

A Study on Art Therapy of Patients with Alzheimer's Disease and Mild Cognitive Impairment by Smart Pin Screen

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Abstract: Recently, patients with dementia and mild cognitive impairment due to aging society have been increasing day by day. Therefore, devices that help diagnose, prevent and manage patients with dementia and cognitive impairment are needed. In addition, it is necessary to develop a device that enables users to collect and process data using functions from anywhere, treat them through non-pharmaceutical game techniques and help them express themselves through non-verbal means. Therefore, in order to solve such a problem, a play apparatus device which is connected with an application can use anytime and anywhere can collect data and diagnoses and treats a patient through non-drug game and non-verbal means.

Key words: Art therapy, Alzheimer's disease, smart pin screen, application, technique, patients

INTRODUCTION

In the 21st century, Korea will enter a full-fledged aging society and the number of demented elderly people will also surge. However, dementia has not yet been tested for confirmation or effective treatment and many drugs have been tried as therapeutic agents but no drugs have been proven to be effective (Lopez, 2011). However, the treatment of dementia based on the treatment to maintain the physical function of the dementia according to the degree of treatment to lighten the symptoms, the progress of the symptoms can be mitigated (Fernandez-Martinez *et al.*, 2010). Therefore, we want to develop a playground device that diagnoses and treats patients through non-pharmaceutical game techniques and non-verbal means which can be used anytime and anywhere and can collect data through this research by Lyketsos *et al.* (2002). Conventional pin-screen devices are one of children's play apparatuses in which a plurality of pins are closely arranged to apply pressure to a hand or a specific body part and a pressed part forms a stereoscopic image. In this study, we diagnose dementia and mild cognitive impairment through these devices and try to treat it (Chatterjee, 2006; Stevens and Killeen, 2006; Pirozzolo *et al.*, 1981).

MATERIALS AND METHODS

Force Sensitive Resistor (FSR) is a sensor designed to measure physical pressure, weight and so on. The FSR sensor changes the resistance value of the sensor

depending on the pressure. Initially it has an infinite resistance value and when a little pressure is applied, it becomes 100 k Ω and thereafter the resistance value drops. When the user presses the pin, the FSR sensor attached to the bottom of the pin is pressed to change the color of the 3-color LED by changing the resistance value and LED on/off is used for the play of the contents of the pin screen.

LEDs are expanding into the existing light source market with advantages such as low power consumption, semi-permanent life span, fast response speed and environmental friendliness. Lamps that use filament as a light source are a light emitting principle that uses light as a light source by allowing a current to flow through the filament which is 90% thermal energy and 10% light energy. However, when an LED lamp injects electrical energy into a light semiconductor. By using this principle, electricity is converted into light directly, so, efficiency is high because it converts more than 90% of the theoretical electric energy to light energy. The biggest advantage of LED lamp is that it can produce various light freely. Each LED of red, green and blue LEDs can realize 256 colors, so if you combine LEDs of three colors, $256 \times 256 \times 256 = 16.7$ million colors will come out. This variety of color lamps is unique to LED lamps and has been utilized in content using this.

Bluetooth refers to a short-range wireless technology standard for exchanging information between mobile devices such as mobile phones, notebooks, earphones and headphones. It is used when a low power wireless connection is required at a very short distance of

about 10 m. Bluetooth wireless systems use the Industrial Scientific and Medical (ISM) frequency band of 2400-2483.5 MHz. In order to prevent the interference of other systems that use the upper and lower frequencies, we use a total of 79 channels, ranging from 2.400-2 and 2483.5-3.5 MHz, excluding 2.402~2.480 MHz. ISM is a frequency band allocated for industrial, scientific and medical uses and is often used for personal wireless devices that emit low-power radio waves without the need for permission to use radio waves. Amateur radio, WLAN and Bluetooth use this ISM band. Because it uses the same frequency band as many systems, interference may occur between systems. To prevent this, Bluetooth adopts frequency hopping method. Frequency hopping is a technique for quickly moving a large number of channels according to a specific pattern and transmitting packets (data) little by little. Bluetooth hops 1600 t/sec to the assigned 79 channels. This hopping pattern must be synchronized between the Bluetooth devices before the communication is established. Bluetooth is connected to the master and slave configurations between devices. If the slave device cannot be synchronized with the frequency hopping that is generated by the master device, communication between the two devices is not performed. As a result, it is possible to stably connect to other systems by avoiding radio interference. A microcontroller is a small computer that performs a specific function by making a microprocessor and an input/output module into a single chip. Arduino includes all the development tools and environments associated with these microcontroller boards. Arduino was initially based on the Atmel AVR microcontroller but it has a variety of boards depending on the application and libraries of development tools and features are available. Because the source code is C++ language-based, you can use the standard library functions of C language in Arduino and you can easily code complex programs because there are many open source. App. inventor is a smartphone App. creation tool that allows anyone to easily create smartphone apps for android by using the block editor in MIT to develop apps on Android-based phones or emulators.

System design: A system for patients with dementia and mild cognitive impairment using diagnostic and therapeutic content on a pin-screen with hardware and software. The system consists of a data processing unit, a data communication unit and an application. The data processing unit performs contents, transmits data through the MCU, communicates via. Bluetooth, controls the system in the application and outputs the data. The MCU for implementing the software uses Arduino Mega ADK (ADK). The contents of the pin screen are largely divided

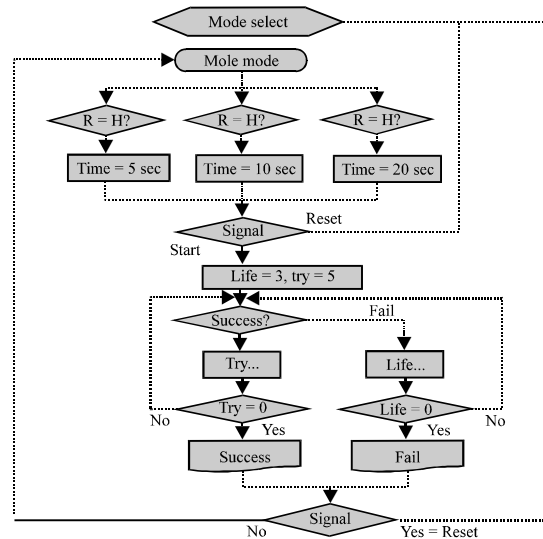


Fig. 1: Diagnostic mode algorithm

into diagnosis and treatment. Diagnostic content is measured by repeated cognitive training to measure cognitive time and the level of dementia and cognitive ability is determined based on the measured time. Therapeutic content stimulates cognitive abilities by repeated cognitive training or by stimulating hand movements, vision, hearing and so on to stimulate the brain movement to alleviate symptoms or prevent progression. The diagnostic content is that the LEDs connected to the four pins of the pin screen are turned on randomly. In this case, the user recognizes the randomly turned on pin and pushes the LED. The LED will remain lit until the corresponding pin is pressed and the cognitive reaction rate is measured by measuring the time until that time. In order to diagnose a precise reaction rate, a single diagnosis content is repeated 10 times in total. First, we collect big data of normal and dementia patients to create a database. Then, they establish criteria for diagnosis of dementia and compare the data collected after the content process to determine the degree of dementia. Figure 1 shows the diagnostic mode algorithm.

It recognizes LEDs that are randomly turned on among the four pins of the pin screen and finds and presses them in the same way as diagnostic contents. However, the treatment contents are set differently depending on the lighting level of the LED according to the upper, middle and lower levels and it is a game in which the target pin is recognized and pressed like a mole game. If you find a pin that has a lighted light on it, it will recognize it as the correct answer and if you press any other pin it will reduce the score and it will show the success. After the game has progressed, you can control

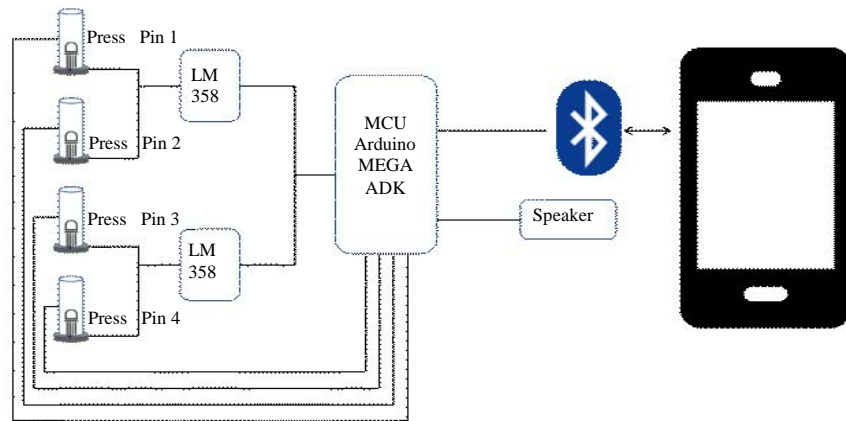


Fig. 2: Hardware configuration diagram

the level of success. The upper level is set at 5, 10 and 15 sec at the beginning but it can be modified later by MCU coding, so that, it can be adjusted by difficulty according to individual differences. The results showed that the degree of dementia was alleviated through hand movement by pressing the palm and fingers (Fernandez-Martinez *et al.*, 2010; Benton, 1977). In addition, hand exercise is now widely used for rehabilitation for alleviation of dementia (Botwinick and Storandt, 1973; Dee and Allen, 1973). The drawing content is hand exercise play therapy using pin LED color change according to the pressure of pushing pin (Ferris *et al.*, 1976; Nebes and Brady, 1992). When the pin is pressed, the pressure sensor attached to the bottom of the pin is stimulated and the voltage value obtained from the pressure sensor is transferred to the MCU and the LED of the pin lights up. The LED uses a 3-color LED which has a different minimum voltage for each color. Through 10 bit ADC, ADC values needed for R, G, B colors from 0-1023 were found and according to the pressing pressure, R, G and B colors are shown. We have developed a picture-drawing content that is displayed in various colors instead of R, G, B monochrome by properly segmenting the ADC range. Piano play therapy contents were created based on the paper that melody, harmony, rhythm, pitch, speed, intensity, tone are effective in correcting problem behaviors of demented elderly (Chatterjee, 2006; Botwinick and Storandt, 1973). I connected the speakers to the pin screen and set the piano scale by varying the frequency of each pin. Also, to distinguish each pin, the LED color of the pin is different and if you expand the number of pins later, you can play with more scale.

Figure 2 shows the overall hardware configuration. A smartphone was used to display the overall control and results of the system. Communication with the main board

uses Bluetooth and overall control from the smartphone. When the corresponding software operates according to the system control, it proceeds by using the pin for each content. The operation of the pin is to combine the LED and the pin switch, attach the pressure sensor under the pin and connect it to the MCU. When pressed, the pressure is applied to the LED according to the input value and the LM358 is used as a buffer amplifier.

The Arduino MCU (and the application communicate via Bluetooth). It uses HC-06 Bluetooth to connect directly to the Arduino and it can transmit and receive stable data through one-to-one security pairing with the corresponding device and password. Application developed through App. inventor can control and output data of this device. When the contents of diagnosis mode and treatment mode are selected through the application, the instruction is transferred to the Arduino MCU and the contents are executed. After the mole game contents are processed in the diagnosis mode or the treatment mode, the result value is outputted to the application.

RESULTS AND DISCUSSION

Dataset: Data were collected for the elderly and demented patients in their 20, 70's and older. The elderly who were in their 20 and 70's were measured 10 times in total and the dementia patients were measured twice 10 times in total (Fig. 3).

Comparing the mean value of each age group, the elderly people in their 20 and 70's showed a difference of about 1.74 times and the elderly in their 20 and 70's showed a difference of 9.64 and 5.53 times, respectively.

In order to check whether the diagnosis of dementia is possible through this device, the reaction rate was confirmed by using diagnosis contents of patients who

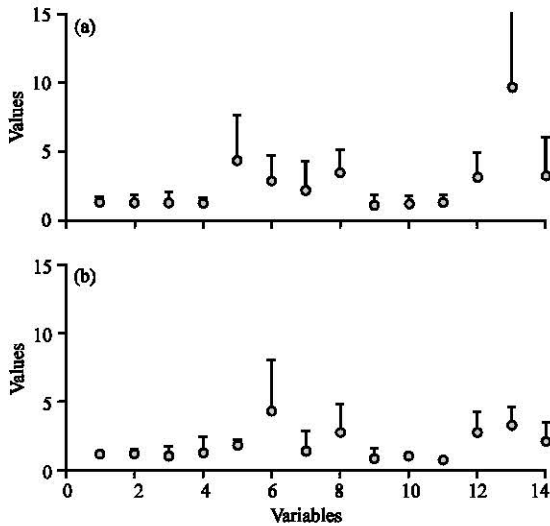


Fig. 3: Average response and standard deviation of time of 10 times measurements of 14 patients with dementia x-axis scale means the case of patients and y-axis scales means response time (sec): a) Trial first and b) Trial second

were diagnosed with dementia in their 20 and 70's. Based on the collected data, it was found that the cognitive response rate of the elderly in their 70's was slower by about 300 msec than that of their 20's by the comparison data according to the age group, the average of 20's was 364.8 msec and the average of 70's was 635.7 msec. In addition, the mean value of dementia patients was 3518.6 msec which was 9.64 and 5.53 times that of those in their 20 and 70's, respectively. In a total of two sets of patients with dementia, the average response rate of two sets was about two times faster than that of one set and some patients were up to 11 times faster. We developed a device that can diagnose dementia patients according to the reaction rate by measuring the cognitive reaction rate through smart pin screen. The response rate of the diagnostic content can be used to classify the elderly who have large deviation or large variance from the mean value as the target group and can be used as the data to advance more accurate dementia and cognitive disorders.

CONCLUSION

So that, the effect of treatment or improvement can be obtained. The smart pin screen is a device that can combine diagnosis, therapy and non-pharmacological elements through play therapy contents by combining

iterative training, hand exercise, art therapy and musical elements. This is expected to have a positive impact on social problems due to an increase in patients with dementia due to the aging society.

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