface and versatility.

PIN DIAGRAM



4.4 BRAIN WAVE INTERFACING SENSOR

A brain wave interfacing sensor, also known as an EEG (Electroencephalogram) sensor, is a device designed to detect and measure electrical activity in the brain. It captures the electrical signals generated by neurons when they communicate with each other, offering a non-invasive way to monitor brain function. These sensors are widely used in various applications, including medical diagnostics, neurofeedback, and brain-computer interface (BCI) technologies.

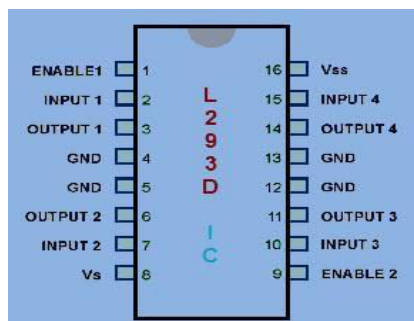
Working Principle: The brain wave interfacing sensor typically consists of electrodes that are placed on the scalp to pick up the electrical signals produced by the brain. These electrodes detect voltage fluctuations caused by the synchronized activity of neurons. The signals are then amplified, filtered, and processed to extract specific frequency components corresponding to different types of brain waves, such as alpha, beta, theta, and delta waves. These brain waves are associated with different mental states and activities, forming the basis for interpreting the user's intent or mental commands in applications like brain-controlled wheelchairs. The resolution, accuracy, and ease of use of these sensors, opening up new possibilities for their integration into various fields to enhance human-machine interactions and contribute to the development of innovative assistive technologies.



4.5 MOTOR DRIVER

A motor driver is a critical electronic component designed to control the movement and direction of motors in various applications. It serves as an intermediary between a microcontroller or microprocessor and the motor, ensuring precise and efficient motor control. Motor drivers are commonly employed in robotics, automation, electric vehicles, and other systems where accurate motor manipulation is essential.

PIN DIAGRAM



4.6 BLUETOOTH MODULE

A Bluetooth module is a hardware component that enables wireless communication between devices over short distances using Bluetooth technology. These modules typically consist of a small circuit board with an

integrated Bluetooth chip, antenna, and supporting components. They are designed to be easily integrated into electronic devices to add Bluetooth connectivity capabilities.

Bluetooth modules come in various form factors and with different features, but they generally share common functionalities such as:

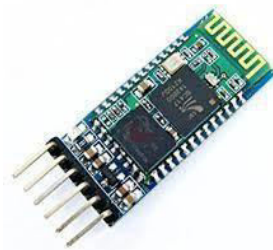
Wireless Connectivity: Bluetooth modules facilitate wireless communication between devices such as smartphones, tablets, laptops, IoT devices, and peripherals like keyboards, mice, speakers, and headphones.

Bluetooth Protocol Support: They support various Bluetooth protocols such as Classic Bluetooth (Bluetooth Basic Rate/Enhanced Data Rate), Bluetooth Low Energy (BLE), or both, depending on the module's specifications.

Serial Communication Interface: Many Bluetooth modules provide a serial communication interface (UART or SPI) to enable easy integration with microcontrollers or other embedded systems.

Power Management: Efficient power management features are often included to optimize power consumption, extending battery life in battery-operated devices.

Configuration and Control: Bluetooth modules typically offer AT commands or APIs to configure settings such as device name, pairing mode, security features, and data transfer parameters.



V. SOFTWARE REQUIREMENTS

5.1 ARDUINO IDE

The Arduino Integrated Development Environment (IDE) is a user-friendly software application designed to simplify the process of programming and uploading code to Arduino microcontroller boards. Developed by the Arduino community, the IDE provides a comprehensive set of tools and features tailored to the needs of hobbyists, students, educators, and professionals alike. With its intuitive interface and extensive library support, the Arduino IDE has become the go-to platform for developing interactive electronics projects and prototypes.

User-Friendly Interface: The Arduino IDE features a straightforward and easy-to-navigate interface, making it accessible to users with varying levels of programming experience. Its minimalist design focuses on essential functions such as writing, compiling, and uploading code, without overwhelming users with unnecessary complications.

VI. RESULT AND DISCUSSION

6.1 RESULT

We have taken data of eight healthy subjects for MI in two sessions as multi-session data collection improves overall real-world performance on new data. We take 100 readings of 5 seconds each, raw data for each subject in both the sessions, which on trimming 1 second and slicing the remaining in four, becomes 800 labeled data points per class. This dataset now go for training.

6.2 DISCUSSION

The development of an advanced wheelchair is a significant breakthrough in enabling independent mobility for elderly and physically impaired individuals. However, it represents only a modest step towards the creation of an empowering and intelligent assistive technology.

There are certain limitations to our approach, such as the manual addition of key points within a known map by developers or admins, which the user can then use for BCI-based control. In contrast, a newly realized map can accept goal coordinates and orientation via manual touch entry. The main obstacle to achieving a higher level of

freedom through BCI control is the intent prediction models associated with BCI. To overcome this, future research can focus on improving the granularity in motor imaging estimates to enable the selection of any point in all maps, both stored and realized, via BCI-based input.

VII.CONCLUSION

From the proposed system wheelchair can be controlled by brain waves. The advantage of brain-controlled wheel chairs is that they respond to commands much faster and that patients who have lost the ability to speak may utilize them. The main purpose of this project is to design a wheelchair for severely disabled person to move them voluntarily. in this paper Attention Parameter is used to control Wheelchair. if Attention Value goes more than 50 then Wheelchair will go Forward otherwise stop.

In conclusion, the development of a Brain-Controlled Wheelchair represents a significant milestone in the field of assistive technology, offering individuals with severe mobility impairments newfound independence and autonomy. Through the integration of innovative two-stage control strategies, combining sustained and brief motor imagery brain-computer interfaces (SB-MI-BCIs), this novel wheelchair design enables users to navigate their environment effortlessly using only their thoughts. The success of this project not only demonstrates the feasibility of leveraging brain-computer interface technology for mobility assistance but also underscores the transformative impact it can have on the lives of individuals facing profound motor disabilities

REFERENCES

1. Wolpaw J, Birbaumer N, McFarland DJ, Pfurtscheller G, Vaughan TM. Brain Computer Interfaces for communication and control. *Clin Neurophysiol.* 2002; 113:767–91.
2. Farwell LA, Donchin E. Talking off the top of your head: Toward a mental prosthesis utilizing eventrelated brain potentials. *Electroencephalogr Clin Neurophysiol.* 1988;70(6):510–23.
3. Hochberg LR, Bacher D, Jarosiewicz B, Masse NY, Simeral JD, Vogel J, et al. Reach and grasp by people with tetraplegia using a neurally controlled robotic arm. *Nature [Internet].* 2012;485(7398):372–5. Available from: <http://www.nature.com/nature/journal/v485/n7398/full/nature11076.html>
4. Leeb R, Tonin L, Rohm M, Desideri L, Carlson T, Millán JDR. Towards Independence: A BCI Telepresence Robot for People With Severe Motor Disabilities. Vol. PP, Proceedings of the IEEE. 2015. p. 1–14.
5. Corralejo R, Hornero R, Álvarez D. A domotic control system using Brain-Computer Interface (BCI). 2011. 345-352 p. (Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics); vol. 6691 LNCS).
6. Daly JJ, Wolpaw JR. Brain-computer interfaces in neurological rehabilitation. *Lancet Neurol.* 2008;7(11):1032–43.
7. Nicolas-Alonso LF, Gomez-Gil J. Brain Computer Interfaces, a Review. *Sensors [Internet].* 2012;12(12):1211–79. Available from: <http://www.mdpi.com/1424-8220/12/2/1211/>
8. Kleber B, Birbaumer N. Direct brain communication: neuroelectric and metabolic approaches at Tübingen. *Cogn Process [Internet].* 2005;6(1):65–74. Available from: <http://dx.doi.org/10.1007/s10339-004-0045-8>
9. Hinterberger T, Schmidt S, Neumann N, Mellinger J, Blankertz B, Curio G, et al. Brain-Computer Communication and Slow Cortical Potentials. *IEEE Trans Biomed Eng.* 2004;51(6):1011–8.
10. Friedrich EVC, Scherer R, Neuper C. The effect of distinct mental strategies on classification performance for brain-computer interfaces. *Int J Psychophysiol [Internet].* Elsevier B.V.; 2012;84(1):86–94. Available from: <http://dx.doi.org/10.1016/j.ijpsycho.2012.01.014>
11. Vialatte F-B, Maurice M, Dauwels J, Cichocki A. Steady-state visually evoked potentials: focus on essential paradigms and future perspectives. *Prog Neurobiol [Internet].* 2010 Apr [cited 2015 Nov 18];90(4):418–38. Available from: <http://www.sciencedirect.com/science/article/pii/S0301008209001853>
12. Thakor N. Biopotentials and Electrophysiology Measurement. In CRC Press; 1999. Available from: <http://dx.doi.org/10.1201/9780415876179.ch74>



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