USING VIDEO GAMES FOR STROKE REHABILITATION AT HOME

SỬ DỤNG TRÒ CHƠI ĐIỆN TỬ ĐỂ PHỤC HỒI CHỨC NĂNG SAU ĐỘT QUỴ

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ABSTRACT

The aim of this feasibility study was to design gloves using touch sensors TTB223B Mini combined with ESP32 module and serious games to improve movement speed, dexterity, and finesse on 4 fingers as well as the levels of satisfaction and compliance among patients in mild-to-moderate stages of the disease. Player data is saved weekly to calculate and evaluate results. The system and the serious games designed may be a promising approach to improving upper extremity function for Stroke patients.

Keywords: *Stroke rehabilitation, upper extremity, serious games, home-based rehabilitation.*

TÓM TẮT

Mục đích của nghiên cứu này là thiết kế găng tay sử dụng cảm biến cảm ứng TTB223B Mini kết hợp với mô-đun ESP32 và các trò chơi để cải thiện tốc độ di chuyển, sự khéo léo của 4 ngón tay cũng như mức độ hài lòng và tuân thủ của bệnh nhân đột quỵ ở giai đoạn trung bình của bệnh từ mức độ nhẹ đến nặng. Dữ liệu người chơi được lưu hàng tuần để tính toán, đánh giá kết quả. Hệ thống và các trò chơi được thiết kế có thể là một cách tiếp cận đầy triển vọng để cải thiện chức năng chi trên cho bệnh nhân đột quỵ.

Từ khóa: *Phục hồi chức năng đột quỵ, chi trên, trò chơi vận động, phục hồi chức năng tại nhà.*

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1. INTRODUCTION

Worldwide, stroke is a leading cause of motor problems. The upper extremity of stroke survivors is often affected by hemiparesis and spasticity. These unilateral motordeficits lead in approximately 40% of the stroke patients to chronic upper extremity impairment, limiting functional use and compromising their quality of life.

In the last few years, telemedicine and telerehabilitation have been strengthened with the implementation of diverse technologies that support rehabilitation processes, oriented toward providing patients with the services required, reducing the number of journeys to main cities, where, in general, specialists, hospitals, clinics, and centers equipped with the technology for the therapies are located. The benefits of telemedicine are more evident in cases associated with traveling and the mobility of the patient, costs, or other factors, for instance... [1, 2].

The methods of using video games and a motion capture system have been shown to be effective in helping patients improve their ability to function in daily activities after a stroke [3]. Standard games such as the Nintendo Wii, Playstation Move and Kinect plus XBOX 360 have been used in stroke rehabilitation. However, often these are either too difficult for patients or the games progress too quickly, failing to provide impairmentfocused training or specifically address patients' needs [4]. Therefore, it is necessary to develop specific serious games for stroke patients. Serious games are defined as games designed for a primary purpose other than that of pure entertainment, and which promote learning and behavior changes for stroke patients. Pilar Fernández-González et al. have designed a leap motion system to restore upper limb function in patients with Parkinson's disease [5]. System uses the Leap Motion Controller (LMC) System®, which uses a sensor that captures the movement of the patient's forearms and hands without the need to place sensors or devices on the body combining the serious games performed in this study aimed to imitate exercises and movements commonly included in conventional rehabilitation. Per Backlund et al designed the Elinor Console for Home-Based Stroke Rehabilitation [6]. Elinor has a library of 15 games and uses USB to record patient activity and outcomes in conjunction with the clinic to gauge patient improvement. Both of these designs are highly appreciated by users for their efficiency (ingenuity and mobility), the user's level of use.

Target research is directed towards creating systems using devices that are common, easy to use and safe for users so we are using a TTB223B Mini capacitive touch attached to the fingertip in combination with the ESP32 module to transmit signals to the computer. This helps the patient perform the movements according to the functional task purpose in the game.

Therefore, the main purpose of this study is to design gloves using touch sensors TTB223B Mini combined with ESP32 module and serious games to improve movement speed, dexterity and finesse on 4 fingers.

2. MATERIALS AND METHODS

2.1. Model System

Block diagram of the system is shown in figure 1.

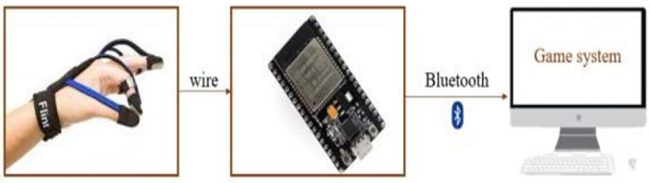

Figure 1. Block diagram of the system

2.2. Design Hardware

2.2.1. Select microprocessor family and embedded programming tools

Figure 2. ESP32 microcontroller

ESP32, which has shown in figure 2, is a low-cost System on Chip (SoC) Microcontroller from Espressif Systems. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of the Tensilica's 32-bit Xtensa LX6 Microprocessor with integrated Wi-Fi and Bluetooth.

The good thing about ESP32, is its integrated RF components like Power Amplifier, Low-Noise Receive Amplifier, Antenna Switch, Filters and RF Balun. This makes designing hardware around ESP32 very easy when requiring very few external components.

Another important thing to know about ESP32 is that it is manufactured using TSMC's ultra-low-power 40 nm technology. So, designing battery operated applications like wearables, audio equipment, baby monitors, smart watches, etc., using ESP32 should be very easy.

2.2.2. Capacitive touch sensor

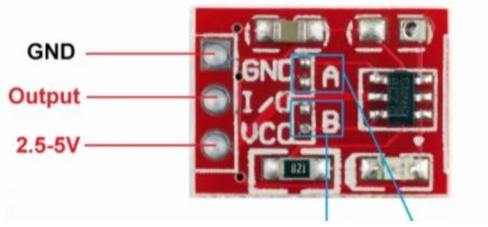

Figure 3. Touch sensor

Acts as a touch switch. When a capacitive carrier (like a player's hand touches it), the sensor outputs a signal.

The sensor has 3 pins, small size (15 x 11 mm), with LED touch indicator light, can penetrate materials such as glass, plastic, mica...

2.2.3. Fingerstall

Figure 4. Fingerstall

+ Connecting the male and female wires together so that the length is 60cm so that the player can comfortably play the game and not be limited => need a total of 3x4 = 12 strings + Soldering the wires to the sensor pins.

+ Attaching sensor to fingertips with needle and thread.

+ Using chicken intestine twisted wire to fix 3 wires of each sensor together.

2.3. Design Software

2.3.1. Game Snake

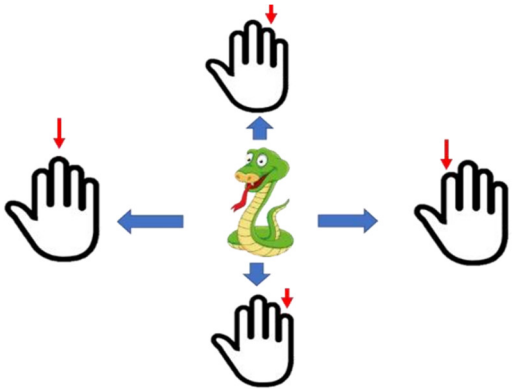

Figure 5. Direction of fingers on game snake

In order to increase attractive and support to follow health process of stroke patient, our team create a Snake game that is on the windows forms platform (C#). The interface of the game is the snake in the land, with additional sounds to increase the vividness of the game.

When the game starts, user need to choose direction for the snake to move. The player will have to manipulate it by touching the thumb with the remaining fingers of the hand. When the thumb touches the ring finger, the snake will move upwards; When the thumb touches the little finger, the snake will move downwards; When the thumb touches the middle finger, the snake will move left; When the thumb touches the ring finger, the snake will move right. This the ways to restore the function of the related hand injuries to a stroke.

2.3.2. Specific

Game interface: Game have snake and ball. Below is the interface of our game.

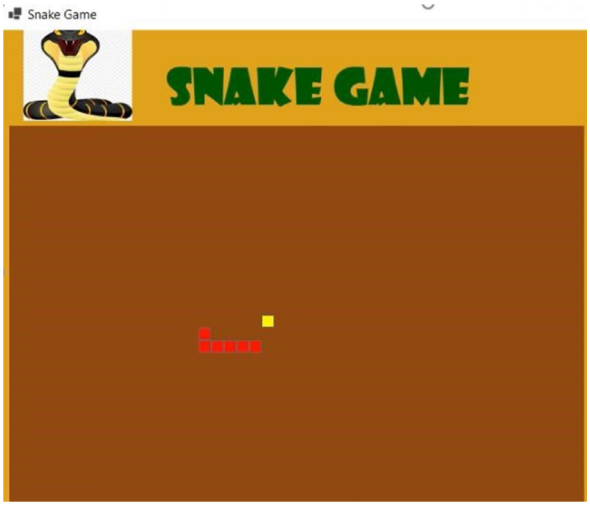

Figure 6. Game interface

The score history: Save score, time, and the number of times the figures are used after each play. Thereby helping to save information to facilitate the doctor's diagnosis and treatment.

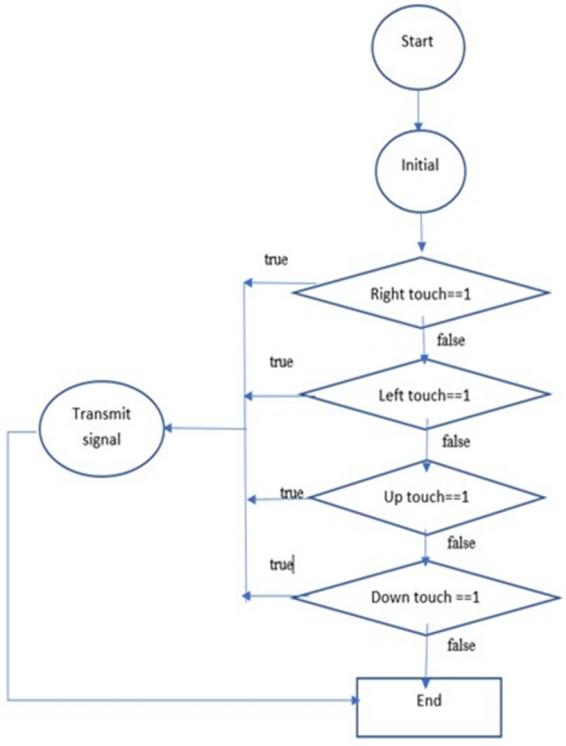

Figure 7. Algorithm diagram of the connection

3. RESULTS AND DISCUSSION

3.1. The Hardware result

Game interface relatively complete. Actual images of the device are shown in figure 8 and 9.

3.2. The software results

Successfully tried to connect the game with hardware using esp32. The snake has received the signal from touch sensor. The result game is shown in figure 10. Connect with game via Bluetooth.

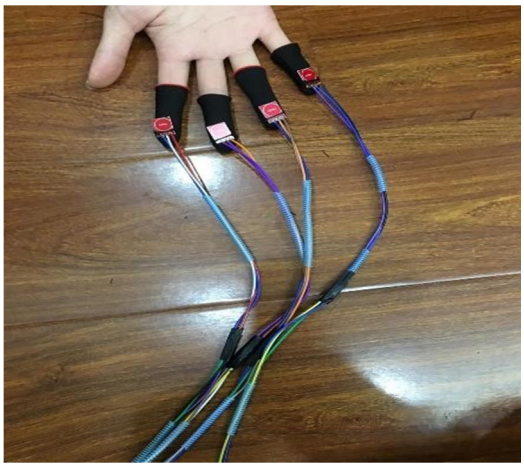

Figure 8. Glove result

Figure 9. Circuit box result

Figure 10. Snake game result on Win-form

4. CONCLUSION

The product has been completed in accordance with the research objectives set out initially. Several patient trials have achieved the expected results. However, the product still needs to continue improving and developing in some directions as follows:

+ Diversify games to motivate patients.

+ Collect and analyze patient adaptive data to support treatment.

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THÔNG TIN TÁC GIẢ

Doãn Thanh Bình

Trường Đại học Điện lực