COMP7960 MSc. Research 1

Topic: Joystick mouse with voice command system architecture for Cerebral Palsy people

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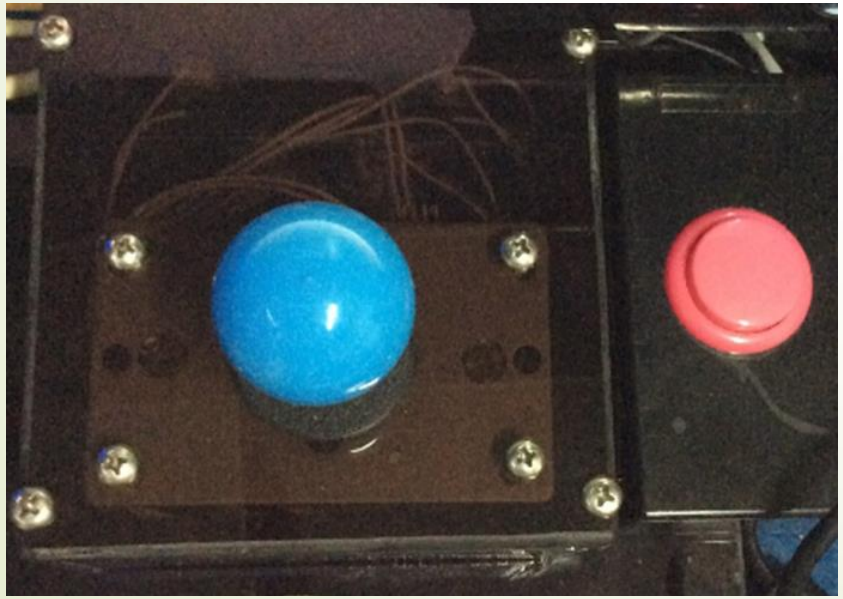


The purposes of research finding

- Due to the problem of poor hand movement, the Cerebral Palsy users are always pressing the wrong or repeated key on the traditional 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.

- In this research report, there have proposed the architecture of the joystick control with voice recognition system for 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 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.

- 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, there may have a problem affects with the progress of learning and intellectual development during teenager. 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 communication board system which has enhanced the communication ability for them.

The benefit of using IT by the CP people

- 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. 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.

- Actually, the therapist has used the manual ability classification system (MACS) for evaluating the CP students with different of upper limb ability. The aim is trying to found out the sophisticated IT solutions when the other people can understand for their needs or thinking more easily.

- The CP students have a basic knowledge of operation the computer and expand their social circle through the internet. 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, the core mission of occupational therapy is provided the barrier-free environment for the handicapped children.

The physical ability training of using the goal activity motor enrichment (GAME) approach

- The occupational therapist has provided some tasks in computer of relating to the CP user's daily life and given appropriate the instructions on how to achieve the tasks by themselves, such as send e-mail and browse information on internet etc.

- The aim is training the basic ability of using the computer, self-learning and know how to exploit IT improving their knowledge, communication with other people via internet. Especially speech disorder and limitation mobility students.

The comparison functionality of some existing assistive technology systems

- 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 accuracy.

- For the using of typing words, they 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. 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.

- For the using of voice recognition, 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, they cannot speak the same words or sentences very clearly every time.

The benefit of using joystick mouse for CP people

- 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 an easier way to control cursor movement on the screen by the 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.

- 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 system.

The problem of system configuration for the existing assistive system

- For the voice recognition systems, it must need to say the specific single word or sentence by the CP users, no sophisticated evaluation method to determine whether is appropriated in using them.

- Although, the joystick control system has automatically fine-tune the moving speed by some evaluation software, such as Cerebral Palsy Kinematic Assessment Tool and OpenSim. All control systems have not provided the function of damping module, it can filter the abnormal movement by CP users, especially a group of Athetoid CP. So, they need to pay the extra effort to rollback the original moving direction.

- All on-screen keyboard system need to move the cursor and click the mouse button on the icon of selected character when the user type the word without using the keyboard. However, the CP user aims to the target character very difficult when they have the unstable muscle tone.

The proposing new evaluation methodology and system design for the joystick mouse with voice command system architecture

- There have three types of system design for improvement:

- Designing of the evaluation process for identifying whether has a problem of speech disorder for CP user, determine what type of the voice recognition system is suitable for their used.

- Implementation of new voice recognition system design for easy to use the CP user who has a problem of speech disorder.

- Implementation of new program algorithm for filtering the abnormal movement of joystick control for CP user, they can control the joystick moving more smoothly.

Designing of the evaluation process in the voice recognition system for CP users

- 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'. The aim is determined whether the user can speak some basic vowels and successes to recognize by a computer.

- 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 aim is determine whether the user can control their tongue muscle movement and lip control position very smoothly.

- For the third stage, the program has selected some simple short sentences in both languages of English and Chinese. 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' etc. The aim is determined whether the user can handle the speed of their speech and voice tone control in normally.

- 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. If the user can finish all stages of the evaluation procedure, they can try to use for the existing voice recognition platforms, because the computer can recognize what they said as well.

Implementation of new system design for the voice recognition system

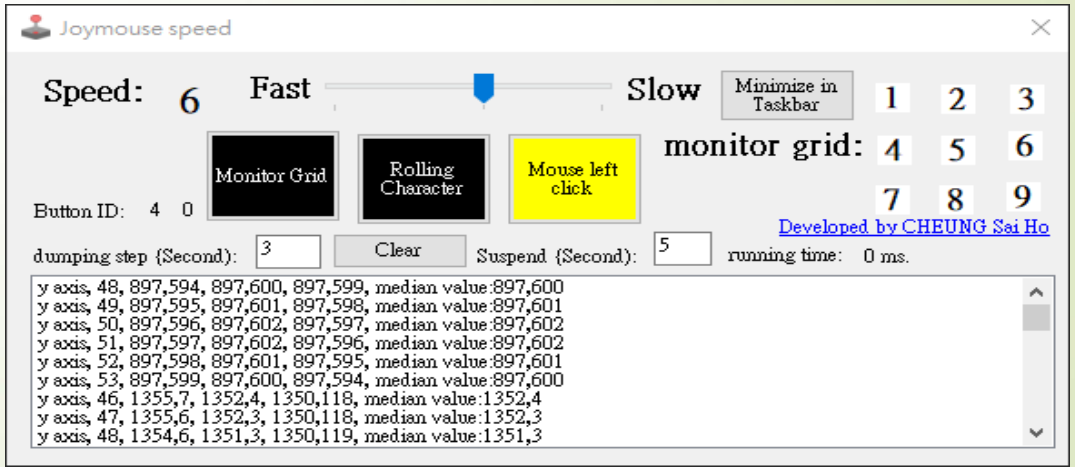
- Due to the hand function problem, the CP user is impossible to press the combination keys when their both hands cannot coordinate as well. the system has provided a data list to contain at most twenty voice commands for the users when they can set these specific combination keys to the voice commands, the matching relationship is only set to one combination key to one voice command.

- According to the failure experience of handicapped e-sports team, 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. it is more easy to execute the specific commands in the game and may can gain the competitions.

Reducing joystick operations error with abnormal muscle control

- For the part of filtering abnormal movement using the joystick, the 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, the new program algorithm is mainly focused on filtering some abnormal movement data from moving the opposite direction suddenly.

- For the part of force detection, 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.



Experiment designed

- The author has already contacted three handicapped 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.

- 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.

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, because the occupational therapist need to practice with them more time and enquiry their parents whether is accepted for joining this experiment. Thus, there have too waste time for the internal administrative procedures.
- As a result, the author is very frustration and disappointed for it. On the other hand, many existing mindset is bad experience about the other assistive system for these schools or parents before, their motivation is very low, or even negative. As most assistive system is a commercial and bundle software, it cannot fulfill their requirement at all.

Future work

- Development of web platform for the system evaluation, all people with severity disability can join the system experiment for themselves without any authorization of the official handicapped organizations, because it is more easy to collect the system evaluation data by them.

- 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.

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