

Joystick mouse with voice command system architecture for Cerebral Palsy people

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M.Sc. Research Report

Department of Computer Science

Hong Kong Baptist University

2019

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An M.Sc. research report submitted in partial fulfillment
of the requirements for the degree of
Master of Science

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January 2019

Acceptance of M.Sc. Research Report

Master of Science in Advanced Information System

Department of Computer Science

Hong Kong Baptist University

We hereby recommend that the M.Sc. Research Report submitted by CHEUNG Sai Ho, Sunny entitled "Joystick mouse with voice command system architecture for Cerebral Palsy people" be accepted in partial fulfillment of the requirements for the degree of Master of Science in Advanced Information System.

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Declaration

I hereby declare that this M.Sc. Research Report represents my own work which has been done after registration for the degree of M.Sc. at the Hong Kong Baptist University, and has not been previously included in a report (other than the report for COMP7460 MSc Practicum for Information System), thesis or dissertation submitted to this or other institution for a degree, diploma or other qualification.

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Date: __30 December 2018

Abstract

At the beginning of the 21st century, the assistive technology has become very popular in the Western countries. Many IT companies and universities have developed the different kinds of computer software such as a communication board system, on-screen keyboard, and different types of human-computer interface hardware devices such as mouse emulating systems to assist people with disabilities in their use of computers. The purpose is to ensure that they can increase their communication ability and typing speed as much as what normal people can do by using these kinds of software and devices. The focus here is on improving the process of using the keyboard when the cerebral palsy people have abnormal hand movement, and these kinds of assistive technology cannot effectively detect which application program the user wants to choose. Thus, the author is proposing a new system architecture to increase the selection accuracy.

Acknowledgments

I would like to express my most sincere gratitude to my supervisor, Prof. Joseph K. Y. NG, for his knowledgeable guidance and supervision of my research work. I have learned a lot through interactions with him. I would also like to thank Dr. Kristen LI for serving as the Observer and providing valuable feedback on my research.

At last, my deepest gratitude goes to my parents, Mr. S.T. CHEUNG and Y.N. CHUNG, for their love, encouragement, patience and support.

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Chapter 1 Introduction of Cerebral Palsy people

1.1 The symptoms of Cerebral Palsy people

A cerebral palsy is a group of movement disorder when it appears in early childhood. Most cases involve a lack of oxygen to the brain during childbirth or viral infections during the baby stage. Actually, it is caused by damage to some parts of the brain and neurological systems in which these parts have controlled motor function, including body posture, balance and movement. According to the symptoms of a disability, it is poor muscle tone and coordination, movement control for their body and limbs, there may be problem affects with speaking, vision, hearing, carrying and walking. In this case, the people with CP cannot take care of themselves. They have different levels of learning difficulty and social injection (Hirsh et al, 2010).

For the problem of motor control, most people with CP have a problem with abnormal muscles tone and motor coordination, it has an involuntary movement with their four limbs. Sometimes their muscle tone is very high or low, so CP people are difficult to do the small motor movement of their hands, including writing and leafing through the physical books. As a result, there may have a problem affects with the progress of learning and intellectual development during teenager (Oskoui et al, 2013). The solutions are using some IT Systems for the enhancement of their learning quality, such as auto-complete with typing word systems, e-book systems and multisensor movement detection systems etc.

For the problem of speech, there may have restricted movement of the parts of oral muscles, around half of CP people are speaking unclearly, or even cannot communicate with people. Therefore, they can only depend on using the computer function of text-to-voice, text typing on-screen and translate to voice or using the communication board system which has enhanced the communication ability for them (Myrden et al, 2014).

In this case, the CP people need to face up the multiple challenges for their whole life, including learning, working and social activity etc. The occupational and speech therapists should have provided some physical training and using the assistive technology to increase their communication ability when they are still staying in the school, it is a crucial part for them. The ultimate objective is that these students have a self-independent ability and positive thinking for their life in the community future.

1.2 The identified of learning and intellectual development with CP people

According to the human behavior of learning, every child has received the knowledge via reading the books or electric learning materials, they can communicate with other people via verbally when they are easy to share their messages and experiences together. Certainly, it is a very important factor to learn how to build up the relationship between interpersonal skills and self-identified ability, this factor has impacted the development of intelligent and emotion management by themselves. However, the CP people have the problem of speech disorder, or even speechless completely when their brain was damaged during childhood. So, most cases have the symptom of developmental delay which is compared with the same aged children, such as could not walk, stand up or sitting on the chair steadiness.

During the childhood stage, the speech therapist has used the Communication Function Classification System (CFCS) for the evaluating of children with CP cognitive ability whether is understood and used the messages in face-to-face communication with other people (Ito, Araki, Tanaka, Tasaki, & Cho, 1997). The therapist should provide some oral training to improve their pronunciation speed, voice and breathe control, such as communication manner, vocabulary for daily used etc. thus, the children have more confidence to open dialog and sharing their thinking with other people, it can help to improve the intelligent development and self-expression ability for the CP children (Bartlett, Galuppi, Palisano, & McCoy, 2016). This is the first step of building up a good relationship for interpersonal. On the other hand, the occupational therapist has used the goal activity motor enrichment (GAME) approach to enhancing the motor development for them, this approach has provided some tasks of relating to their daily life and given appropriate the instructions on how to achieve the tasks by themselves, such as wear clothes, shoes and go toilet etc. The aim is training the basic ability of self-caring and independence and knows how to meet their targets ultimately (Morgan, 2015).

For the above physical training of self-caring practical from the therapist, the CP children can handle their studying life in the primary school, but they are very difficult to follow the learning progress of regular class, this class is requested a high speed of writing and intensive teaching schedule. Especially the traditional education system in Hong Kong. So, this group of children is not appropriated to get into the regular schools, the educational psychologist should recommend that they need to enter the special school which is provided the training of life skill and speech treatment. Although, the education bureau of Hong Kong has promoted "integrated education" to apply the mainstream school (Peters, 2003). It means the special education needs (SEN) students need to be adapted to the normal learning environment. Unfortunately, the government does not have allocated enough resource and completed planning for the long-term (Sharma & Chow, 2008). Many schools have also complained that they have a lack of professional support, or even does not provide the special training for teachers. As a result, these students are feeling very frustration and hopeless in their study journey (Lui, Yang, & Sin, 2017)(Yuen, Westwood, & Wong, 2005)(Yang, Sin, & Lui, 2015).

Due to the CP children's hand movement do not very coordinated, their handwriting performance is very slow and poor, or even lose the writing ability absolutely. So, this is a huge barrier to their learning. The

therapist has promoted some solutions to replace their handwriting dependently, such as wrist hand orthosis, using a computer or mobile devices. These solutions are the best way to improve their learning interested and efficiency on the school life, the most important thing is that these students can increase the self-confident to face up their physical challenge in the life future, instead of focusing on academic performance only.

1.3 The benefit of using IT by the CP people with severity disability

With the entering of technology era, some research theses have reported that the using of computer is most main task to involve the daily work for the CP people, including learning, communication, entertainment, and social activity etc (SI, Uldall, Hansen, &Madsen, 2006)(Albrecht, Simon L., Bakker, Arnold B., Gruman, Jamie A., Macey, William H. and Saks, 2012)(Caron &Light, 2016). The occupational therapist has provided a variety of alternated assistive devices and software which is according to their hand movement ability for each individual case, instead of using traditional input devices or specific type of assistive technology.

Actually, the therapist has used the manual ability classification system (MACS) for evaluating the CP students with different of upper limb ability, it is a medical standard on classification how to use their hands with handled the objects during daily living. This system is separated the five levels to describe the limitation of control and coordinating ability on using their both hands simultaneously. The level I has described that their hand's ability it seems like to the normal students, it can accurate to handle the appropriate objects very easily. However, the level V is opposite to the level I, it is described that their hand's ability is very poor and need total assistance to pick up the objects (Kruijsen-terpstra, Jongmans, Ketelaar, &OW, 2015)(Tan et al., 2016).

There have described the details of MACS classification and should have used the different types of assistive technology for each level, which is shown below:

For the level I, the CP students with hand function and intellectual quotient performance are very good which can handle the target objects very accuracy and ease of finishing the daily activities for requiring speed independently. Their both hands are satisfied with the coordination of motor control very efficiency, but some limitations of handling the objects need to high the muscles performance, such as very small, heavy or fragile. In this case, there have not needed any extra assistive technology for their using the computer, it may need to do more typing practice for the students when they can increase the speed of typing on the keyboard. Moreover, their verbal communication ability is very good, every people can understand what they said very clearly, most speech recognition software can translate their speaking to the text directly.

For the level II, it seems like to the level I, the hand ability of CP students can handle the target objects quite well, but the quality of performance and speed should have decreased. Their both hands coordination performance have typical different and limited effect, they cannot handle the objects simultaneously without any surface support their hands. In this case, the therapist may propose some assistive technology for these students used, such as a mini keyboard with trackball mouse or using a tablet. As it can fully control these devices more easily in one hand, most tablets have already installed the word prediction software and can increase the typing speed for using the auto-complete function, instead of pressing character by character in the touchscreen.

For the level III and IV, the CP students with hand movement ability are very poor and limited, they cannot handle the targeted objects quite well. So, they need the assistance support or adapted equipment to perform for the daily activities independently, it is meaning that their hand's performance is very slow and extremely uncoordinated. In this case, the therapist should need to adjust some assistive technology for them when they can use the computer as well, such as a variety of alternative input devices, multisensory systems and assistive software etc (Davies, Chau, Fehlings, Ameratunga, &Stott, 2010)(Davies, Mudge, Ameratunga, &Stott, 2010). the aim is trying to found out the sophisticated solutions when the other people can understand for their needs or thinking more easily. As students in these levels may always have the severity disability problems, including speech disorder, less mobility and unstable muscle tone, but their mind is very clear and has a normal intelligent or above. Although, their thought is very good and always stay hungry for learning knowledge more and more. Unfortunately, the physical barrier is very huge to disrupt their dream when the therapist and students cannot find out the sophisticated assistive software to fulfill their needs until now. Thus, it is surely a very painful situation for their study journey, or even become a problem of special education on the society.

For the level V, it is a worse situation for the hand ability of CP students, or even has an intellectual disability. They do not handle any object for their hand and lack of performance to achieve the simple movement probably. For example, pressing a enlarge buttons in their communication board only.

According to the evaluation result of the MACS classification, the therapist has proposed the feasibility solutions and training about using the computer skill. For example, how to park their wheelchair in front of the desk with matching the height of the upper limb and operation the computer input devices appropriately etc. In addition, a variety of assistive technology have already published on the internet, the occupational therapist and CP people have found out this information in globally anytime, they can compare with a wide range of the system functionality very easily. The advantage is reduced the cost of information searching and can make a good decision appropriately, but each system is only focused on solving one problem of physical disability and lack of macro view for their using of the computer (Islam, Banerjee, Das, Ghosh, &Neogi, 2017). If they need to solve multiple physical disability problems during their input, it is only installed a different kind of assistive software or requested to develop the tailor-made system from the outsourcing. However, this solution cannot fulfill the requirements in most cases, especially CP users with severity disability.

Actually, the occupational therapist should have set some tasks in the computer when the CP students need to finish them for the period of time probably which is applied to the GAME approach. These tasks should have involved for their daily activities on the computer, including playing the computer games, finding some information on the website or typing exercises, the CP students can understand how to move the cursor and click the target icon accuracy (Olds, Sibenaller, Cooper, Ding, &Riviere, 2008). Through these practical tasks, the CP students have a basic knowledge of operation the computer and expand their social circle through the internet, because they can use the text mode to communicate with other people via the social network platform. Although, they have a problem with a speech disorder and less mobility. The aim is enhanced by their self-learning and communication ability for CP students when their computer can

connect to the internet. It is not only focused on their learning stage from the primary to secondary school, but it is definitely a survival skill when they were graduated on the special school (Pizzi & Vroman, 2013)(Zioti et al., 2016). As the core mission of occupational therapy is provided the barrier-free environment for the handicapped children. Hopefully, they have built up self-independent ability to face up all the challenge after left the school life (C et al., 2002).

In this research study, there have focused on the group of CP users which is belonged to the level III and IV of MACS, because their intellectual development is related to the physical limitation. Although, the therapist can provide several solutions for assistive technology when the CP users can operate the computer for daily uses. Due to the problem of poor hand movement, the CP users are always pressing the wrong or repeated key on the input devices, they should need to pay extra effort rollback in the original place. certainly, this action is very annoying and waste time for them. Therefore, the author is proposing some innovative ideas to reduce the pressing of wrong buttons when their unstable muscle tone happens during nervous movement. Thus, it can enhance the performance of learning and work during the using of the computer.

Chapter 2 Existing assistive technology systems and architecture

2.1 The comparison functionality of some existing assistive technology systems

Due to these two major problems of verbal and movement disorder, most CP people have used the on-screen keyboard, mouse function software and communication board system to interact with the computer and other people. Due to their speech disorder and poor hand movement, the global market has provided different types of assistive technology systems, such as text-to-voice, brain-computer interface (BCI) system, adaptive virtual keyboard, mouse program and multiple sensor detective systems for the Microsoft Kinect device (Pousada et al, 2014). The objective of these systems development is only focused on how to speed up the pressing button process, instead of ensuring their choice is correct or not.

There have provided some literature reviews of using some existing assistive technology or systems and briefly discussed why they are not suitable for them, which is summarized below:

1. BCI system can be used to type text and to control mouse cursor easier than by using an original mouse because the CP user can send a simple command to the brain-computer interface device by their brain wave signal. It can reduce the probability of typing mistakes on the various types of input devices by the users. However, hardware devices have high costs and it also requires a lot of time for the system to adopt the brain wave signal of users through systematic learning. In addition, the system interface has only provided the fix items, which are not easy to change. As the number of alphabets is fixed, the system can define them all. It is appropriated using the phrase 'typing speed' for enhancement and replaces the on-screen keyboard (Buyer &Wittenberg, 2015).
2. The mouse drag and drop software can solve the problem of holding a button and control mouse moving in right position simultaneously, which is a difficult action for the CP user. It is because their fingers cannot control drag behavior effectively. However, the software is needed to move a cursor in the target position using the rolling of the mouse wheel by the user's finger (Shih, 2011). According to the symptom of cerebral palsy users, their hand function cannot stay a fixed position and poke the finger for rolling the mouse wheel to control virtual cursor doing some tasks similar to the action of drag and drop. It is absolutely not suitable for them.
3. Based on new multisensor software architecture for movement detection, sensors are placed on the four limbs, users can easily trigger the command system via an external button board according to their hand gestures, head movement and the frequency of eye blink. It can be translated into a hardware signal from the sensors (Molina, Guerrero et al, 2016). However, the sensors cannot detect which movement was real for the button, because users have a lot of uncontrollable movement of their limbs. Frequently, they select a wrong choice in a communication board, and the helper gets the wrong meaning for them.
4. The meal assistance system has detected the muscle contraction pattern to collect from the two sides of shoulders and calves. The system is operated by electromyogram signals to control the joystick movement via mouse cursor or electric wheelchair control, it can be reduced much more motion operations for disabled people with upper limbs (Zhang, Wang, Wang, Sugi, &Nakamura, 2010).

However, the CP people are not appropriated for use in this system, because they cannot control the muscle movement of their human body very well. Especially four limbs. In this case, the system cannot detect the signals very accuracy for this group of people.

5. The speech recognition system can control the computer system operations or electric wheelchair movement via the small set of voice command when the user has configured the validation of few words to represent the specific commands in this system. For example, the multi-modal system which is using for a set of sensors and speech recognition system to control the movement of the electric wheelchair (Fezari, Bousbia-salah, & Bedda, 2006). The benefit is avoided to collision something on the road when the CP people is the out of control to joystick movement during sudden cause, but the voice command system is needed high accuracy for pronouncing in whole words. It may not be appropriated for this group of people with a speech disorder.

Due to the fact that most cerebral palsy people cannot use both hands to do multiple tasks at the same time, the occupation therapists often propose to use a joystick device to replace the traditional mouse. (Mann et al, 2007) Using joystick only needs the user to put his hand in a fixed spot and to exercise a small movement, the user can control the joystick very smoothly and effectively because most joystick devices are basically limited to four movement directions, up, down, right and left. It is no need to use other fingers or hand gestures to move the cursor. In addition, the advantage of the joystick mouse is a very generic USB device, low cost and reliable. In view of the different extent of hand movement control exerted by different users, there is a need to customize for individuals' joystick model, including controller shape, cursor speed, acceleration and the number of buttons (Gushiken, Kamisato et al, 2014).

For the past ten years, most cerebral palsy people have been using electric wheelchairs to improve their mobility. Electric wheelchairs use the joystick to control the movement direction and can be easily tuned for operation. There is no need for the extra effort of evaluation process and training by the occupational therapist. An optional mouse cursor can be connected by USB, so that joystick is the most common input devices for assistive technology systems (Casas, Quilez et al, 2013).

2.2 The benefit of using joystick mouse for CP people

As most CP people have the problem of hand control muscles movement, the especially tiny movement for using their fingers and arms. They cannot control the traditional keyboard and mouse very accurately. In this situation, the occupational therapist has proposed the joystick device with an on-screen keyboard for their use, the advantage is not needed to spend the amount of money when therapist seeks the appropriated software or IT solutions from the outsourcing companies. Using a joystick with the on-screen keyboard is the most common solution and low cost in the existing computer input methods for them (Christopher et al., 2015). However, the on-screen keyboard software, while the user wants to choose the targeted of character or a special symbol, the cursor has needed to move on the character icon correctly, and then need to press the mouse left click for confirming their choice. In addition, the icon size is too small, it is very difficult to focus on the right location for using the joystick every time.

Using a joystick mouse is an easier way to control cursor movement on the screen by the cerebral palsy (CP) users, while they are using the graphic user interface (GUI) computer system. The user has to position the cursor on top of the target application icon on screen for selection, and the effectiveness is determined by movement speed and accuracy. In general, the joystick mouse movement speed is related to the user's given force. The stronger it is, the faster it moves. As such the cursor can take less time to go a target location on a two-dimensional screen layout with a bigger force. When the force has decreased or disappeared, the cursor slows down or even stops. According to the people with CP, their muscle control is unstable, sometimes being too tight while other times too loose. Since their hand muscle is not always under control, and especially when disturbed by for a sudden noise, for instance, they would have difficulty properly controlling the movement of the joystick mouse. Therefore, it is preferable to set a limit value of speed, instead of simply following the pressing force on the joystick to increase the cursor speed without an upper limit (Shibata, Zhang et al, 2015). Actually, the smart wheelchair has embedded the micro-controller board to record the values of joystick movement directions and the motor running speed, it can create the planning of static path and save it for the first time of driving which is according to the roadmap (Trivedi, Singh, Digumarti, Fulwani, &Kumar, 2013). For the next time, the wheelchair can automatically drive on the same path without human control, it can be avoided to do the repeated task and reduced the probability of human error by the CP people. Therefore, this technology has applied to control the cursor movement on the screen via joystick. The system has only recorded the location of joystick movement which is selected the targeted application or file icon for the first time by them. It can enhance the accuracy of movement and reduce the access time in the same path.

On the other hand, some existing joystick control software has provided the mapping function of mouse click command and specific buttons on the joystick, it can also control the speed of cursor movement via joystick such as Joy2key etc (Khalid &Khan, 2011). For the function of mouse drag and drop, it can use the windows system built-in function with the keyboard number pad. Although, these kinds of software have provided the different mouse click function and control the cursor movement for the joystick. The advantage is to find out this software on the internet very easily and free, the users can compare with their system functions which one is the best usability for users. The aim is replaced the traditional keyboard and

mouse devices when they have overcome their difficulty of using a computer. However, all mouse clicking functions need to trigger the joystick buttons during the user pressing, it cannot prevent the frequency of wrong clicking behavior by their unstable muscles tone.

Furthermore, the traditional layout designed of joystick device has contained around six to eight buttons on the joystick surface. So, the joystick control program has provided the different mapping function of system commands and joystick buttons, it is not suitable for their poor hand function. Therefore, the workshop of occupational therapy department in Hong Kong Red cross handicapped school has proposed a new joystick layout designed which is contained only one button and joystick layout is smaller than a traditional one. The benefit has reduced the distance of joystick and button when the user can press the button more accuracy and get back to hold on joystick again more quickly. Thus, this joystick control program has only provided the function of the monitor grid for the button control. During the button pressing, it is only used for controlling the cursor that it jumps to the nine different position in monitor dimension which is according to the 'z' shape. They can fast move the cursor near to their target, it is faster than using the joystick control cursor movement only.

In conjunction with the part of triggering command, some latest assistive technology software has used the motion detection techniques to replace the pressing of external buttons by the users. The advantage is to reduce the need to put extra effort and thus the frequency of error for each pressing. The motion detection technique is mainly by focusing on the hand gesture and face emotion in order to determinate whether it is the right moment to trigger the selection command on behalf of the CP user. It is found east and increasing speed on 'command confirmation' by using the software. According to the SixthSense technology, the feature is attributable to the algorithms of color pattern recognition and human body motion detection. It can recognize the body movement of the user within three or four seconds after the webcam device has captured his movement, such as arm movement, the direction of head turning, the frequency of eye blinking etc. The main concept of the object tracking is to find out the difference between the images (Narvekar 2013). The idea is to capture images at the first and third second of the recognition process. Then the images are filtered off of all color pattern, preserving human skin color only, before being stored as binary images. The two photos taken at different moments are compared with the size of the area changed. For example, in order to recognize eye blinking behaviors, face detection algorithm is used to find out the area of the user's face and a pair of eyes, then color pattern filtering is used to determine the eye area, as there must be a white area in human eyes. If no white area is detected, it represents that the eyes are closed. Otherwise, the eyes are open. Currently, a graphics card and webcam device image processing capabilities are so high that recognition accuracy can reach up to 90% (Pallejà et al. 2013). However, the triggering command interval is too short for most CP users such that it seems rather difficult for them to repeat the same standard movement to confirm the behavior of triggering command. So, this algorithm cannot avoid the fault of command selection.

2.3 The system architecture of existing voice recognition applications

The technology of voice recognition has a high-speed development in the past few years, most smartphone and tablet computer devices have installed the voice recognition applications. It can be provided the system interface to control the other smart home accessories, or even smart wheelchair by users, while they have a self-defined of voice commands and can be achieved some simple specific tasks on these smart devices via the mobile applications, such as turn on or off the power for the time of schedule automatically. This interface has implemented the engine of voice recognition by Apple Siri System and Google voice recognition system for Android which is according to use the vendor of the mobile device. the benefit is reduced the pressing real power buttons on the control panel and easy to remote access on the smartphone by users. Especially disabled people.

According to the system architecture of voice recognition, the speaker has collected the speech waveform to transform the digital signal form by a user's pronouncing, the digital form has extracted some patterns of signal level at every discrete time step for using two mathematical techniques, including Mel Frequency Cepstral Coefficient (MFCC) and Dynamic Time Warping (DTW) (Muda, Begam, &Elamvazuthi, 2010). These patterns are compared with the similarity rate from the existing data of the database, so it has needed to produce the amount of sampling data from the collecting of another user soundtrack. The voice recognition algorithm has consisted of the two major phrases, training phrase and testing phrase. For the training phrase, it has collected all voice data by users input and build up a references template model into the database system. For the testing phase, it has checked the user's voice input whether is matched to the template model. If matched, the system will execute the related tasks which are according to the voice command.

Unfortunately, most of existing voice command applications need to pronounce for the whole words or sentences in order to execute the specific application programs. In this case, the CP users are not appropriated using them. Since CP users' speech tone is very unclearly and low speed, the voice recognition system is needed to configure the two components of voice speed and accuracy level when these functions can be fulfilled their needs. However, these applications belong to the package software, it is not easy to modify them and only focusing on commercial needs, it is not designed for CP users. On the other hand, their pronouncing frequency is not the same way each time, because the mouth muscle cannot control very well. These applications need to require their pronunciation very accuracy, otherwise, the applications may be increasing the risk of wrong voice command representing specific tasks.

2.4 The problems of system parameters configuration for the existing assistive technology

Most joystick control and voice recognition systems have needed to configure the system parameters by the users or using the evaluation process of GAME approach by the occupational therapist which is including the speed of cursor movement and sampling of the soundtrack. As each user's physical ability is different, some CP users or people with severe disability can only control the joystick movement very smoothly, but their speaking is not very clearly or only pronouncing short sentences. oppositely, some cases can speak very clearly, but their hand function is very poor with unstable movement and moving the joystick on specific certain location very difficult. unfortunately, these systems have not an automating procedure of adapted the different kinds of people with severe disability, or even these parameters cannot easy to change the system setting by themselves.

There have given some examples to describe the limitation of these system parameters set when the users need. the joy2key system is very common for use in the joystick control, it has provided the two major functions of mapping the system commands on the different joystick buttons and the range of cursor movement speed by joystick control. however, there have not the features of uncertain muscle movement filtering, some CP user's muscle is very tightness and cannot easy to release the button during pressing. In this case, many unnecessary commands should be repeatedly generated at this moment, they need to spend much more time to roll back the command redundantly, it is very inefficiency for their using on the computer. In addition, this system cannot easy to fine turn a movement speed of cursor control appropriately by them, because the speed range has only provided three standard levels of movement speed value, fast, medium and low. Certainly, the system interface has a value bar to increase or decrease the speed of cursor movement on the screen. However, this system parameter is needed to configure for their hand and try so many times for each speed value. As a result, the occupational therapist may need to spend a lot of time to find out which the speed value is most appropriate for their control the cursor moves smoothly.

For the existing evaluation process of joystick movement speed, the occupational therapist is needed to observe the range of cursor movement speed on a targeted application icon when the CP users cannot use the traditional mouse for their poor hand function. The therapist is designed a scenario to evaluate the duration of finishing time when some specific tasks of the cursor moving and icon selection are set up for them. The aim is to find out the relationship between the cursor movement speed and the happening times of unstable muscle tone (Cantin, 2012), hence to determine the optimal value of joystick mouse operations speed for the CP users. Based on the system response and operations of users. Through this observation, we can tell the impact of the joystick cursor movement speed against the precision of the cursor movement. Therefore, the value of joystick movement speed is a very crucial part of the system parameter for the joystick control. As the monitor models have so many different sizes, the cursor movement speed cannot just set a single value to fulfill all sizes of the monitor.

In this case, the therapist is very difficult to adjust the cursor speed for different kinds of monitor resolutions. If the cursor speed is too fast, it cannot decide the right choice of icon effectively. However, if

the cursor speed is too slow, the user has no patience in using the system given little efficiency. So, if the value of speed setting is wrong, the user cannot go to the correct position and choose the application icon easily. Although, the application program icons are usually fixed in size and in screen positions, such as taskbars, start menu bars and desktop shortcut icons in Microsoft Windows systems. Their positions are usually unchanged on the screen. The cursor movement speed value is set according to the monitor resolution. The movement speed value bar has defined in a scale from 0=fastest to 10= slowest. the value as stiffness. According to the Fitts' law, it is the model using the relationship of motor control in movement time, between the distance of the target location and its size. It can predict the movement time in target reaching activities on monitors of different sizes. The aim is to find out the value of movement speed which is best suitable for positioning tasks (Rao, Seliktar et al, 2000). If the monitor size is large, the value of resolution is high, then the distance between an application icon and the cursor is relatively bigger. So, the stiffness should be reduced in order to allow a higher movement speed and to reduce the time required by the cursor to get on to the target icon. The converse is also true.

For the measurement of the movement speed of the joystick mouse, it needs to apply the Fitts' law for adjusting different speed values for monitors of different sizes. Since joystick mouse systems are only compatible with the Windows-based personal computer. In this observation, it is mainly focused on Microsoft Windows system with monitors of various sizes, 14", 17", 23", and 28". As for tablets and smartphones which make use of a touch screen for cursor control, the joystick mouse device is not supported, so they will be omitted from the test.

Actually, the evaluation of scenario design is full depended on this occupational therapist experiences which is according to the CP user's hand ability for each case. The aim is to count the duration of finishing time when they can achieve for each assigning task, but the users need to do the same tasks so many times in different speed values of joystick movement control. The therapist can collect this dataset of time to evaluate which is most suitable the range of joystick movement speed for them. Therefore, there have spent a lot of time for the whole evaluation process in both. Although the scenario design is created by the therapist, there may have appropriated to apply the similar case of CP users, instead of focusing on the specific user only. however, this kind of information is only stored in the case files or clinic web portal system by the therapist. So, the different therapist may need to do the same work in the different clinics, it is not very effective during the evaluation process.

Besides, the speech platform of Microsoft Windows systems, Google and Apple Siri have implemented the artificial intelligent technology to interpret the system command or sentence from human pronunciation, but these platforms have not handled some special cases of people with a speech disability or recognized which user is appropriate for using them. Although the platforms have provided the difference language templates for all regions of people around the world, it can get easy to adapt for use in the variety of language environment. However, there have not provided the functions of self-defined the voice commands and the rate of recognized accuracy tuner when the people with a speech disability cannot speak the same words or sentences very clearly every time.

In fact, the author is suffered from athetoid cerebral palsy and live in Hong Kong, so Cantonese is his mother language, his speaking is not very clear and faltering. Therefore, he has designed an experiment for using in existing voice recognition platforms whether can recognize some Chinese word to represent the self-defined commands from his voice, such as Google voice service and Apple Siri. The aim is proved that the people with a speech disability can interpret their voice to the particulars of Chinese words successful or not when these platforms of using voice recognition technology are top of the world.

In this experiment, the author has a selected the five words which are pronounced for contrast and simple consonants, including ‘醫, /ji1/’, ‘人, /jan4/’, ‘口, /hau2/’, ‘大, /daai6/’ and ‘娃, /waa1/’. He wants to try the existing voice recognition platforms whether can recognize some Chinese word. In this experiment setting, the author has tried to speak these words in five times for using the Google search and Siri assistant via a smartphone’s speaker closely, he can see and evaluate the result on the screen immediately. this assumption of selective Chinese words can avoid the problem of pronunciation confusing, it may increase the probability of recognition rates to use these platforms. In addition, the setting of speaking times is very important the system parameter when these platforms can receive the sampling of the soundtrack to store in the database system when this soundtrack data would be used in the training model of voice recognition engine. The accuracy rate is full depended on the size of sampling data in this model, so this dataset should need to collect more and more by the soundtrack of different users, this ratio can increase much higher relatively. However, the author feels annoying when he needs to speak the same word so many times. Oppositely, if he has only spoken the same word for one or two times, it is not good enough evidence to prove whether can be recognized these Chinese words by these two platforms. Therefore, each word needs to pronounce in five times appropriately.

Unfortunately, there has not any result or few nonrelevant words to show on the screen for using both platforms, because the author’s pronunciation is not similar to the normal people, his sound wave frequency is a big difference to the existing waveform frequency in training model. So, these platforms cannot recognize what he said. The accuracy rate of the voice recognition process is needed the matching percentage of this two waveform frequency very high because the voice recognition engine is needed to ensure that the output result must sure to display on the screen what the users said. On the other hand, the author cannot pronounce the same sound wave of these five Chinese words for each time, so the system cannot extract the voice pattern in his soundtrack files. As a result, the author has believed that people with the speech disability are very difficult to use the function of voice recognition by these platforms as well.

The main reason is according to the similar pronunciation of representing many different words in Cantonese because all pronunciation of Chinese word is organized by two elements which are contained the consonant and vowel. In the Cantonese pronouncing system, each consonant can combine the eight-difference frequency of vowels from high to low, these combinations can interpret the eight difference meaning of Chinese words. As the people with a speech disability cannot pronunciation some consonants as well, especially involved the consonant of starting with s, t or complicated syllables, their performance of mouth muscles and tongue movement position are controlled so poor.

According to the problem of using voice recognition system from Google and Apple Siri, the author has already tried to develop the voice command system which is used the language template of Cantonese for Microsoft Speech platform. due to the specification of voice recognized system, it has assumed the user's pronunciation in the words that the sound waveform frequency almost the same for each time, so the result is failed and cannot recognize his speaking accuracy.

For the program design of this voice recognition system, there have two system parameters very important which are including the level of speaker volume and voice recognition accuracy rate. certainly, the using of the existing internal microphone cannot detect the parameters of audio position and direction, so it can only use the level of speaker volume which is ignored the unnecessary voice nearly from the user. the level value is set a range of 45 to 65 decibel in the system because people with normal speaking is limited to this range of decibel level. As a result, the system can recognize that this kind of voice is generated by the human, instead of noise. It can accurate to predict that the user is really want to interact and execute some commands on the computer. So, it can avoid the error of the voice detection process and reduce the unnecessary workload from the server hardware resources.

On the other hand, the accuracy rate of voice recognition is predicted the output of result by the user pronunciation. For the common case, this ratio is setting very highly over 96% for the people with normal speech, because the advantage is reduced the typing time of smartphone's on-screen keyboard by them, they are only speaking some sentences or words on the microphone, it can transform their speaking to the content in the textbox immediately. however, people with a speech disability can only predict what they said approximately, instead of exactly. therefore, this ratio should be decreased to lower than 70%. If the percentage is too low, the output result may very randomly and chaos, it cannot display what they said accurately. oppositely, the result is seemed like to use for the Google voice and Apple Siri platforms.

In this experiment, the author has spoken these five Chinese words within five times for using this voice recognition system, the purpose is proven whether this system can recognize more accurately than using these two platforms for their speaking. The author has observed that the system can display some relevant word during his pronunciation, but it is not showing these five words exactly. The system has shown some Chinese words of pronunciation similarly in random, so it is very difficult to recognize the Chinese word particularly and use for producing the voice command by the people with a speech disability.

Due to some research reports have demonstrated a variety of evaluation methods to find out the system parameters for the joystick movement, such as the average speed value of joystick movement, the range of accelerating speed during the movement continuously and the time interval of triggering buttons etc. these evaluation methods have included using some electric sport games or scenario of computer tasks, the CP users can only need to use the common joystick or alternative pointer devices to control a cursor when they move it on the targeted icon. There has used a Measurement Time Evaluator software which keeps track of cursor path to accumulating the duration of time for each evaluation task, it is implemented the Fitts' law to adjust the speed value of joystick movement in different size of monitor (Davies, Almanji,

&Stott, 2014)(Dicianno, Mahajan, Guirand, Cooper, &Service, 2015)(Geerdink, 2004)(Hernandez et al., 2012).

Actually, the Cerebral Palsy Kinematic Assessment Tool (CPKAT) is a laptop-based IT System, it is specially designed for the evaluation of CP user's upper limb kinematic outside the rehabilitation clinics or hospital environment (Unless, Act, Rose, If, &Rose, 2014). The purpose of the evaluation is finding out some critical information for using the joystick in their hand movement which is including the path length, movement time, smoothness and path accuracy. This information can generate the most appropriate of joystick movement speed for them and produce the hardware control profile to store in their computer for each user. On the other hand, the OpenSim software is measured the muscle force and passive muscle stiffness when it can produce a musculoskeletal model on the screen (Van DerKrogt, Bar-On, Kindt, Desloovere, &Harlaar, 2016). The result can be shown which hand function has worse from spastic muscle effectively, it is an important factor to determine which side of the hand is better using in the joystick control than another hand.

In these kinds of evaluation processes, it can classify the different level of hand function for CP users and automatically optimize the system parameters for the joystick control. The advantage is reduced the evaluation time and workload by the occupational therapist, they can finish the evaluation procedures independently. However, there have not designed an evaluation process for identifying whether has a problem of speech disorder for CP users, it is a very important factor to determine what type of speech recognition applications is appropriate for their use. therefore, the author has proposed a new evaluation method in this research report [Refer to Chapter 3.1].

As a result, the author has exploited two different kinds of technology for filtering the hand abnormal movement and input the combination keys without keyboard in the joystick mouse with voice command system architecture, which is shown below:

The technology of voice recognition for the e-sports team:

Nowadays, some disable young people has joined the e-sports team by the NGO in Hong Kong, they have paid extremely effort to practice the playing skill how to win the game or even in the big competitions. However, the final result is not so good in the ranking of team list, the main reason has involved the speed of input some combination keys with using the keyboard because these keys have needed to control the role play of various fighting action in the game continuously.

Because of pressing the combination keys must need to use both hands and following the input frequency on the keyboard, so the physical disability players are very difficult to do this for their hands when their fingers do not control smoothly as well. As a result, they cannot win the game competitions to the other teams when these teammates are the normal people. Thus, the author has proposed a new voice command system design for solving this problem. The users can assign the first voice command and specific combination key, the second voice command can represent the executing times repeatedly on the system interface. They can only need to say these two voice commands when this combination key is pressing the specific times continuously, the advantage is to reduce the pressing of physical keyboard and rate of input error by the users [Refer to Chapter 3.2].

The detection of unstable muscle tone in the joystick control:

According to the unstable muscles control by CP people, they cannot control the normal movement of their four limbs during nervous environment, such as sudden noise or time pressure and something happen near them. Most cases have involved by the thunderstorm and the period of examination time or some people are screaming on their back suddenly etc (Rosenbaum et al., 2007)(Hilberink et al., 2007)(Sankar &Mundkur, 2005). The program design pattern is the most difficult to handle in this situation because their nervous movement is very uncertainly. Actually, the existing of the joystick control system has only provided the function of movement speed control for the range of values, the value can control the speed of cursor movement from fast to slow by the users. As they can easy to control the movement more smoothly, the cursor has performed the same standard movement with the joystick mouse, instead of accelerating in the direction during movement. However, it has not handled the problem of unexpected movement by their hand. Therefore, the author has proposed a new method to implement for the new joystick control system, it is called for the module of force detection.

Nowadays, the smartwatch device is very common and become the private healthcare assistant, because it can keep track of important life index, including heart rate and blood pressure rate. Every people has changed of these two rates which are related to their emotion or muscle movement, the device has collected this information to send the mobile applications simultaneously. People can understand their health performance more easily, they do not need to the traditional medical devices for using in this test anytime (Wijaya, Setijadi, Mengko, &Mengko, 2014)(Albaghli, Raja, &Anderson, 2017)(Reeder &David,

2016). In this case, this concept can apply to the CP people, their muscle control is stabled or not, it is fully depended on the external environment changed. The joystick control program can detect the changing of their heart rate or blood pressure rate which is determined to decelerate the speed of cursor movement or stop it to the certain point of screen location immediately. While they have wearied the smartwatch on their hand for using the joystick movement, these indexes data should be uploaded to the cloud database system by mobile network and synchronized the speed of movement control on the joystick program.

Besides, some CP people muscle control is very tightness, their hand can hold the joystick very substantial, it does not leave to the joystick frequently, but the cannot stop on the targeted icon or specific screen location very well. They may go over to their target on the screen very far away, if the joystick program has not implemented the force detection, they must spend the extra time to go back their targeted location originally. However, nobody can promise that their movement is met the target absolutely. Therefore, the module of force detection has calculated the percentage of heart rate and blood pressure rate changed by the smartwatch. while the users have gone over their targeted location, they will feel nervous and their two rates of life indexes should be increased for a very short time. The speed of cursor movement control would be decreased or return to zero which is according to the percentage changing of these rates [Refer to Chapter 3.3].

An experiment is proposed to observe the joystick control system to finetune the movement speed which is determined by the changing of heart rate or blood pressure rate by users. The aim is to the preventing of unexpected movement by the CP user's muscle tone, it can reduce the time of returning back to correct the direction when they have loss of joystick control during the nervous moment. Through this experiment, the module of the force detection can stop the error of joystick control during their nervous moment, it has controlled the joystick movement to achieve their targeted location more accurately. This is achievable since repeated attempts are permitted, and avoided put extra effort to press the mouse button repeatedly (Henzen, 2016).

Chapter 3 Joystick mouse with voice command system architecture

For the above discussion, the architecture of the joystick control system has proposed a new evaluation method of classifying speech disorder people and three new types of system designs when it can control the joystick operations of filtering abnormal muscle movement and voice recognition process more efficient for CP people.

The prerequisite of this system operation is assumed that it can retrieve the data of voice command and the system setting of joystick movement in the database via a network because the system has stored these kinds of data in the central database system for each user. The aim is to avoid the repeated configuration of voice command and the other personal setting for using this system, such as the ratio of voice recognition accuracy, the level of speaker voice volume etc. As the users should do the training phrase of voice command recognition for the first time of uses, they do not need to change this combination frequently. In addition, this system has provided to use for many different types of CP people in the handicapped schools or other social service organizations what they have focused on the rehabilitation service for this group of people. So, the collected data can easy to find out what kinds of English characters or words are the most recognized by their pronunciation successfully, it can increase the procedure of recognition speed during the voice training phrase.

In determining the classifying of people with speech disorder by using the voice recognition system, make use of voice command with a joystick device and avoiding of operations error with abnormal muscle control while the user is using a joystick mouse, there are three factors that could impact the accuracy or efficiency:

3.1 Classify of people with speech disorder by using the voice recognition system

For the part of system initialization, the author has proposed a new evaluation method of classifying which kind of CP user can use the existing voice recognition platforms. It is a very important procedure when they need to do the voice training process and justify their speech ability for using in a specific type of voice recognition system appropriately.

According to the problem of voice training process by the CP people with speech disorder, it is not appropriated for using all of the existing voice recognition platforms and have not provided the function of self-defined voice command for them, because the existing process of voice training model is collected the amount of voice data from different people when these platforms have retrieved the same pattern from this dataset, it is not focused on training for each person individually. On the other hand, some research reports have conducted that the speech recognition system can help people with severity disabled to achieve maximizing productivity by using the computer. especially CP people, they use their speech to transform some commands for calling applications without using their hand input. However, some part of CP people speech is not very clear, because their lips and tongue muscles cannot smooth control during pronunciation or oral communication, this is deceased the level of speech articulation and not easy to

understand what they said for the computer (LPennington, 2012)(LindsayPennington, 2016)(Hafidz &Ng, 2011). Therefore, the voice training process is needed to determine what the specific of English characters or single words are recognized to their voice easiest.

In this case, most handicapped schools and rehabilitation clinics have provided a speech therapy service for their students when they need. The speech therapist has focused on the development of breathing control training for their speech and optimize speaking speed appropriately, so the students can improve their self-confident to communicate with other people and expand a set of vocabulary for their daily use. However, it cannot ensure that their voice should be recognized by the voice recognition system. As a result, the author has proposed three different stages of evaluation their speech whether is appropriated for using the existing voice recognition platforms. Currently, most voice-to-text software and smart device control applications have translated the user's voice to some words or command execution by these platforms, so it is a very crucial part for increasing their usability of the computer or smartphone without depending on the keyboard input.

For these three different stages of evaluation procedures, this aim is to determine that the voice recognition system can recognize which kind of set words have pronounced by the CP users. These kinds of set words have included the simple English or Chinese words to provide for them during the system testing. There have described the detail of evaluation procedures how to recognize the speech ability and produce the self-defined voice commands for interacting between the CP user and computer, which is shown below:

For the first stage, the program interface has displayed the five English vowels characters within five rounds which is including the 'a, e, i, o, u', each round has not repeated to generate for the same character randomly. As these five characters pronunciations are the most contrast and simplest in the whole English language system. Surely, all existing English words and sentences have based on formulating from these characters, there have not needed any professional training how to speak them by the user. Therefore, the users are only speaking in the five times what the character is showing on the screen, the program has recorded the success rate during user's pronunciation. In this stage, the program can determine whether the user can speak some basic vowels and successes to recognize by a computer because this is an extremely important part for the whole process of the voice recognition system. If failed, it can prove that this user is totally speechless and may not be suitable for use in any type of voice recognition system.

For the second stage, the program has selected some English characters which are contained a consonant and similar pronunciation, such as 'b, c, d, g, p, q'. The interface has shown these characters for one by one in randomly and does not repeat to generate on the screen, the user needs to pronounce them correctly as far as possible. Thus, the testing result has recorded by the system when it has recognized by the user's pronunciation successfully. In this stage, the program can determine whether the user can control their tongue muscle movement and lip control position very smoothly because these criteria are the main point for pronunciation correctly and would be recognized the other words by the voice recognition system more easily.

For the third stage, the program has selected some simple short sentences in both languages of English and Chinese, because it can provide more than one language options for the user's choices what they understand. These short sentences have only contained a simple consonant and contrast pronunciation during the testing process, such as 'hello, how are you, one boy, on bay', '大學, 歐羅, 豪華' etc. the user is needed to pronounce them correctly when these sentences have not repeated to display on the screen for each round. The aim is determined whether the user can handle the speed of their speech and voice tone control in normally.

Due to the considering of speed up this evaluation procedure, this program has automatically passed to the next stage when the user has correctly pronounced the showing characters or sentences in two rounds continuously. Oppositely, their pronunciation has not recognized them within five times, this program should be terminated and redirect to other voice recognition system which is according to the different stages of evaluation procedure by themselves. In the special case, the user pronunciation can pass to this round and fail to next round, the program will generate the third character of supplement round for their tried because it is ensured whether is recognized succeeds in the current stage by their pronunciation. If the user is stopped in the first or second stage, this program should pass to the voice recognition system which is developed by the author. This system can only recognize the specific of English characters, words or Chinese words, it can be controlled the level of speaker volume and similarity ratio of speech by the user need. If the user can finish all stages of the evaluation procedure, the program should have encouraged for the user when they can try to use for the existing voice recognition platforms, because the computer can recognize what they said as well.

For the program output of voice recognition system for the CP users:

請阿海嘗試發音.. oK...

系統辨識結果: 黑

Speaker volume: [Slider]

辨識準確度: [Slider]

低 高

Speaker bar: [Green bar]

Developed by CHEUNG Sai Ho

3.2 Make use of voice command system design for the e-sports team

Through the above evaluation procedure of classifying people with speech disorder, this program has determined whether they can appropriate using the voice command in the existing voice recognition platforms. otherwise, it should have automatically redirected a new proposing of voice recognition system when their speech is not recognized in these platforms, so this voice recognition system design is mainly focused on how to handle by this case.

According to the system function of words recognition, the computer can be recognized the wide range of English characters and some single words by the user's pronunciation, the system interface can define the voice command dictionary by themselves when it has provided a textbox for their input. The users can input the English characters, words or Chinese words on it what they need, the system has requested to pronounce the five times by them. In this process, the system can make sure whether is recognized in this character or word by the user said, if their pronunciation has succeeded to recognize it in five times continuously, it can produce the voice command and store in the system. otherwise, the system has thrown it away and requested to input the other word or character again during a verified process. The benefit is expanded to produce much more the voice commands to the system when the user can only control some combination keys with using in both hands, several fingers dependently.

Due to the fact that all combination keys should have involved organizing the multiple function keys on the keyboard, these function keys are distributed the keyboard position of the left bottom corner and right upper corner. therefore, the CP user is impossible to press these specific keys simultaneously when their both hands cannot coordinate as well. For example, this kind of user wants to open the task manager program for terminating some running programs when they have crashed accidentally. Normally, the user must need to press three specific function keys of 'ctrl-alt-del' on the keyboard for calling the task manager program, but this action is very difficult for the people with physical disability and need to extra support from other people.

The aim is to study how to press the combination keys via the voice commands, so the user can use some shortcut way to speed up their input, instead of using only the mouse move on the function icon and click it. As all combination keys are usually organized the two or three specific function keys on the keyboard, such as the printing document is used the keyboard function key of 'ctrl-p', the switching between applications in the windows system is used the keyboard function key of 'alt-p', and the closing currently active windows or webpage is used the keyboard function of 'alt-f4' etc. For example, the system has set a voice command of 'print' to represent the printing document, while the user finishes to type their article on the word processor system and pronounces this voice command, it has automatically executed the keyboard function key of printing document when the cursor has stayed in the currently active document. It does not need to press the specific function keys on the keyboard and move the mouse on the system printing icon. Therefore, it can reduce much more the duration time of mouse transferring to a targeted position on the active windows. In this case, the system has provided a data list to contain at most twenty

voice commands for the users when they can set these specific combination keys to the voice commands, the matching relationship is only set to one combination key to one voice command. While this list is stored excess twenty items, the user may remember all items of combination very difficult and no necessity for using all of them frequently.

In recent years, e-sports has become a new driving force for economic growth. Many countries and regions have regularly set up e-sports training courses and professional consultant support, so the Olympus game association has proposed to list e-sports as a sports project. The Hong Kong Government has encouraged tertiary institutions to run relevant courses to enhance the acceptability of e-sports professionals and their professional status, thereby attracting more young people to join the e-sports industry. Therefore, the Hong Kong PHAB Association has established the first handicapped E-sports team. With the rise of e-sports in recent years, e-sports provides a platform for disabled and healthy people to learn from each other. E-sports can help the disabled adapt to the well-developed social environment of today's information technology to improve their self-confidence, social circles and career development path. Because of their hand movement control is not so good, their typing speed and controlling the mouse clicking is slower than the normal people. As a result, the handicapped e-sports team has finally lost when they compete fiercely with other e-sports teams.

According to the failure experience of the handicapped e-sports team, it may need to use the voice commands for replacing the traditional input devices by their hands. As the e-sports competition is mainly focused on the sport and shooting game, these two types of games need to quick response for input specific keys on the keyboard and good teamwork for every team member. However, most input commands have to use some combination keys in these games, they may need to press these keys correctly within two or three seconds, or even pressing them continuously in a short time. For example, the user should have configured the input command set of shooting game when they need to aim a gun and shoot on the enemy, this action is usually needed to press three specific keys on the keyboard, including two function keys and one English character, these two function keys may have controlled to raise up the gun and aim it on the shooting target, the English character should be controlled to the event of bullet-shooting when the player pressing this key continuously. So, the player may need to press the set of combination keys with high speed so many times repeatedly when they have joined some e-sports competition. Certainly, it is a huge challenge for these people, especially their hands or fingers cannot control very smoothly. In this case, there has proposed a solution for them, it can be avoided to do this action without pressing the keyboard again and again by their hands.

Due to the new proposing of voice recognition system, there has provided a system function of user-defined voice commands for representing the set of combination keys. However, the system has only executed the specific combination key in one time when the user has pronounced the voice command relevantly. It cannot automatically execute it more than one time, if the system has provided a number box to control the repeated times of choosing the combination key when the user needs to input the number on it, this is a very low efficiency and take a long time to control the cursor moving between the voice recognition system and currently active windows. Absolutely, this is a very bad practice for them. So, this

voice recognition system has provided two system interfaces to manage the combination key and pressing repeated times, because the set of voice commands can reuse in these two different system interfaces, the user can only need to set the specific combination key and repeated times in the single voice command.

In this case, it can be avoided to produce too many voice commands by the user, thereby simplified the operation procedure in the voice recognition system. For the above case of shooting game, while the player has set the combination key of control shooting on the gun which is pressing on the keyboard function key of 'ctrl-alt-p', they can set this function key to the specific voice command in the system interface of combination keys management, the number of repeated time is set the pressing five times to the same voice command when the player has entered in the system interface of pressing repeated time management. Therefore, this player is only needed to control the joystick mouse when they have pointed to the enemy and say this voice command two times, then the gun would continuously shoot five times in this game. In addition, the player can set at most twenty different combinations in this system data list and it should have stored in the central database, they do not need to set these same combinations again during the next time.

3.3 Reducing joystick operations error with abnormal muscle control

For the joystick movement, the author has this idea of a damping module and the following data algorithm: Assuming the mouse or joystick input data is a continuous stream of $\langle x, y \rangle$ coordinates of the screen. The function of the damping module is to smooth out the input stream such that a sudden deviation of the input data (that is sudden moves) will be filtered out. It is taken the x-axis or y-axis of the input stream first, and the system will store the recent N data in a buffer where N is user-specific (i.e. system adjustable parameter, such as the cursor moving speed and temporary suspending time of cursor position from the median value among the abnormal movement scope.)

X or Y coordination input \rightarrow [Damping Module with Buffer of Size N] \rightarrow output of suspending coordination position with the median value

Algorithm of filter joystick abnormal movement from Cerebral Palsy people, as the latest data flow of joystick movement is according from right-hand side to left-hand side, this position value of movement data is based on two dimension $P(x,y)$, the x value is meaning for x-axis, the y value is meaning for y-axis. If athetoid cerebral palsy people muscle control is very unstable during the nervous moment, especially holding on joystick moment. The movement direction is very chaos, instead of moving on the single direction continuously. So, if the joystick is continuous moving to one direction, the value of x or y is grown up/down sequencing and smoothly, when they can hold the joystick in a stable position with arm support. Otherwise, the movement stream data may have moved the opposite direction suddenly, then return back to original the moving direction.

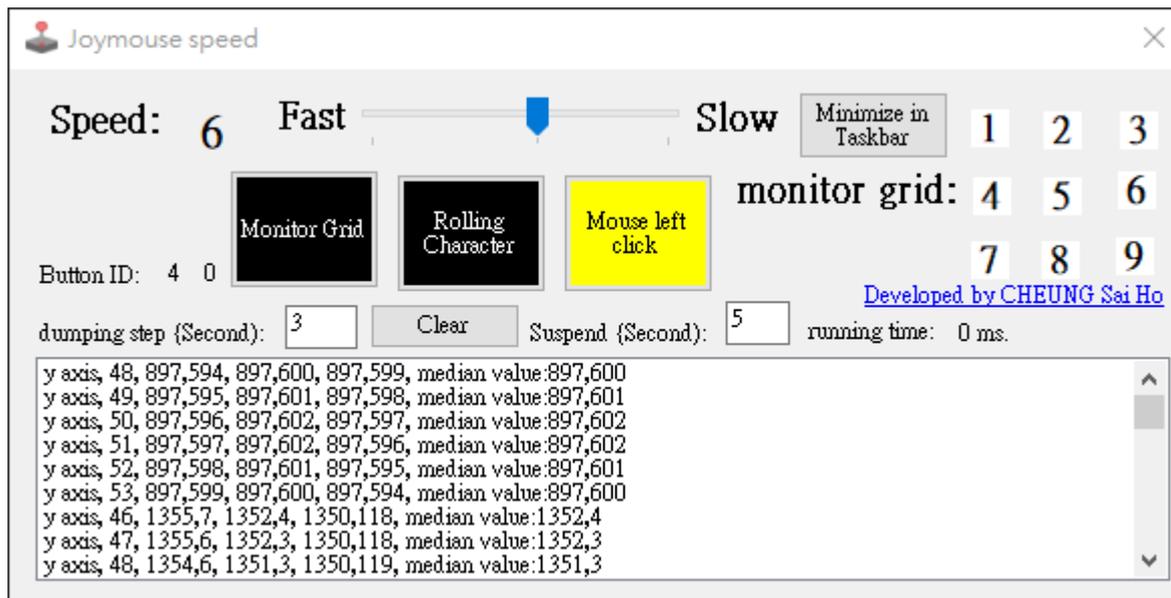
In this case, the algorithm is mainly focused on filtering some abnormal movement data from moving the

opposite direction suddenly. There has shown a pseudo-code to explain how to prevent the chaos movement by the Cerebral Palsy people.

```
// Function of calculation median value
Function (integer a, integer b, integer c)
Set median_value to integer
median_value = sum of the integer a, b, c / number of function parameters
return median_value
End function

// Procedure of abnormal movement data filtering
Procedure (coordination data array as a, axis direction as b, cursor moving speed as c)
Set suddenmov to the string list
Set a to reverse array
For each i to the number of a elements do
    For each time of looping p of i do
        If p within i then
            If the current element value of a is greater then next array element and less then previous
            array element or opposite conditions which is according to select the comparing of array element by the c
            value
                Set medianve to the integer list
                Set suddenpt to the string
                If b is the x -axis then
                    Add the coordination value of current index and element to suddenpt with a label for x-
                    axis
                Else
                    Add the coordination value of current index and element to suddenpt with label for y-
                    axis
                End if
                If suddenpt not in suddenmov then
                    Add the suddenpt to suddenmov
                    Call the function of calculation median value (previous element, current element,
                    next element )
                    Set the cursor position from this median value and suspending on it by few second
                End if
            End if
        End if
    End for
End for
End procedure
```

The program output of the damping module:



For the part of force detection, the ratio of muscle tone index in terms of percentage changing when the CP users have wearied the smartwatch device for using the joystick movement. As the joystick control system has embedded the module of force detection which is detected the changing of CP user's heart rate or blood pressure by the smartwatch device. The joystick has controlled the cursor movement on the screen when the sensor has detected the force of pushing in one direction or the changing ratio of this index is very stable continuously. Otherwise, if the force has lost or the percentage of change is very huge, the cursor would be stopped at this location immediately. it is the instance to acknowledge that the user has selected his target, and confirmed the intention to choose the system icon of his selection. As this percentage can determine the CP users whether is feeling very nervous at this moment, the system can help to cool down their emotion and stop the cursor movement temporary when they have appeared in the unstable movement of joystick control.

Chapter 4 Experiment

Experiment Designed

As this system is specially designed for the targeted group of CP users or severity disable people, it must need to find out this kind of people in the handicapped schools or some NGOs for the system trail testing. So, the author has already contacted three schools and organizations when these parties have agreed to join this system testing, each joining organization will assign at most six participants for doing an experiment.

In this experiment, the aim is to find out the statistical data for using this system whether is good for using the existing input method by the participants. Therefore, the author will collect this statistic data from the observation, this system will record the movie clips of screen captured automatically when it has detected the joystick mouse on the screen by participants. The draft of system experiment has described in the point form, which is shown below:

- Test purposes:
 1. Collect improvement suggestions and observe the use of participants.
 2. Encounter the duration time of specific tasks for the system trail testing.
- The testing process:
 1. Provide a list of tasks (check email, log in to social networks, watch online videos, and play a 30-word English essay). And measure how much time the participants need without using the system.
 2. Learn to use the system, ask to do the same task again, and measure the time required.
 3. screen captured to the movie clips
 4. After the event, participants will be asked to provide their opinions and collect them by interview or email.
- data collection:
 1. All movie clips are anonymous and confidential, it will be completely destroyed after one year.
 2. Films will be filmed during the test, but the participants will not be photographed positively and publicly on the Internet.
 3. Never involve any commercial or personal interests, purely academic research at this stage.
 4. If you feel uncomfortable, you can choose to quit or give no comments.
- System setup time: less than five minutes
- Equipment required for the system: A laptop and USB Joystick device will be provided, and the center wireless Internet service will be borrowed.
- Number of participants: A total of 6 people, respectively: (4 cerebral palsy, preferred to take electric wheelchair and speech disorder), (2 can be muscle atrophy or quadriplegia)
- Trial time per participant: 45 minutes or one hour

Chapter 5 Experiment result

Although, the author has already invited the red cross handicapped schools and SAHK for joining this system experiment when it should be started with summer holidays.

However, they have only provided a few video clips for me when the students were used in this system unfortunately, there have not any statistic data which is provided by them, because the occupational therapist needs to practice with them more time and inquiry their parents whether is accepted for joining this experiment. Thus, there have to waste a lot of time for internal administrative procedures [Refer to Appendix].

As a result, the author is very frustrated and disappointed for it. On the other hand, many existing mindsets is a bad experience about the other assistive system for these schools or parents before, their motivation is very low, or even negative. As the most assistive system is a commercial and bundled software, it cannot fulfill their requirement at all. In addition, these input devices are mostly dependent on imports from overseas, and the price is very expensive. The worst case is manufacturers no longer produce these products, they have disappeared in the market. In Hong Kong, disability assistive technology is not the mainstream IT development direction, and such a commercial market is relatively small, lacking commercial interests and research funding to support these projects.

Chapter 6 Future work

According to the problem of collection the system evaluation data by other handicapped parties, the author will propose to develop a web platform for the system evaluation, all evaluation procedures, instructions and testing programs have uploaded on it. All people with severe disability can join the system experiment for themselves without any authorization of the official handicapped organizations because it is easier to collect the system evaluation data by them. the testing programs should automatically record the movie clip during the system evaluation and count the finish time for each task. after that, this collecting data has uploaded to the network server and the users can give some comments via verbally or plain text. the author can base on this comment and statistic data to improve a new version of the system as well.

As each CP people abnormal movement duration time may have different, the system should need to record this frequency in the central database, it can automatically fine-tune the suspending time of abnormal movement detection without any input by human hand. this kind of system function should be involved in the artificial intelligent technique to build up a huge data model when the joystick control system can estimate the abnormal movement pattern by them.

Conclusion

The main purpose of this research is to find a suitable filtering abnormal movement of joystick control system and the evaluation method of voice recognition system for the CP people, it can reduce the computer hardware resources of using artificial intelligent technique to predict what they said, enhance the efficiency of learning and working for them. The benefit has reduced the pressure on caregivers and improve the quality of life in this group of people. Besides, the findings will provide some guidance for the design of the assistive technology system, so that the community can easier to accept multiple people with physical disabilities, so this research is worth doing and meaningful.

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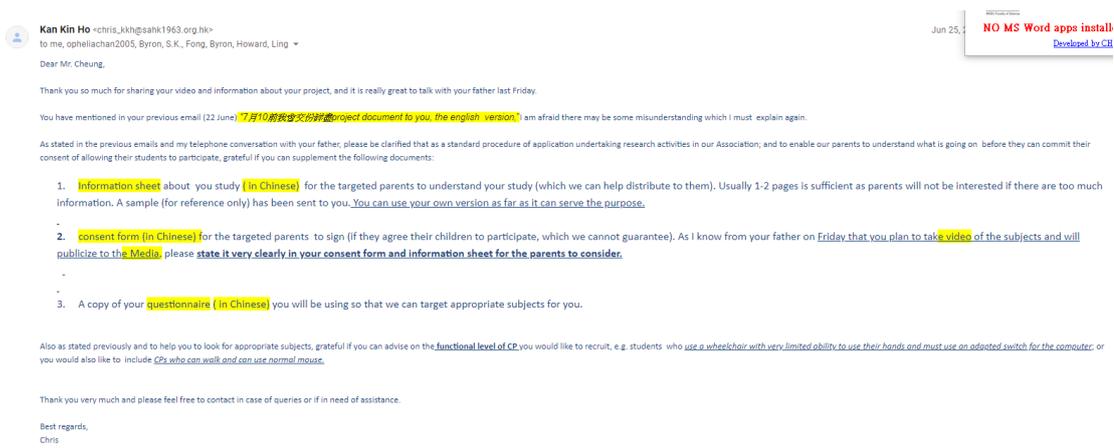
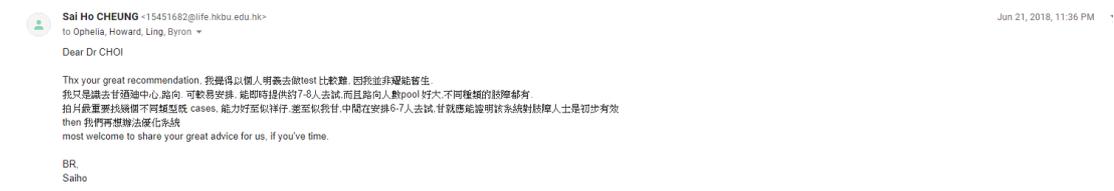
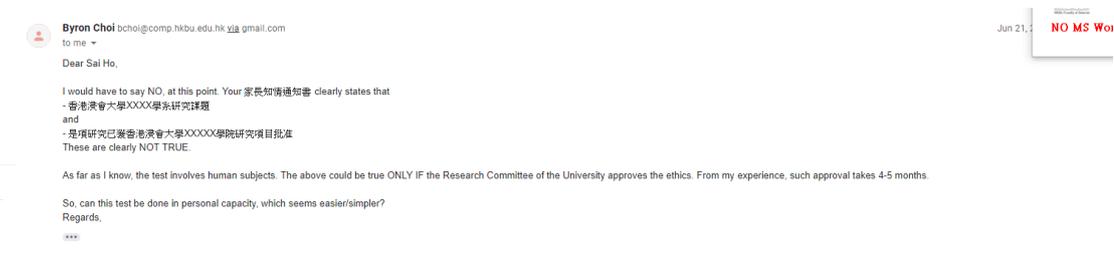
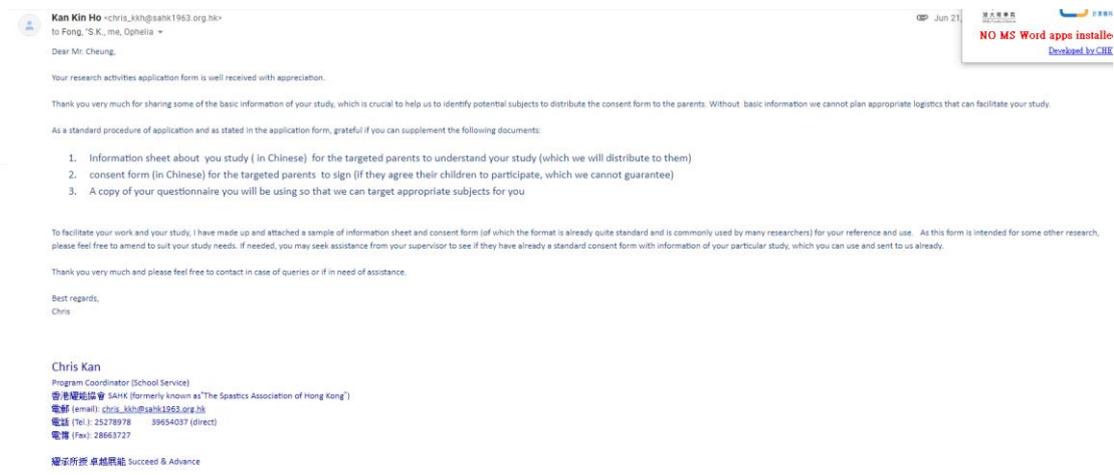
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Appendix



From: Kan Kin Ho [mailto:chris_kkh@sahk1963.org.hk]

Sent: Tuesday, July 03, 2018 12:54 PM

To: "Sai Ho CHEUNG"; "Kan Kin Ho"

Cc: "Ophelia Chan"; "Byron Choi"; "S.K. Law"; "Mr. Fong"; "Byron Choi"; "Howard LING"; "Ling"

Subject: RE: Test Run Joy stick



Dear Mr. Cheung,

Your email with the consent form is well received and it is very helpful in making known of your inclusion criteria of the targeted subjects. We hope to be able to find some potential subjects that meet the criteria to distribute the form later.

About the consent form. Because it serves as an information sheet for the parents to understand and to reply, it will be helpful for them if you add the following 3 sections in your consent form (similar to the samples I sent to you in previous emails):

1. A very short introduction about the purpose of the consent form
2. 聯繫方式
3. 家長知情同意簽署回條

For your convenience and to facilitate the process, I have add in sample sections (in red fonts) in your consent form and attached for your reference.

From the information in your consent form, there are some details I would like to clarify:

1. Please clarify whether the video will be publicized to the media or how it will be used.
2. Please clarify whether the parents have to come to the school to accompany the participants during the trials.
3. Please provide a copy of the questionnaire in Chinese

Thank you very much.

Best regards,
Chris