IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 66-68

Involuntary Action Enabled Robotic Prosthesis with Brainwave Control

Viraj Parab[1], Mohit Naik[2], Amit Parab[3], Mishal Roy[4], Dr. Bhavin Shah
[1,2,3,4,5]*(Electronics and Telecommunications Engineering, Atharva College Of Engineering/Mumbai University, India)*

Abstract: *As the field of robotics grows, robotic arms are becoming more and more popular among the specially abled people. The robotic arms controlled directly by brainwaves, or mind-controlled robotic arms as they are called, can carry out a wide range of actions and can greatly improve living conditions for the user. However, most of these arms can only carry out voluntary functions, involuntary (reflex) actions cannot be completed. To rectify this drawback, we shall be proposing a robotic arm which can carry out reflex actions, just like a normal human arm. Our aim would be to put forward an arm which detects motion of the objects in its vicinity, and accordingly carries out reflex actions. The detection of motion shall be done using ultrasonic, proximity and tactile sensors. Arduino and MATLAB software shall be used for transferring the command signal from the sensors to the arm*

Keywords: *Proximity sensor, Ultrasound sensor, TakkFast, Reflex actions,*

I. Introduction

Prosthesis is an interesting and very inquisitive field of research. The early age of prosthesis saw hooks and pegs followed with myoelectric. It gained a huge success on the successful training and implementation of mind- controlled prosthesis. But still something was lacking, which was the reflex actions. The mind-controlled prosthesis no matter how good did not have solution for reflex actions.

The solution to this problem can be achieved by grouping some sensors which can detect an obstacle and then estimate its position and distance from the user to defend the user from the obstacle. There are two such sensors who can possibly do the work. These sensors a well-known, easily available and inexpensive. They are the proximity sensor used in smartphones and the ultrasonic sensor used in cars to assist for parking. The proximity sensor projects an electromagnetic field which can be used to realise the whereabouts of any object coming towards the user. The ultrasonic sensor is used to approximate the distance of the obstacle from the user. These sensors are connected to “TakkFast”. TakkFast is a tactile sensor board which helps the sensors to give a quick response.

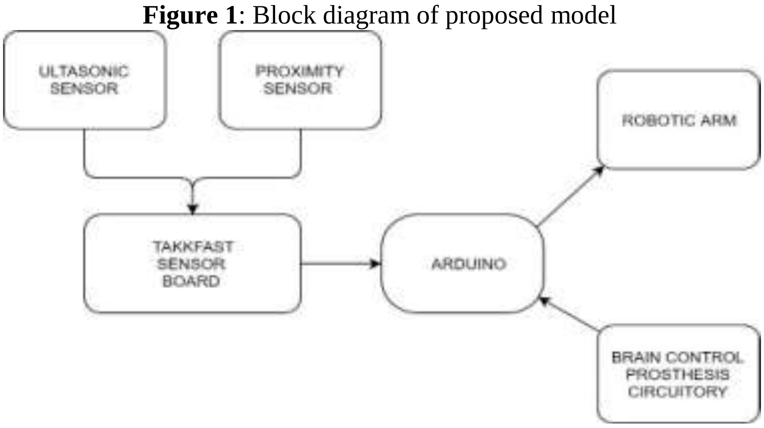
Thus, with the help of this group of sensors the prosthesis can reflect to any obstacle making a user safe against dangers and at the same time making the prosthesis more realistic.

II. Literature Survey

Reflex actions typically involve an action which immediately follows a stimulus. Reflex actions are done without any active thought put in by the brain. This implies that the brain does not commence any thought process before the reaction takes place. The reaction is quick and instantaneous. A reflex action happens as a reaction to well-imbibed, well-gathered understanding of alertness and caution. The path that a reflex action follows consists of an afferent nerve (carries the signal from the sensory nerves to the central nervous system and brain), an efferent nerve (carries signal from CNS and brain to the sensory nerves), and various other intermediate nerve cells which lie in the nervous system. The pupillary light reflex is a well-known example of a reflex action. On beaming a light near one’s eyes, the pupils of both the eyes contract involuntarily. In this case, the stimulus is light, the optic nerve does the function of transmitting the signal to the CNS, and the response signal is delivered to the muscles in the pupil region by nerves that are linked to the eye. The one particular reflex action that we are concerned with, with respect to this robotic arm, is the hand’s immediate motion to protect the body when some object is coming towards it. Once again, the optic nerves detect the stimuli (the incoming object) and deliver the signal to the CNS, which instructs the arm instantaneously to move defensively so as to act as an obstacle between the object and the body. A high voltage electric current is given to the transducer within the ultrasonic sensor. It begins to vibrate at a specific frequency, and this triggers a surge of sound waves[1,2,3]. These waves reflect back from a hurdle in its path, in the form of echo waves. The time period between sending the waves and receiving of the echo is calculated, and this gives us the distance between the sensor and the obstacle. When attached to the robotic arm, the ultrasonic sensor acts as the sensory nerve, and the Arduino panel acts as the CNS.Block Diagram

I. Technical Specifications

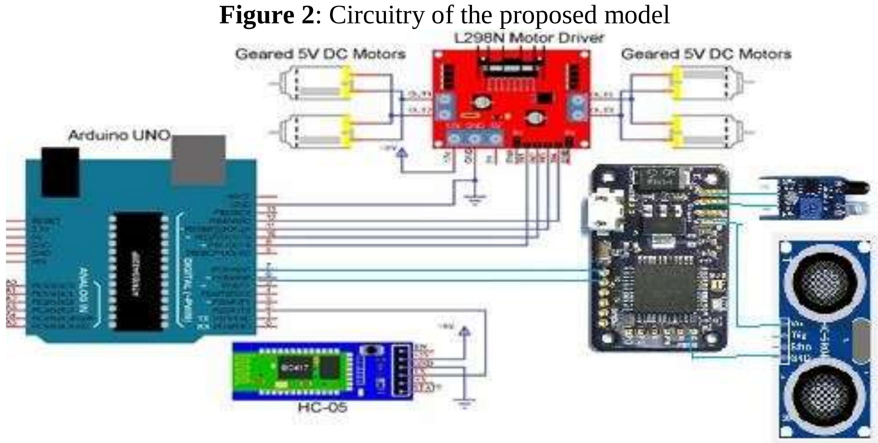
Figure 1: Block diagram of proposed model



For measuring distance through ultrasonic waves an ultrasonic sensor is used. The head sensor emits an RF wave and the reflected wave gives the overall measured distance. Proximity sensor is used to detect nearby objects. This is done using electromagnetic field and the return signal gives the information about all objects in vicinity[4,5]. The ultrasonic sensor provides the distance and proximity sensor provides the objects in the surrounding, both the information is given to Takkfast sensor board. Takkfast is a type of board that takes all the signals from different sensors and provides an interface with Arduino. It gives all the input sensor information at the Arduino input side. Takkfast has 5 solder terminals. Brain control headset gives the neuro signal to the Arduino where these signals are been processed along with the proximity and ultrasonic signals[6,7,8]. At the end Arduino gives the output as a movement of robotic arm which is connected after Arduino. Arduino consist of programs for different movements. At the output robotic arm shows different hand movements for reflexes.

Working of the proposed ideology

Figure 2: Circuitry of the proposed model



Detection of obstacle

The proximity sensors are the sensors which operate with infrared or electromagnetic field. They continuously project a field, if any obstacle is coming towards the user the rays will be reflected back to the sensor. This activity confirms that there is an obstacle approaching the user. This will turn on the ultrasonic sensors. The ultrasonic sensors approximates the distance and position of the object from the user. The ultrasonic sensor projects an ultrasonic wave which hits the obstacle and comes back to the sensor on the receiver end and thus the distance and position of the obstacle is tracked[9,10,11]. Once the sensors sense this a signal is sent to TakkFast sensor board which in return sends a signal to Arduino.

Robotic arm

The robotic arm consists of the geared stepper motors connected to the motor driver circuit. The motor driver circuit is as output from Arduino is +5v while the motors require +12v to operate. The commands are taken from the circuitry of brain wave control as TakkFast is connected as an input as well as an interrupt controller to Arduino as the defending of an obstacle is more necessary than a task to be performed.

Swift response

The TakkFast is a tactile sensor board which is used for sensing touch. Touch signals are very sensitive as compared to signals from Ultrasonic and proximity sensors[12]. This assures that the board will be easily able to coordinate with the Arduino on signals at very high speed. TakkFast board is embedded with the Arduino board. The TakkFast board is connected at input port as well as an interrupt and the Arduino can be programmed such that, if a signal comes from the TakkFast board and there is a task which Arduino is already performing it will take the signal as a priority interrupt which will reset the Arduino and the signal from TakkFast board will be taken first as priority and according to the signal the task will be performed. This assures the safety of the user.

III. Conclusion

Including reflex actions within the repertoire of the robotic arm will greatly increase its functionality and efficiency. Using ultrasonic and proximity sensors, the functions of the nerves and human nervous system can be replicated in the robotic arm to a huge extent. More than carrying out everyday functions, protection from incoming damage is of more importance for specially abled people. The proposed arm can provide and assure the user of a degree of safety in this respect. The greater the functionality of the robotic arm, the more it can serve as an effective replacement for a human arm. Further, there is great scope for improvement and progress in this project. Robotic arms performing voluntary functions are already available. On combining the reflex action technology of this arm with that of voluntary action arms, a complete substitute for the human arm can be created. The arm can be highly useful tool to serve specially abled patients and can prove to be a revolutionary advancement in the field of medicine and prosthesis.

References

[1]. Lee, H.K., Chang, S.I. and Yoon, E., A Flexible Capacitive Tactile Sensor for Robots Implemented with Proximity Sensing Capability on a Single Polymer Platform.

[2]. G. Benet, F. Blanes, J.E. Simó, P. Pérez,Using infrared sensors for distance measurement in mobile robots,Robotics and Autonomous Systems,Volume 40, Issue 4,2002,Pages 255-266,ISSN 0921-8890,https://doi.org/10.1016/S0921-8890(02)00271-3.

[3]. P.M Novotny, N.J. Ferrier, "Using infrared sensor and the Phong illumination model to measure distances," International Conference on Robotics and Automation, Detroit, MI, vol. 2, April 1999, pp. 1644- 1649.

[4]. G. Benet, F. Blanes, J.E. Simo, P. Perez, "Using infrared sensors for distance measurement in mobile robots," Journal of Robotics and Autonomous Systems, vol. 10, 2002, pp. 255-266.

[5]. A. Sabatini, V. Genovose, E. Guglielmelli, A. Mantuano, G. Ratti, and P. Dario, "A low-cost, composite sensor array combining ultrasonic and infrared proximity sensors," International Conference on Intelligent Robots and Systems, Pittsburgh, Pennsylvania, vol. 3, August 1995, pp. 120-126.

[6]. V. Colla, A.M. Sabatini, "A composite proximity sensor for target location and color estimation," IMEKO Sixth International Symposium on Measurement and Control in Robotics, Brussels, 1996, pp. 134–139.

[7]. L. Korba, S. Elgazzar, T. Welch, "Active infrared sensors for mobile robots," IEEE Transactions on Instrumentation and Measuremen, vol. 2(43), 1994, pp. 283–287.

[8]. A.M. Sabatini, V. Genovese, E. Guglielmelli, "A low-cost, composite sensor array combining ultrasonic and infrared proximity sensors, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Pittsburgh, PA, vol. 3, 1995, pp. 120 –126. [7] H.R. Everett, Sensors for Mobile Robots, AK Peters, Ltd., Wellesley, MA, 1995.

[9]. A.M. Flynn, "Combining sonar and infrared sensors for mobile robot navigation," The International Journal of Robotics Research, vol. 7(6), 1988, pp. 5-14.

[10]. G. Benet, J. Albaladejo, A. Rodas, P.J. Gil, "An intelligent ultrasonic sensor for ranging in an industrial distributed control system," IFAC Symposium on Intelligent Components and Instruments for Control Applications, Malaga, Spain, May 1992, pp. 299–303. [10] B.

T. Phong., "Illumination for computer generated pictures," Communications of the ACM, vol. 18(6), June 1975, pp. 311-317.

[11]. Honeywell Sensing and Control Catalog. (2000) Series 940-942 Ultrasonic Sensors. [Online]. Available: www.honeywell.ca/sensing/. [12]. Flintoff, Zak & Johnston, Bruno & Liarokapis, Minas. (2018). Single-Grasp, Model-Free Object Classification using a Hyper-Adaptive Hand, Google Soli, and Tactile Sensors. 10.1109/IROS.2018.8594166.