Full Length Research Article

OUM v0.1: MIND CONTROLLED ROBOTIC ARM

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ABSTRACT

The field of Robotics is growing fast in order to make the people's life efficient and easy. There are various machines or robots designed and manufactured in this particular field to help the handicapped people facing the problems like blindness, broken legs or arms, body part dislocation etc. As, there are limitations in the robotic works, the people are focusing on more accuracy provided by robots. The mind controlled robotic arm (OUM v0.1) is the next step in order to achieve more accuracy. Thus, to overcome the mentioned problem, we are designing and manufacturing a robotic arm in order to make it more useful by the people residing in the mentioned category. OUM (One Universal Mind) is a field created by us and thus we are developing various projects in it. The project OUM v0.1 aims to develop and engineer a Robotic Arm which will be controlled directly by human being's brainwaves. These brainwaves will be sensed by using EEG (Electroencephalogram) technology. The intelligence in this technology is to build an algorithm which will grasp the current activity of human brain i.e. collecting the information generated by Neurons which are activated by human brain and convert them into plan of actions which will be processed by robot using Digital Signal Processing (DSP) technique. OUM v0.1 robot will then receive the human brainwaves as digital input and will work accordingly. The robot motions and movements of robotic arm will be completely dependent on the brainwaves which human beings will produce. The modules on the robot will be for the robotic arm Actuations by using an android app or by using Gyroscope sensors. These modules will be additional in this project. The methodology of this project is based on the fields of Robotics, Artificial Intelligence (AI), Internet of Things (IoT) and Artificial Neural Networks (ANN). There are various sensors which we are going to deploy on the structure of robotic arm for sensing the physical parameters such as room temperature, pressure, light, fire hazards, etc. The project cost will be increased accordingly. OUM v0.1 will be the advanced robot of the generation and it will not be developed on the basis of any particular domain as we are trying to merge the different domains in this single project. Hence, this will be an innovation in the field of above mentioned domains.

INTRODUCTION

A considerable amount of research effort has been channeled towards the identification and utilization of information of human emotions. Various ways of human-computer and human-machine interaction have been studied in the effort of enabling computers and machines to be more alert to the emotions and affective needs of human beings. The BCI (Brain Computer Interface) is the latest innovation in the field of Artificial Neural Network and channelize human emotions or using them efficiently for some activities or actions. OUM (One Universal Mind) is a field created by us and thus we are developing various projects in it.

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legs or arms, body part dislocation etc. As, there are limitations in the robotic works, the people are focusing on more accuracy provided by robots. The main aim of OUM v0.1 is to make use of prosthetic arm i.e. the robotic arm which will be more useful to handicapped or physically challenged people to make use of their brainwave directly using an EEG (Electroencephalogram) system in order to control the arm actions accordingly. There will be various sensors deployed on robot which will increase in applications for more challenges.

Scope

Use in Day to Day life

People who are physically challenged having various physical illnesses are the main focus behind developing the project. They can make use of the robot arm in order to take control over various actions which are impossible for handicapped people.

Medical and Healthcare

This project also aims to provide a helping hand for handling various hazardous chemicals in medical industry or to provide more accuracy for performing any healthcare based actions.

Military and Industrial Use

The robot arms are very useful in military bases in order to handle heavy loads and to handle dangerous weapons and to perform transportation from one place to another. Also, this project includes the industrial use in order to perform accurate tasks which human beings lacks in some tasks but by using their brains as the brain activities have the accuracy which will provided to robots.

Definitions, Acronyms and Abbreviations

OUM (One Universal Mind)

OUM is the derived field which combines the work from various domains or fields such as Artificial Neural Networks (ANN), Internet of Things (IOT), Robotics, Artificial Intelligence and Embedded Systems. It is a field of study where people can work on these mentioned fields and combine them in order to make world a better place.

EEG (Electroencephalogram)

EEG is used to record information of the human brain activities in the form of measurement of electrical activity of the brain. The electrical activities of the brain are recorded from electrodes placed on the scalp and this measurement may indicate the emotion state of human subject while the information is recorded. Researchers believe that the states of the brain changes as feelings change, therefore, EEG is suitable for the task of recording the changes in brain waves which vary in accordance to feelings or emotions.

Arduino

Arduino is an open-source electronics platform based on easy to use hardware and software. It is intended for anyone making interactive projects. Arduino senses the environment by receiving inputs from many sensors, and affects its surroundings by controlling various output actions. You can write the code in order to perform some specified task needs to be done by the Arduino board. It is having its own development environment.

Product Perspective

The product is supposed to be for the physically challenged people and to perform the tasks which are not performed by human being but having the same accuracy as the human brain has. The following are the perspectives of the project:

Cross-platform support

Offers operating support for the most known and commercial operating systems

User Privacy

The users are allowed to create their own account at front end in order to access the system by themselves only.

Help Section

The help section provides user in order to make proper decisions about making the right connections, proper utilization of system, etc.

Efficiency

The basic need about this project that it should work efficiently and the product release will be having several versions in order to provide maximum efficiency.

Dependencies

The product is highly depending upon the human brain activities which are considered as neurons. The product is also depending on the interface between the hardware which is to be used and the USB dongle used by the EEG headband.

Design and Implementation Constraint

The product is completely built on Embedded Systems framework where the interface is important between the hardware and the human brain. The design is fixed for the interfaces while it is adaptable according to use of various sensors which will be deployed.

Software and Hardware Interface

Software Interface

Front End

The front end will have the JAVA stand-alone Application which will provide the desired user interface in order to make connection of brain with EEG system. Also, it will provide various graphical and signaling interface in order to show the connection status and the data transfer between human brainwaves and microcontroller to achieve customer satisfaction.

Back End

The back end will consist of an algorithm which is developed in Arduino IDE which will take cover on the every activity of robot arm and it is also responsible to make connection with the EEG headband. It also takes care of data transfer & the additional works depending upon use of various sensors being used. It gives output as control signals to servos used in robot arm as per the defined commands in Embedded C language.

Hardware Interface

USB dongle to Arduino

The Arduino microcontroller consists of receiver and transmitter pins which are used for communications with external modules or devices. The USB dongle associated with the EEG headband is interfaced with Arduino RX,TX pins in order to obtain the data transfer.

Servo motors

The servos or servo motors associated with robotic arm structure are connected to Arduino. These will perform or actuate in angles which take input form EEG system.

Pulleys/Gear Mechanism

Small pulleys will be used to control the movement of fingers or gear mechanism will be used.

EEG Headband

The main product is the EEG headband which performs main operation of taking input as brainwaves and sends the data on the USB dongle which communicates with it.

Techologies to be used

Arduino IDE

Arduino is an open-source electronics platform based on easy to use hardware and software. It is having its own development environment where the code can be written to perform specific operations according to hardware or as per defined logic.

Java

Java is used in this project in order to build the front end application for providing user interaction for using the EEG headband in order to recognize how system works. It provides various operations such as checking the EEG connections, maintaining graphs and data logs, etc.

Embedded C

Embedded C is used in this project for giving desired commands to EEG system through use of transistors, capacitors and amplifiers. The electrodes on the scalp of human brain are integrated with commands generated for each EEG captured brainwaves. Each brainwave has given a command which will send the control signal to actuators or any required output action.

Sensors

Sensors which perceive the various environmental factors are used as per the requirements such as temperature, proximity, gyroscope, accelerometer sensors, etc.

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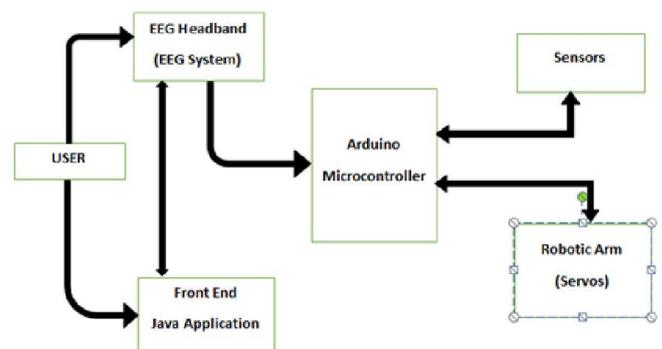
Productfunctions

Figure 1. Basic Architecture Design

Functions of EEG Headband

- Enable the user to interact with the EEG hardware.
- Enable the user to deploy the headband easily on the scalp.
- Making less use of Electrode gel that leads towards tedious deployment of headband.
- Headband must have emergency on/off switch.

Functions of USB Dongle

- Make successful communication with the EEG headband.
- Perform data transfer between Arduino and headband.
- Organizing the analog signals generated from brainwaves into group of data packets.

Functions of Arduino microcontroller

- Accept the input in the form of data packets.
- Perform desired algorithm to convert the packet into frames containing digital signals in the form of bits.
- Send control signal over servos according to accepted input.

Functions of Java Application

- Enable the user to perform checking of each electrode on the scalp of its brain.
- Enable the user to interact with the desired user interface for performing sending data operations and to display the

graph of related data.

- Enable the user to login into the system for ensuring its privacy.

User Characteristcs

It is considered that user must not be Mentally Challenged. The system will work for the physically challenged people to perform several other works as per the human thoughts. User should be aware about login credentials which are useful for controlling the system. User should have the concentrated mind in order to take control over the system. The concentration helps in making use of system more efficient.

Constraints

Hardware Constraints

The system must enable all the communication channels necessary to perform the data transfer from EEG to USB dongle to Arduino microcontroller. This data is then given to servos as control signal to perform necessary arm movement.

Software Constraints

The system must provide the user interaction to user for handling the system efficiently and utilize it to greater extent. The software should provide the security and privacy for the individual user to keep track of their own task with the help of graphs and figures. It should also provide help to keep user aware about the system.

Assumptions and Dependencies

One assumption about the project is that user is not mentally challenged and human is under his/her psychological behaviors. The second assumption is that user is aware about the robotics systems i.e. users have the overview on the robotic system. The another assumption is that user knows how the computer application works or depending upon provided installation steps, the user is able to install the software on the computer system. If user is unaware about how system works then it will be problematic in different ways. The application cannot be adaptable according to user needs. It will always have the fixed User Interaction design and format.

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