Behavioral treatment in autism spectrum disorder children by Repetitive motion control

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Abstract

Health is a significant concern that focuses on the physical, mental, and social living of humankind. Today keeping individuals as healthy and active with readily available healthcare system is a necessity. Autism is one of the developmental disorders, usually noticed with signs in the first two or three years of child growth which shows symptoms like communication and language inability. Researchers have proved that autism disorders can be overcome by holding therapy or applying deep pressure in children. The treatment involves forced/ tight holding provided by physiotherapist or parents to calm. The improper behaviour of child slowly stops for a fixed time period. The current research suggests a behavioural treatment for repetitive motion in an autistic child. This intervention is achieved due to the control of repetitive or stereotypic motion by sensing the unbalanced signals received from heartbeat and motion sensors placed in the autistic child's body. The irregular sensor signals are communicated to parents and therapist for future data analysis.

Keywords: *Health care system, Autism Spectrum Disorders, Repetitive motion control, Holding therapy.*

Introduction

A modernized patient monitoring system provides individuals with improved healthcare facilities in an economical and patient-friendly way at any instant. The healthcare system is currently experiencing both cultural and modernized transition from a traditional approach to a modernized approach. Healthcare professionals play a vital role in providing knowledge significant part to the patient in the conventional strategy. The basic problem associated is that healthcare professionals must be insight with the patient who is admitted in hospital and they stay bedside to the medical instruments. To overcome this concern, the patients should be equipped with adequate knowledge to play an important role in self-diagnosis and preventive measures. Notification of present state of a patient and its recording for future predictions is of great importance in patient monitoring.

Autism Spectrum Disorders (ASD) is a challenge even to educator those try to plan effective instructional programs for recovery [1]. Autism affected young children are at high risk to face communicational behaviours. Early intervention in autism young children should be done for analyzing their functional and problem behavioural treatment [2]. Because of the ubiquitous nature of autism impacts on the functioning of the individual in college and home, parents need to be included as active partners in the development of the instructional plan of their child. Autism children reported deficits in their ability to generalize their behaviours learned from one person to others [3].

The necessary elements needed for the treatment of autism disorders are support from individuals and families, instructions, well-structured learning environment, approach to their problematic behaviour, and involvement of member of family. Influence of family members is valuable in monitoring a child's environment [4]. A joint partnership with the family and doctors can contribute to the effectiveness of treatments. In their child development, parents are actually the first to recognize delays and difficulties. They are constantly seeking diagnoses and procedures that will enable their kids to gain autonomous abilities and a better quality of life [5]. The present survey has suggested that in order for educational programs that address problematic behaviours of children to be successful, their proactive behaviours must be monitored periodically.

This provides a clear that the problem behaviour of the

Child is not altered, instead,treatments should be focused on replacing the problem conduct with an effective suitable alternative conduct or mechanism resulting in a comparable effect.

A person will not be able to concentrate on a particular work at all means and tend to lose their concentration at certain times that provides a chance for mistakes. Modern patient monitoring should at all times obtain, record, display and communicate physiological information from a patient's body to a distant place by encapsulating the benefits of current bioinstrumentation and telecommunicationtechniques. [6] [7].

A different form of the patient monitoring system should be used to monitor the autistic child. The autistic child behaviour is sent as real-time data by appropriate sensors to their doctor and parents. In case of critical information in the obtained sensor data, the child must be saved by the engineered autistic system and a message of the current state of child should be sent to the doctor as well as parent. The purpose of this work is to engineer a proof of concept system that will inflate an air jacket worn by the child at the desired pressure limit.

Experimental Method

Sensing in the device begins with a motion sensor, and the sensor readings are provided to a microcontroller for processing. Initially, A microcontroller converts the sensor measurements from an analog to a discrete value. This process is achieved before entering the microcontroller bypassing the sensor outputs through an Analog to Digital Converter (ADC). To calculate the necessary elements, the microcontroller must take the digital data from the ADC and apply various formulas and conversion factors. Then microcontroller compares the digital input with threshold limit, initiating triggers when certain preset values or limits get exceeded. In the entire process of sensor readings, the algorithm tries to detect a repetitive motion [8] [9] [10].

Upon detecting this dangerous sensation, the microcontroller initiates a signal which will turn on the driver to inflate an airbag strategically placed at the waist of the patient. Fig 1 shows the process flow for triggering inflation jacket during autism disorders. When the child experiences repetitive problem behaviour s like frequent gestures, unusual postures, teeth grinding, hand flapping, and self-injurious behaviour, causes the change in motion or movement that produces vibration. The sensors acquire the vibration from the child's body and it is provided to the Arduino. The microcontroller receives the signal from the motion sensor and heartbeat sensors located in the child body. The microcontroller actuates the relay if the signal obtained is beyond the threshold limit. In turn, the relay actuates the 24V direction control valve (DCV).

This valve is an integrated electro-mechanical device containing a solenoid coil that actuates a solenoid switch. This opens the pneumatic pressure air to inflate the air jacket worn by the autistic disordered child. This inflation causes a jerk or sudden movement of the person wearing the jacket. This actuation mechanism induces a change in the behaviour of autism children, and finally, the child attains consciousness and tends to stop the repetitive movements. The sensors continuously check for the threshold limit and monitor the behavioural nature of the child.

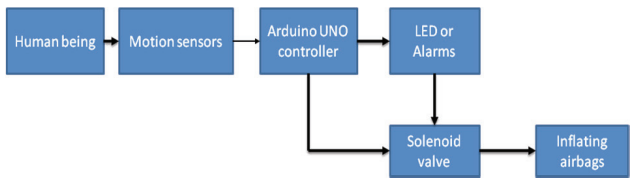

Fig. 1. Process flow for triggering Inflation jacket during Autism Disorders

The present conditions of child behaviour are predicted through simple programs embedded in the controller. The controller contains GSM module and mobile communication modem [11]. Suppose if the child didn't stop the behaviour after the threshold time interval, it sends the data about the problematic state of the child to doctor and parents via a messaging service.

Working of the Project

A child experiences repetitive behaviours, which include frequent gestures, unusual postures, teeth grinding, hand flapping, and self-injurious behaviour. It occurs in the child's body, causing self-injury. Hence these behaviour need to be sensed by a motion sensor like the adxl335 accelerometer. It is a 3-axis accelerometer with low energy, signal voltage conditioning. The sensor measures acceleration with a minimum 3.0 g range and measures static gravitational tilt acceleration to detect dynamic shock or vibration speed. Motion sensors detect the motion after calibrating it to an initial point in the three-dimensional axis. Motion sensors can be placed at

the wrist and neck.

Initially, the motion sensor senses which gives the analog value, and then the analog values are compared to previous analog value when it reaches the higher level the sensor produces output voltage. The output depends on the programming of the Arduino controller. Motion sensors used in this system senses the resonating motion and sends the signal to the Arduino controller that actuates the alarm and sets the LED to glow. Fig 2 shows the Process set-up for triggering inflation jacket. The Arduino board then actuates the solenoid valve and makes the airbags to inflate, and when the readings exceed the saturation value, a signal is sent to the GSM module which sends a message to the patient's parents.

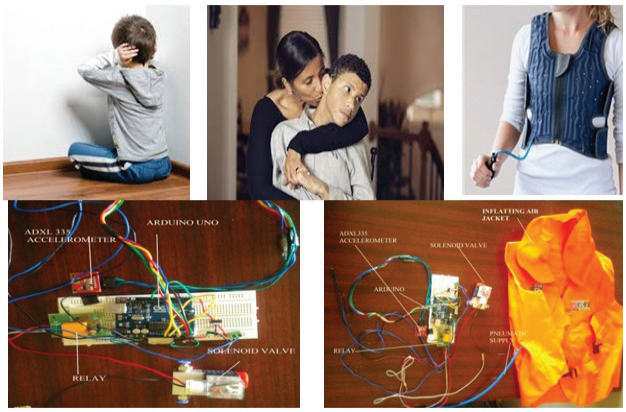

Fig. 2. Wearable air jacket set-up with controller mechanism

Arduino works on the basis of c programming. It is actuated by the signal from the accelerometer sensor. The Arduino controller works on the input of 5volt. The program can be dumped into the Arduino controller based on the requirement. The Arduino controller gives an output voltage of 5v when the accelerometer gives output. A time delay can be added to the program so that we can control the time of output voltage. This output signal from the Arduino is used to actuate the 12V relay. After the actuation of the relay, it remains on position for a particular time based on the Arduino programming. This 12V relay actuates the 24V DC solenoid valve. Thus actuation of solenoid valve opens the pneumatic supply to actuate the inflating airbag.

The solenoid opens according to the timing in the Arduino controller. This quick opening of solenoid valve causes sudden expansion of the inflating air jacket suddenly. The sudden inflation of the pneumatic airbag causes a jerk or sudden movement of the person wearing the inflating airbag. This actuation mechanism of the inflating airbag induces a change in the behaviour of autism children. Thus this sudden expansion causes a change in behaviour, and the child attains consciousness and stops the repetitive movements.

An inflatable air jacket has major components like the chamber to hold air, source for gas (compressed air or CO_2 gas cylinder), and mechanism to discharge gas from the cylinder into the chamber and inflation tube to inflate /deflate air to/from the chamber manually. Usually, inflatable jacket uses compressed air or CO_2 to fill with air. The inflatable air jacket inflates automatically when the jacket is triggered by the sensor signal and inflation of the jacket takes place.

The gas from cylinder fills a nylon or polyamide material jacket such that the gas fills at a velocity of 100 m/s. The entire process that is from the initial sensing to fill the air jacket takes about approx. 500 milliseconds. This set-up weighs approximately 0.9 kg and is fitted inside the standard protective jacket. Timing is crucial in the airbag's ability to save lives in a repetitive mechanism. An air jacket must be able to deployable in a matter of seconds from the initial sensor signal recognition. It must also be prevented from deploying when there is non-occurrence of problematic situation. Hence, the first component of the airbag set-up is a sensor that can detect and immediately trigger the air jacket's deployment.

Thus, as a result, the inflated air jacket is now filled with air from the pressurized cylinders and prevents the impact of repetitive behaviour. This, in turn, reduces their chance of injury. And at the same instant, the GSM module gets activated to send messages to the child's parent and doctor. The doctor can be able to predict the behaviour of child with the help of this GPS system and provides the necessary treatment. The air jacket serves the purpose of protection from the impact of repetitive behaviour by control action.

Conclusion

Children affected with autism should be protected from self-injuring and their problematic behaviour should be overcome. And at the same time parents and doctors will be able to know to monitor the child's health even from the remote location. The significance of extensive behavioural analysis will reduce problems and add aspects to the lives of a child to enhance the richness and efficiency of life, teaching and community activities.

future scope

The sensors can be used to gather and analyze the numbers of biomedical parameters. This scheme may also be coupled with a web-based architecture in which mail is sent to the physicians concerned. The prescribed patient study may also make automated delivery of drugs possible. Miniaturized pneumatic compressors/ cylinders can be used to make the inflating air jackets compact and independent of external pneumatic supply. We predict that the field of system change will be defined and refined in future years, but it is clear that any attempt to implement existing best practices in behaviour al support must recognize that the intervention unit is expanding.

Ethical Clearance- Not required since it is in development phase only.

Source of Funding- Self

Conflict of Interest -NIL

References

1. Boyd, Brian A., et al. "Sensory features and repetitive behaviour s in children with autism and developmental delays." Autism Research 3.2 (2010): 78-87.
2. Boyd, Brian A., Stephen G. McDonough, and James W. Bodfish. "Evidence-based behavioural interventions for repetitive behaviour s in autism." Journal of autism and developmental disorders 42.6 (2012): 1236-1248.
3. Stronach, Sheri, and Amy M. Wetherby. "Examining restricted and repetitive behaviour s in young children with autism spectrum disorder during two observational contexts." Autism18.2 (2014): 127-136.
4. Johnson, Chris Plauché, and Scott M. Myers. "Identification and evaluation of children with autism spectrum disorders." Paediatrics 120.5 (2007): 1183-1215.
5. Clifton, L., Clifton, D. A., Pimentel, M. A., Watkinson, P. J., & Tarassenko, L. Predictive monitoring of mobile patients by combining clinical observations with data from wearable sensors. IEEE Journal of biomedical and health informatics, (2013). 18(3), 722-730.
6. Lee, Young-Dong, and Wan-Young Chung. "Wireless sensor network based wearable smart shirt for ubiquitous health and activity monitoring." Sensors and Actuators B: Chemical 140.2 (2009): 390-395.
7. Yuce, Mehmet R. "Implementation of wireless body area networks for healthcare systems." Sensors and Actuators A: Physical 162.1 (2010): 116-129.
8. Liang, X., Barua, M., Chen, L., Lu, R., Shen, X., Li, X., & Luo, H. Y. "Enabling pervasive healthcare through continuous remote health monitoring." IEEE Wireless Communications 19.6 (2012): 10-18.
9. Nawka, N., Maguliri, A. K., Sharma, D., & Saluja, P "SESGARH: A scalable extensible smart-phone based mobile gateway and application for remote health monitoring." 2011 IEEE 5th International Conference on Internet Multimedia Systems Architecture and Application. IEEE, 2011.
10. Pereira, O. R., Caldeira, J. M., Shu, L., & Rodrigues, J. J "An efficient and low-cost Windows Mobile BSN monitoring system based on TinyOS." Telecommunication Systems 55.1 (2014): 115-124.
11. Yu, Hongzhou, and Lu Liu. "Remote health monitoring system using Zigbee network and GPRS transmission technology." 2011 Fourth International Symposium on Computational Intelligence and Design. Vol. 1. IEEE, 2011.