Voice Commanding System of a Personal Computer for People with Disabilities

Dong Hyun Kim, Young Sil Lee

Abstract: Approximately 77% of disabled people use the internet using various devices including a personal computer. Since a keyboard and a mouse is the default computer interface basically, it is difficult for the disabled person such as a patient in total paralysis to use a personal computer. In this paper, we design and implement the voice commanding system of a personal computer using the Amazon Echo. In the proposed system, the Echo accepts a voice command of a user and sends the command to skills. The skills and the lamda functions in the Amazon Web Service analyze the voice command and transforms the commands to the executable instruction. The transformed instruction is transferred to the controller of the user' PC and executed. The benefit of the proposed voice commanding system is the exact control of the personal computer following the intention of the disabled person requiring even low costs.

Index Terms: amazon echo, amazon web service, disabled person, human computer interface, voice commanding.

I. INTRODUCTION

In order to get information, the best device for a disabled person is a personal computer. The 2017 Digital Information Gap survey[1] said that the 57.8% of disabled people own personal computers. When comparing with the percentage of disabled people keeping computers in 2016, the rate becomes to rising. Also, the 77.7% of disabled people exploit the internet using various computing devices including a personal computer in order to interact with the outer world.

However, the disabled person is hard to use most of the personal computers with a keyboard or a mouse. Since the user of a PC should exploit fingers for exact executions of both the keyboard and the mouse, it is difficult for the disabled person having no fingers or problems with fingers to manipulate the keyboard and the mouse. For example, a patient in total paralysis caused by a car accident cannot use a computer since it is impossible for him to move his arms or fingers. He is only possible to move his lips or make voices.

The integramouse[2] operates the personal computer with a mouth. A user bites a specialized mouthpiece and moves the mouse by moving lips. The myo[3] recognizes electrical signals of muscles and the transformed motion signal moves a mouse. In [4], they measure the keyboard and the mouse errors caused by the disabled people. [5] shows the system to measure and evaluates the input ability of spinal cord injury patient for a PC. The frequency components for a brain to computer interface are selected in [6]. [7] presents a EMG controlled pointing device using a neural network. The head-operated mouse is proposed in [8] and [9] proposes the acoustic control system using a non-verbal sound. The novel fuzzy mouse cursor control system is described in [10] and [11] evaluates the performance of four different computer-access solutions. A novel camera mouse driven by 3D model is introduced in [12]. [13] shows a gyro-mouse for handling and click and move function of a mouse.

In this paper, we design the voice commanding system of the personal computer using the amazon Echo for people with disabilities. The amazon Eco speaker accepts the voice commands of a user and sends them to the skills of the Amazon Web Service(AWS). The skills and lamda functions analyze and transform the recognized commands and send the executable instructions to the controller installed in the user's personal computer. We also implement the skills and the lamda function for the AWS and the controller for the user's PC using the spring framework.

The rest of the paper is as follows. In section 2, the related works are presented and the concept and design of the proposed system are described in section 3 and 4. Section 5 shows the results of the implementation and the conclusion is presented in section 6.

II. RELATE WORKS

The IntegraMouse[2] operates a personal computer with a mouth. A user bites a specialized mouthpiece and moves the mouse by moving lips. By sipping and puffing, the click of the mouse is executed. It has been developed for people with paralysis or progressive muscle diseases. The Myo[3] is the wearable device uses the electrical activity of the user's muscles. When the user waves his arm or hand, the wave motion is digitalized and transferred to the connected computer. If the specific motion is connected with the specific command of the computer, the command is executed. However, since these devices are so dedicated for a disabled person, it has the problem to be too expensive or inexact.

The keyboard and the mouse errors caused by the people with motor disabilities are presented in [4]. Six important classes of keyboard difficulties are identified and difficulties with all aspects of mouse usage were observed. They suggest that automatic detection is able to solve most difficulties. Reference [5] shows the system to measure and evaluate the input ability of spinal cord injury patients. The system measures the position of a

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mouse cursor and three time parameters when a patient uses the computer with a mouse. The input abilities of the patient were evaluated using the measured time parameters. The frequency components for a brain to computer interface(BCI) are selected in [6]. They pointed out the selection should be individual for the subject and the electrode position. The most relevant frequency bands should not be symmetrical and the relevance of certain frequency components can be increased by the biofeedback. They suggest that frequency selection need dynamic adaptation. Reference [7] proposes an EMG controlled pointing device using a neural network and develop a prototype system. The proposed system measures the user's intended direction of a pointer based on the finite number of base directions. The probabilities of the movements for each base directions are estimated by the neural network and applied to the movements of the pointer.

The head-operated mouse is proposed in [8]. They employ two tilt sensors placed in the headset. One is for detecting the lateral head motion to move the left/right movements of a mouse and the other is for detecting head's vertical motion to move up/down. The click operations are executed by the movements of the user's cheek. Reference [9] proposes the acoustic control system of a mouse using non-verbal sounds such as whistling or humming. In an orthogonal mode, a user can move the pointer horizontally or vertically at any one time with variable speed. In melodic mode, the user can move the pointer in any direction with fixed speed. The novel fuzzy mouse cursor control system(FMCCS) is described in [10]. In FMCCS core, several fuzzy control functions define different user interaction with the system. Reference [11] evaluates the performance of four different computer-access solutions, the CameraMouse, the ASL head array mouse emulator, the CrossScanner and Quick Glance Eye Tracking System. The goal of this work is to provide a procedure for evaluating the output of computer-access systems. A novel camera mouse driven by 3D model is introduced in [12]. The introduced system exploits the visual face tracking system to retrieve the motion parameters from video at real time. The retrieved head orientation, translation and mouth movement moves the mouse cursor and events. Reference [13] shows a gyro-mouse to provide a new human-computer interface for handling the click and move function of a mouse. They adopt the artificial neural network to recognize the quick-nodding pattern of the disabled person.

III. Voice Commanding of a Personal Computer

The basic way to exploit a personal computer is to manipulate a keyboard and a mouse with hands. There are several ways to control the computer using other parts of a body. The first way is to use foots. The usage of foots has the benefits to be similar to the manipulation using hands and intuitive. However, the foots has less precision and make the user to be tired easily and quickly. The second is to use lips. The usage of lips is more precise and comfortable than the foots. But the device for the lips should keep clean since it is easy to be dirty and cause health problems. The third is the motion recognition using a gyro sensor or a motion sensor. The motion recognition takes advantage of various parts of a body but is too expensive. The last is to use a voice. The device for a voice takes less cost and is able to provide various methods to control a computer. The basic idea to control a personal computer for a disabled person is to manipulate a mouse and a keyboard exploiting voice commands based on the amazon Echo.

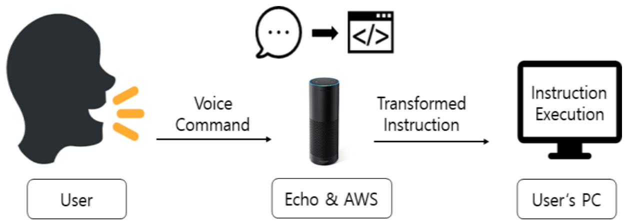

Fig 1. System Concept Diagram

Fig 1 shows the concept diagram of voice commanding system proposed in this paper. When a user speaks a voice command to the Echo, the skills and the lamda functions installed on the AWS analyze the voice command and transfer the transformed instruction to the personal computer of the user. The controller module on the PC executes the transferred instruction.

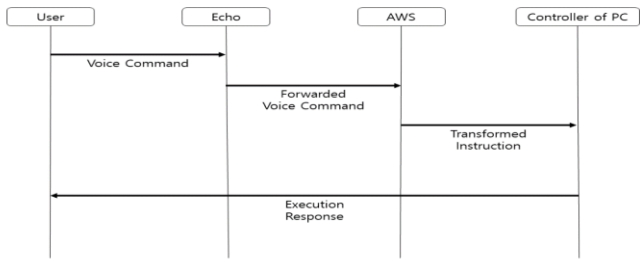

Fig 2. Sequence diagram

The sequence diagram of proposed voice commanding system is shown in Fig 2. The user inputs the voice command into the Echo. The Echo forwards the voice command to skills installed on the AWS. The skills analyze the voice command and invoke the related lamda function. The lamda function developed by JAVA transforms the voice command to the executable instruction. The transformed instruction is transferred to the controller module of the user's PC. Finally, the controller module executes the instruction and the user is able to confirm the result of the execution.

IV. Design of Voice Commanding System

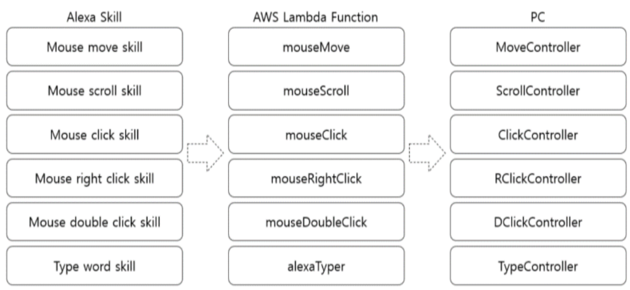

Fig 3. System structure

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Fig 3 shows the system structure of the proposed voice commanding system. The whole system is composed of the Alexa skills, the AWS lamda functions and the controller of a PC. For the voice commands entered by the Echo, each Alexa skill is designed. Table 1 shows the designed skills and roles. Each skill analyzes the incoming voice command and invokes the related lamda function of the AWS

Table 1. Role of the Alexa skills

Division	Command	Role
Mouse Role	mouseMove	Move mouse pointer
	mouseScroll	Mouse scroll
	mouseClick	Mouse left click
	mouseRightClick	Mouse right click
	mouseDoubleClick	Mouse double click
Keyboard Role	alexaTyper	Typing command text

The lamda function accepts the parameters analyzed in the skill and transforms them to the executable instruction. The lamda functions for a mouse are classified into 3 types. The first is a move function. The mouseMove function measures the direction and distance values for the mouse using the parameters analyzed in the skill and creates the mouse instruction. The second is a scroll function. The mouseScroll function makes the direction of a mouse wheel and the velocity of the scroll using the parameters analyzed in the skill. The last is a click function. Each mouseClick, mouseRighrClick and mouseDoubleClick function creates the left click instruction of a mouse, the right click instruction of a mouse and the double left click instruction of a mouse. The single lamda function for a keyboard is designed. A alexaTyper function creates the keyboard instruction and strings using the parameters analyzed in the skill. All transformed instructions are transferred to the controller of a PC. The controller of a PC is composed of 6 modules and executes the instructions transformed at the related lamda functions. The MoveController moves the mouse pointer using the direction and the distance values transferred from the lamda function. The ScrollController execute a scroll function based on the transferred direction and velocity values. The ClickController, RClickController and DClickController executes the left click, the right click and the double click of a mouse by the transformed instruction. The TypeController executes the keyboard instruction based on the transferred strings.

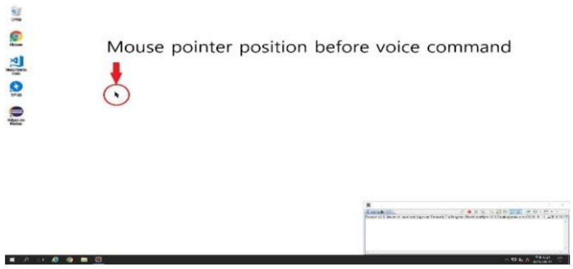
V. SYSTEM IMPLEMENTATION

Table 2 shows the system environments to implement the designed voice commanding system of a PC.

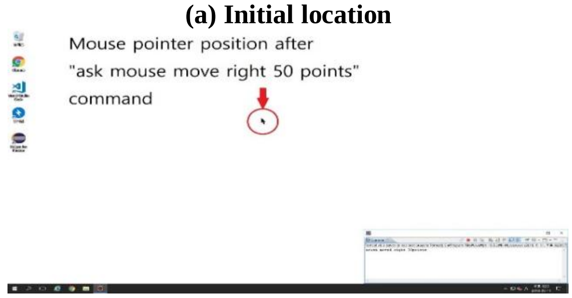
Table 2. Implementation environments

Division	Environment
OS	Windows Server 2016 Standard
Processor	Intel(R) Xeon(R) CPU E5-2680 v4 @ 2.400GHz
RAM	16.0GB
System Type	64bit Operating System

To show the result of "move mouse" command, the mouse pointer is located initially on the random position as shown in Fig 4(a). When the voice command, "Alexa, ask mouse move right 50 points", is entered to the Echo, the mouse pointer moves to the right direction on 50 points from the initial location and the executed command is displayed on the console window as shown in Fig 4(b).

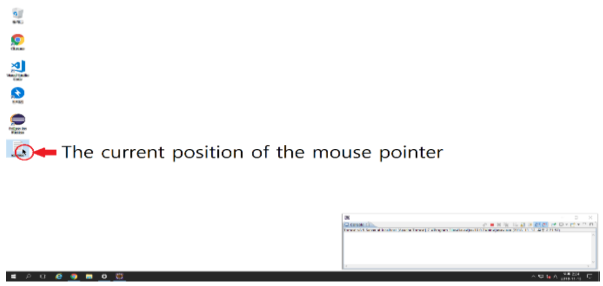


(a) Initial location

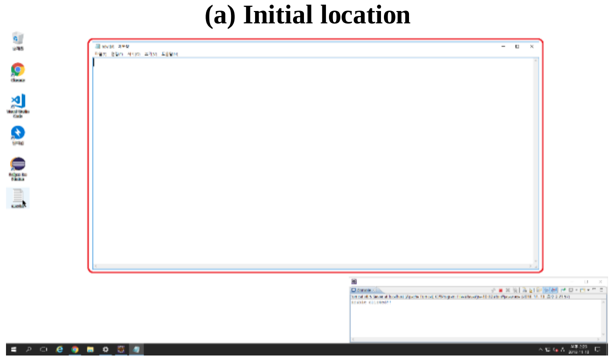


(b) After command execution

Fig 4. Commands "Alexa, ask mouse move right 50 points"



(a) Initial location



(b) After command execution

Fig 5. Commands "Alexa, mouse double click"

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To test a mouse click and a keyboard command, the mouse pointer is located on the memo application icon as shown in Fig 5(a). When the voice command, "Alexa, mouse double click", is entered to the Echo, the memo application is executed following the double click of a mouse execution as shown in Fig 5(b).

Fig 6 shows the result of a keyboard execution. When the user speaks the voice command, "Alexa, type hello world", the string, "hello world", is typed and the executed command is displayed on the console.

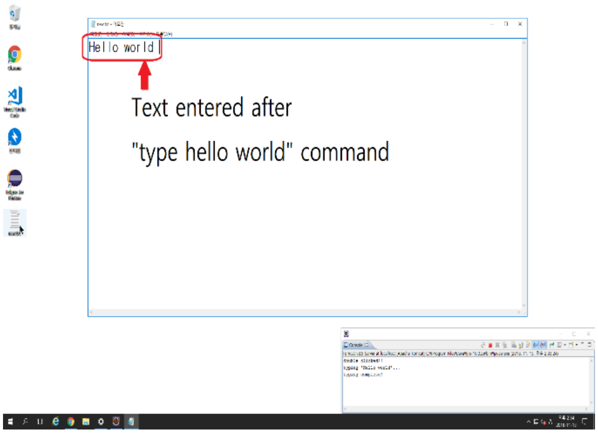

Fig 6. After commanding "Alexa, type hello world"

VI. CONCLUSION

In order to get information and interact with the outer world, the best way for a disabled person is to exploit a personal computer. However, since the basic interface devices are a mouse and a keyboard, it is difficult for the disabled person to exploit a personal computer in his way. The specialized devices dedicated for a disabled person such as the patient in total paralysis are too expensive or require much cares. In this paper, we designed and implemented the voice commanding system of a personal computer for a person with disabilities. The proposed system accepts the voice commands via the amazon Echo and transforms them to the executable instructions using the skills and lamda functions installed on the AWS. The transformed instructions are transferred to the controller of the user's PC and execute the mouse and the keyboard functions. The further research is to develop the system to customize and execute the application installed on the user's PC using the voice commands.

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