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Brain-Computer control Of Wheelchair concluded Mobile Robot

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***Abstract*— This paper reports an Electroencephalogram based- brain actuated telepresence system to provide a user with the presence in remote environments through the mobile robot. We present the design of brain computer interface control of wheelchair and a mobile robot with autonomous navigation. The shared control strategy is built by the BCI decoding of task- related orders which can be autonomously executed by the robot. The quality of life of people suffering from severe motor disabilities can benefit from use of this technology capable of communication. Brain computer interfaces are the systems that can translate brain activity into signals that control the external devices. Thus they can represent the only technology for severally paralyzed patients to maintain their communication within the surrounding environment.**

***Index Terms*—**Brain Computer Interfaces, Telerobitic

I. INTRODUCTION

Brain Computer Interface (BCIs) provide users with communication and control using only their brain activity.

BCI donot rely on the brain's normal output channel communication for people with severe neurological or muscular diseases, such as amyotrophic lateral sclerosis (ALS), brain-stem stroke, cerebral palsy, and spinal cord injury. The ability to work with noninvasive recording methods (the electroencephalogram or EEG is the most popular method) is one of the major goals for the development of brain-actuated systems for humans. The first noninvasive brain-actuated control of a physical device was demonstrated in wheelchairs. All these developments have the Property in common: user and robot are placed in the same environment. Very recent research has focused on BCI applications where the human and the robot are not collocated, such as in robot tele-operation. The ability to brain- teleoperate robots in a remote scenario could provide severely disabled patients with telepresence. Telepresence could be seen as an extension of the sensorial functions of daily life by means of a physical device, embodied in the real environment and placed anywhere in the world, which could perceive, explore, manipulate, and interact with the motor d remote scenario, and controlled only by brain activity. Furthermore, it has been suggested that the use of these BCIs could have a neurorehabilitation effect and/or a maintenance of neural activity, avoiding or delaying the extinction of thought, hypothesized to occur in patients like ALS.

This principle was initially explored in the context of BCI control of wheelchairs and very recently applied to BCI telepresence. This paper is in line with these works, The present BCI telepresence system relies on a synchronous P300-based BCI and a mobile robot with autonomous navigation. Following the typical P300 visual stimulation processes, the BCI collects the EEG brain activity and decodes the user's in-tensions', which are transferred to the robot. The robot autonomously executes the orders using the navigation system. The shared-control strategy is built by means of the mental selection of robot navigation, which can be autonomously executed by the robot. In principle, this shared-control design shapes the low information transfer rates (ITRs) of existing BCIs, avoids the exhausting mental effort of BCIs that require continuous control, and over-comes the Internet delay problems in the control loop. In relation to the shared-control approach used in [17] to teleoperate a mobile robot, which relies on a motor imagery BCI and low-level robot motion primitives, the contribution of the present engineering system is a shared-control design that incorporates a much higher degree of autonomy in the robotic layer.

An added value of this research is the experimental method-ology and validation protocol, which could guide future de-velopments. The telepresence system was evaluated using five healthy participants in two consecutive steps: 1) screening and training of participants and 2) preestablished navigation. The overall result was that all participants were able to complete the designed tasks, reporting no failures, which shows the robustness of the system and its feasibility to solve tasks in real settings where joint navigation are needed. Furthermore, the participants showed great adaptation to the system.

TELEPRESENCE TECHNOLOGY

The telepresence system consisted of a user station and a robot station, both remotely located and connected via the Internet (Fig. 1). At the user station, the BCI decodes the user's intentions, which are transferred to the robotic system. At the robot station, the user's decisions are au-tonomously executed using autonomous navigation. Telepresence is to provide the safe interaction of the mobile robot with the remote environment and it is used to detect the obstacles and provide the awareness of surrounding object to human telepresence operation. As telepresence technology improves and people became more comfortable with the medium, new avenues of sharing will emerge. Improvements in network transfer rates encourage telepresence to merge with virtual world resulting robustness. In this work we want to explore a BCI mobile robot for telepresence. Such telepresence mobile robot enables patience to meet their demand without guidance of others. The telepresence system consisted of a user station and robot station both remotely located at the user station BCI decodes the user's intentions, which are transferred to robotic system. At the robot station, the user's decision are executed using autonomous navigation. The user then concentrates on the desired location and a visual stimulation process elicits the P300 visual evoked potential enables to decode the desired location which is transferred to the robotic station. In the robot navigation mode, the autonomous navigation system drives the robot to the target location while avoiding collisions with obstacles detected by IR sensors. The cooperation between human and intelligence devices allows to focus the attention on the final destination and ignores low level problem related to navigation tasks .To avoid obstacles collisions, the robot uses infrared sensors. Without shared control the robot Stops in front of obstacle and wait for the next manual command If share control is enabled the obstacle avoidance module will make robot turns toward the opposite direction where the path is free. Since our goal is to develop BCI system for physically disabled patients, we follow autonomous approach to give BCI user the feeling of full control of robot.

BRAIN COMPUTER INTERFACE

Brain computer interface is otherwise called a mind-machine interface (MMI), or sometimes called a direct neural interface or a brain–machine interface (BMI), is a direct communication pathway between the brain and an external device.BCI is a communication and control system that does not depend in any way on the brain's normal neuromuscular output channels. The user's intent is conveyed by brain signals (such as EEG) rather than by peripheral nerves and muscles, and these brain signals do not depend for their generation on neuromuscular activity. BCIs are essentially "wire-tapping "or "mind-reading" technology, devices for listening in on the brain, detecting its intent, and then accomplishing that intent directly rather than through muscles. BCI use depends on the interaction of two factors: the user must generate brain signals that encode intent and the BCI system that must translate these signals into commands to the robot. Thus, BCI use is a skill that both user and system must acquire and maintain. The user must encode intent in signal features that the BCI system can measure these features and translate them into device commands. It uses the P300 component of the event-related brain potential, which appears in the centroparietal EEG which provide visual stimulus. By detecting this P300 potential, the BCI system can determine the user's choice.

ELECTROENCEPHALOGRAM:

Electroencephalography (EEG) is the recording of electrical activity along the scalp. EEG measures voltage fluctuations resulting from ionic current flows within the neurons of the brain.[1] EEG refers to the recording of the brain's spontaneous electrical activity over a short period of time, usually 20–40 minutes, as recorded from multiple derivatives of the EEG technique include evoked potentials (EP), which involves averaging the EEG activity time-locked to the presentation of a stimulus. The brain's electrical charge is maintained by billions of neurons. Neurons are electrically charged (or "polarized") by membrane transport proteins that pump ions across their membranes. Neurons are constantly exchanging ions with the extracellular milieu. Ions of similar charge repel each other, and when many ions are pushed out of many neurons at the same time, they can push their neighbours, who push their neighbours, and so on, in a wave. This process is known as volume conduction.

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When the wave of ions reaches the electrodes on the scalp, they can push or pull electrons on the metal on the electrodes. Since metal conducts the push and pull electrons easily, the difference in push or pull voltages between any two electrodes can be measured by a voltmeter. Electroencephalography (EEG) is the most studied potential non-invasive interface, mainly due to its fine tempelectrodes placed over the scalp oral resolution, ease of use, portability and low set-up cost.

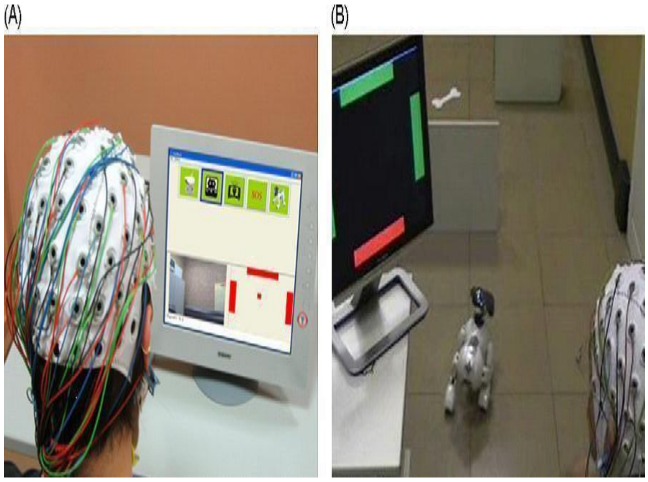

Figure 1.A.Electroencephalogram B. BCI control of robot

EEG was acquired using a commercial gTec EEG (EEG cap, 16 electrodes, and a gUSBamp amplifier). The electrodes were located at Fp1, Fp2, F3, F4, C3, C4, P3, P4, T7,T8, CP3, CP4, Fz, Pz, Cz, and Oz, according to the international 10/20 system, as suggested in previous studies [26]. The ground electrode was positioned on the forehead (position Fpz), and the reference electrode was placed on the left earlobe. The EEG was amplified, digitalized with a sampling frequency of 256 Hz, power-line notch filtered, and bandpass filtered between 0.5 and 30 Hz. Graphical interface and signal recording and processing were developed through the BCI2000 platform [27], placed on an Intel Core2 Duo processor at 2.10 GHz with Windows XP operating system.

II. EXPERIMENT METHODOLOGY

The experimental setup for the BCI of wheelchair based telepresence application is natural environment thus replicating the daily life situations where the patients might want to drive the mobile robot. Brain–computer interface (BCI) technology gives their users communication and control channels that do not depend on the brain's normal output channels of peripheral nerves and muscles. And can allow completely paralyzed individuals to communicate with the surrounding environment A BCI detects activation patterns in the brain that correspond to the user's intention and it's transferred to robot.

The present BCI Telepresence system relies on a synchronous P300 based BCI and a mobile robot with autonomous navigation. During operation, the user concentrates on the desired location to robot, from the P300 visual stimulation processes the BCI collects the EEG brain activity and decodes the user's intentions to robotic system which autonomously executes navigation system. In the robot navigation mode, the autonomous navigation system drives the robot to the target location while avoiding the collisions with obstacles detected by infrared sensor. The navigation modes where used by the disabled patients to control the robotic system and it assist the user with the environment and communicating with the wheelchair.

TELEPRESENCE MOBILE ROBOT:

Mobile robot technology and its application in various sector is currently an area of high interest. The variety of service robots were designed to operate in populated environments which facilitate safe, reliable and effective operation of mobile robots and execution of assigned task. In order to navigate safely and reliably, mobile robot must be able to create suitable representation of environment. Telepresence could be seen as an extension of the sensorial functions of daily life by means of physical device, embodied in the real environment and placed anywhere in the world could perceive, explore, manipulate, and interact with the remote scenario, and controlled only by brain activity. The important requirement for the telepresence system is to provide the safe interaction of the mobile robot with the remote environment, so the key point from mobile robot is to accurately detect the obstacles and provide the awareness to the user.

Figure 2.BCI control of wheelchair

III.RESULT

Figure 3.Robotic station

Our Telepresence mobile robot consist of wheels, RF-receiver, motor drivers, AT89S52and the robot is equipped with the Infrared sensor capable of detecting the obstacles and for the navigation connected the two gear motors which keeps the full control of wheelchair, one gear motor is used to move forward and backward directions while other one is used to turn the wheelchair towards left and left positions.

In this work we are using Radio frequency system to provide communication for the navigation system, RF system comprises of an RF Transmitter receives serial data and transmits it wirelessly through its antenna and the encoder is used for encoding parallel data for transmission while RF receiver were placed over the robotic station which is used to receive the data through the antenna where the reception is decoded by the decoder and it is connected to the port 1 of the microcontroller.

Motor drivers are connected to the port to which consist of two gear motors ne is used for the movement of forward and backward direction and the other one is used to turn the wheelchair towards left and right position and it is situated near the wheels.IR sensor are connected to port 0 which is used to detect the obstacles to avoid the collusion and buzzer are used to hear the sound which create the awareness to the user and it is placed front panel of wheelchair.

IV.CONCLUSIONS

This paper reported a synchronous P300- based BCI teleportation system that provide users with presence in remote environments through a mobile robot. The shared control strategy is built by the BCI decoding of task-related navigation autonomously executed by the robot.Our implementation of shared control focuses on low-level obstacle detection and avoidance. This way the subject keeps full control of the driving of the robot. The default behavior of the robot is to move forward and backward, then it turn left and right direction at a constant speed. To avoid obstacle collision, the robot uses infrared sensor. Without shared control, the robot stops in front of the detected obstacles and wait for the next mental command. If shared control is enabled, the obstacles avoidance module will make the robot turns toward the opposite direction where the obstacle is detected until the path is free. The integration between the BCI system and the robotic system was satisfactory, achieving on overall high performance of the system.

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