**Design of Multimodal Adaptive Wireless Control System-MAWCS for Disabled and Elder People**

**Abstract**

This project describes a Multimodal Adaptive Wireless Control System (MAWCS) to help individuals with disabilities and elders with the help of Assistive Robotic Arm (ARA). The proposed system uses a wearable and wireless body sensor network (WBSN) supporting up to six sensor nodes to measure the natural upper-body gesture and a speech recognition module to recognise the voice of the users and translate it into control commands. Natural gesture of the head and upper-body parts, as well as muscular activity are measured using Inertial Measurement Units (IMUs) and surface electromyography (sEMG) using custom-designed multimodal wireless sensor nodes. An IMU sensing node is attached to a headset worn by the user along with a microphone. It has a size of 2.9 cm × 2.9 cm, a maximum power consumption of 31 mW, and provides particular angular precision. Multimodal patch sensor nodes, including both IMU and sEMG sensing modalities are placed over the user able-body parts to measure the motion and muscular activity. These nodes have a size of 2.5 cm × 4.0 cm and a maximum power consumption of 11mW. The proposed BoMI runs on a Raspberry Pi. It can adapt to several types of users through different control scenarios using the head and shoulder motion, voice commands of the user as well as muscular activity, and provides a power autonomy of up to 24 hours. The users can perform all tasks with the proposed MAWCS and ARA, almost as fast as with the Mobile application, with only 30% time overhead on average, while being potentially more accessible to the upper-body disabled who cannot use the conventional joystick controller. It can also be controlled using the voice commands of the user in case of total paralysed patient.

Introduction:

Functional capacities of people living with disabilities have been considerably improving over the past recent years due to signiﬁcant advances in assistive technology and rehabilitation engineering. A ﬂeet of assistive devices have arisen worldwide to increase and/or maintain residual capacities of impaired users, in their activities of daily life(ADLs). By positioning assistive technology as an intervention with the potential to enhance quality of life (QOL) across many, if not all, of the core QOL domains: emotional wellbeing, interpersonal relationships, material wellbeing, personal development, physical wellbeing, self-determination, social inclusion and rights[1] While technologies such as hearing aids, retinal implants and haptic feedback systems, etc aim at providing or restoring apprehension abilities. The ideal binary mask is one algorithm speciﬁcally shown to improve speech intelligibility. The speech intelligibility scores reported by normal hearing listeners increased from 12% to 100% after speech embedded in four-talker babble was processed by the ideal binary mask. Similarly, the ideal binary mask improved speech intelligibility from nearly 0% to 100% in the study described in [2]–[4]. mobility aids (intelligent wheelchairs, prosthetic devices and other domestic appliances such as robotic manipulators) require a voluntary user interaction based on their residual functional capacities(RFC’s). The main purpose of the proposed orientation control system is to enhance the users’ experience by enabling them to control the robot with more performance and intuitiveness. The first priority of robotic devices is safety, they must also be intuitive and efficient from an engineering point of view in order to be adopted by a broad range of users. [5]–[8]. . Even though extrinsic enablers among the latter category are game changers and contribute to users quality of life (QoL) improvement, the lack of readily available and affordable adaptive controllers limits their efﬁciency and adoption rate by people living with severe disabilities [9]. Tools such as switch devices, dedicated keypads, mice, trackballs, joysticks, head and hand pointers, sip-and-puff tools, mouth sticks or lip control systems [10]- [11] require a mechanical intervention from the users, which can be obtrusive and drain physical resources of severely impaired users. Smart and unobtrusive Body-Machine Interfaces (BoMIs) have been designed based on latest technologies for easing interaction with assistive devices by exploiting users’ RFCs. Computer vision with 3 dimensional (3D) cameras has been explored to detect and reach/grab objects [12], [13]. Similarly, in [14], eye tracking is used to infer human intents, detect objects and control an AT device in 3D. Brain-computer interfaces (BCI) using EEG [15] and/or electrocorticography (ECoG) [16] have also been designed and tested, but although they achieved promising results, this category of BoMI can remain difficult to operate without extensive training, or be very invasive when they are requiring a physical connections to the actuating organs, through electrodes, for instance [17].

In order to operate robotic arms and operate motorised wheel chairs, non invasive and wearable controllers based on Electrooculography (EOG) have been implemented successfully.[18]-[19].

In order to translate user’s residual muscular activity into commands, surface electromyography was used, these activities are identified by robust detection and pattern recognition techniques. Along with the systems that are based on electrophysiological signal measurement, there are different types of BoMI which works on the residual natural body motion sensing have been designed [20-21]. In [28], a multimodal interface is combining head motion, speech recognition to control a computer. The combination of sEMG, eye-tacking and EEG is proposed in [29] to manipulate a prosthesis with high dexterirty. Such approaches are deemed to provide many more degrees of freedom (DoF) then unimodal control systems, opening up the possibility of harnessing more potential control strategies better suited to each individual user [30]. A multimodal BoMI based on a adaptive wireless control system (AWCS) is developed for people living with upper-body disabilities. Already, concept of 2D BoMI prototype has been proved. It has three nine-degree-of-freedom (9-DOF) inertial measurement units (IMUs) are connected to a microcontroller and help measuring the user’s head and shoulders position, using a complementary filter approach. The results are then transmitted to a base-station via a 2.4-GHz low-power wireless transceiver and interpreted by the control algorithm running on a PC host [31]. Now, In this paper, a complete 3D BoMI based on AWCS running on a Raspberry Pi (RPi) is presented.

**AUDIO MODEL**

**A. Requirements**

In MAWCS, first adaptive model is voice model. Generally, the agenda of MAWCS, is to help the disability persons. This audio model helps the disable persons to operate the arm by voice commands. This model consists of Raspberry pi, motor shield, servo motor, mic.

**B. Functional Description**

The proposed control interface exploits user’s voice through mic. Those voice signals are converted to electromagnetic waves and transmitted by the help of trans receiver to raspberry pi, since the connection between mic and raspberry pi is wireless.

The received signals are compared with the predefined voice commands which are already fed in raspberry pi, and after finding the command it moves the respective joint of the arm with the help of motor shield.

**ADAPTIVE MODEL – 2**

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