COMPUTER PLAY IN EDUCATIONAL THERAPY FOR CHILDREN WITH STUTTERING PROBLEM: HARDWARE SETUP AND INTERVENTION

Nur Azah Hamzaid, Ammar Ali Al-Aawr, Khairul Azly Rosli

Faculty of Engineering
University of Malaya
azah.hamzaid@um.edu.my

ABSTRACT

Children learn best through play. A child with a disability might greatly benefit from this principle. This paper presented the development of a proposed computerized educational toy for children stuttering treatment intervention. Stuttering voice signal were processed and fed into the system to determine the stuttering severity or speech improvements and the toy would respond accordingly as a motivation and direct feedback to the child's speech performance. Signal processing and hardware integrated control were successfully developed using LabVIEW programme. The prototype could be used as the basis for further stuttering intervention development amongst children.

Field of Research: stuttering, children, play intervention therapy.

1. Introduction

The field of child stuttering intervention has been quite established but the use of technology is still not optimized. Most of the intervention employed the principles of speech-pathologist based therapy, and some of them include the child's parents training and environment modification. These have to be properly conducted or the treatment might not be effective. Otherwise, a child is required to visit the therapist on a weekly basis which may involve compliance issues, thus might impede or delay the improvement of the child's speech. Therefore, an assistive technology could be employed to supplement the traditional treatment or intervention, in order to maintain or improve the training effects.

2. Objective

This work aims to develop a prototype of robotic play hardware to provide a comfortable environment amongst children with stuttering disorders. The project mainly focused on how to provide an interesting environment for children who stutter by utilizing computer and robotics technology.
3. Method

3.1 Stuttering Signal Discrimination

The first step in order to classify the stuttering signal is to record the sound signal data. The necessary acquired data were analyzed using LabView, which is able to custom made whatever analysis, measurements and classification of data. Then, a full range of algorithm will be developed to classify the level of stuttering. This algorithm will be used back in order to create a real-time sound acquiring data instead of recording the signal.

After hardware setup and algorithm development, voice of stuttering and stammering children was acquired by sound card of any laptop or computer. The input was based from the signal from a microphone, then amplified and filtered using LabView software. The filtered signal was analyzed with LabView to automatically classify the type of stuttering that the patient had based on the pre-developed algorithm. This classification was required in order to determine the appropriate mini-robot movement.

The stuttering was set into 4 levels and so does the robot. That means, the level of stuttering that children have will indicate level of robot action. Level 1 will have less robot action than the higher level, and keep on increasing until the maximum level. The signal that made the robot move was transferred to the Reconfigurable Input Output device that is Arduino (Single board-RIO) and sent to the robot. This is basically the deployment of target device from the LabView software that had been programmed. This ensured the fun element in the children’s playing experience, even when they are alone. A stuttering or stammering child usually has low self-esteem when talking to another person. That is why they will not have good progressing to cure the stuttering or stammering. This invention ensures they still have their therapy even when not talking to anyone else outside.

The sound signal was acquire from the patient through the Imation BMH210 wireless microphone. Optionally, the children behavior when stuttering could be acquired, to ensure the reliability and accuracy of the sound signal, by using the Logitech WebCam, and recorded using LabVIEW software that had been programmed. The sound signal of the patient was recorded using Gold Wave Editor Pro software. More than 3 samples were recorded for each child to ensure the accuracy in classification.

The sample were played-back in LabVIEW to analyze the pattern and classified into the 8 types and 4 levels of stuttering. The analysis depends on the pitch, signal timing, formant frequency, resonance, amplitude and other identified parameters.

3.2 Mechanism of the Proposed Computer Play Therapy

The children will initially familiarize themselves with the computer play therapy software by simply playing and communicating with it. However, instead of just playing the games, the program analyzes the stuttering pattern and level. As the game ended, the data of the level of stuttering will be transferred to the robot system in real time. The robot will act and move depending on the level of that particular children level of stuttering. For the software to interact with the robot, Arduino (Single board-RIO) was used as their output channel to the robot movement.
3.3 Hardware Setup and Integration

A spinning Ferris wheel toy was chosen as the hardware main components. Spinning Ferris wheel has a relatively flexible structure which can be modified to fit the design requirements. Two DC motors and 4 LEDs were attached to the toy.

The first actuators, i.e. a big DC motor, was attached on the center of the spinning wheel and a second one, i.e. a smaller motor, was attached to the small doll toy. The LEDs were placed on different positions on the toy. As mentioned earlier that frequency differs on stutters and non-stutters to numerous levels. Based on this concept, the sample toy will be acting various movements depending on the frequency level. The graphical program on LabView will be used to differentiate four frequency levels which are first level \((25>F≥0)\%\) or partially not stuttering children, the second level \((50>F≥25)\%\) or mild stuttering, the third level \((75>F≥50)\%\) or moderate stuttering, and the forth level \((100>F≥75)\%\) or high stuttering. The sample toy will be responding differently based on the frequency level. For example, if the stutter has the second frequency level, the small doll will be rotating and 3 LEDs will be ON. Fig 1 illustrates the frequency levels with its corresponding sample toy action.

4 Toy Performance

LabVIEW was used to develop a graphical program to control the speed of motors and ON-OFF LEDs. The program developed is capable to control two DC motors and four LEDs in different conditions (Fig. 2).
After the Labview program simulation has been successfully done, the NI-DAQ interface card were integrated with the motors and the LEDs to be attached to the sample toy. Since we need to control a motor, it was connected to an analog output channel on the DAQ card. On the other hand, LEDs is connected to digital output channels. The big motor was connected to the analog channel output 0 (AO 0) and the small motor is connected to the analogy channel output 1 (AO1). The LED_1, LED_2, LED_3 and LED_4 were connected to the digital output channels P0.1, P0.2, P0.3 and P0.4 respectively.

The big motor needs external voltage supply with at least 6V. Therefore, a RY5W-K relay that can permit us to use external voltage was used. The function of the relay is to work as a switch. When the relay receives the control signal from the Labview graphical program through DAQ card, it will switch the external voltage.

DAQ card has a maximum supply voltage of 5V. Therefore, the small motor will supplied be the DAQ card voltage and it does not have to be supplied by external voltage. The maximum voltage of the small motor is 6V. LEDs power was supplied using DAQ card.

The hardware setup integrated the DC motors and the LEDs to the sample toy. The big motor connected to the center of the Ferris wheel, the small motor was set for the doll and the LEDs were attached to the different positions on the spinning Ferris wheel. Some modifications on the sample toy were done to ease the attachments of the hardware attachment. The set up of hardware components to the Ferris wheel were illustrated in Fig 3.
5  Clinical Aspect of the Toy

Stuttering robotic play for rehabilitation is considered as clinical research which involves in treatment of the stuttering children. From the clinical point of view the child will gain two benefits from the toy which are the providing therapy and having fun while interacting with the toy. The therapy is the essential purpose of design this toy with different responses to enable different stutters to deal with. Toy therapy also benefits the children to improve their self-confidence and self-control. Another advantage of this toy is that it can be used in home or in clinics. The toy is proposed for stuttering children with age of 5-12 years old. This toy is considered a safe toy to be used individually by the child without any direct clinical observation.

This is a new development, as this approach to treat stuttering has not been much considered before, as speech therapists prefer and are more accustomed to traditional way of one-to-one and personal technique.

6  Future Work

For further work, more samples have to be collected in order to accurately classify the type of stuttering. The most appropriate and optimized algorithm can be developed by referring to all acquired signal. Other development will be on the robot design, sound effect improvements, and proper signal processing program.

6.1  Robot Design

In terms of robot design, one of the suggested improvements is to design different robots according to the age and the gender of the child. Since there are psychological differences between the children in different ages, the robot should be designed to fit...
level of thinking and attention. For example, the toy for a child of age between 5 and 8 years old should be more simple and friendly looking than the toy of age between 8 and 12 years old which need to be more complex and look like a character toy. We should also take the gender differences in consideration. It is obvious that the female child is attracted to the light color like pink however the male child likes the brown and gray color.

Another development that should be considered is the attachment of the hardware component such as motor and LEDs to the sample toy so that the toy will be durable and can be used for a long time.

6.2 Sound Effects

Another idea to improve this project is to include sound effects. Sound effects will make the toy more attractive. An example for sound effects is provide motivated statements such as “well done!” when the child pronounce properly and “try again!” when the child is stuttering. The apparatus for the sound effects should be attached to the toy such as microphone and recorder. Sound effects should be matches with the type of the toy. For example, if the toy is a soldier, its sound effects should be suitable with it.

Besides that, this idea could be improved by attaching the toy with a recorder to record the child speech and then play it, so that the child can listen to his own speech. When the child listens to his own speech he will try to correct the speech mistakes. A high quality sound apparatus such as microphone and recorder could be used. That can help to come up with a clear sound and less noise effects.

A speaking dictionary could be involved with the toy. The purpose of that is to make the toy more toward educational toy and in the same time an enjoyable toy as well. The dictionary will help the child to know the correct pronunciation of the words that he cannot pronounce.

6.3 Software development

The program can also include a virtual animation to provide attractive interaction environment between the child and the software instead of using the classical Labview environment. It will be better to develop virtual animation similar with the robot hardware.

7 Conclusion

The main aim is to design a mini robotic play that can be controlled by a stuttering child’s stuttering performance. A simple graphical LabVIEW program was successfully developed to meet the desired toy response. This could be used as a prototype for a better stuttering treatment intervention.
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References
