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On the Basis of Eye Tracker to Design A Remote Home Care Application System

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Abstract. *his study is to provide the disable mobility to care himself / herself in life, entertainment, emergency and other functions. One is to reduce the burden of family care the disability to deal with things. Secondly, people will not feel life is boring cause disability such that their lives just like ordinary people. In addition to, APP provides family members can monitor the disability family by the APP at any time to provide the remote operation. This research combines different technology and use the eye tracker to be a control device. The main reason is to provide a set of home care system with disable mobility. The disability only needs to focus the eyes of the optional button on the screen to perform the instructions simply. It is convenient for disable mobility to be a control device*
Keywords: Dye tracker, Disability, Home care, APP

1. **Introduction.** Most people in the daily can easily deal with the life things, but the amyotrophic lateral sclerosis (ALS) [1], the apoplectic and other inconvenience with the deterioration of the disease will make action, behavior gradually lost ability, may even deal with simple life have to spend a lot of effort. So they need to rely on family and care workers spend a lot of time, mental and physical to care. We communicate with the physician after several communications and experiments to understand the needs of mobility problems, simple operation, low cost, easy installation and high stability of the system. This system provides computer functions such as emergency, entertainment and environmental control. It can be used to watch the function of the screen through the eyes, and also provide APP for the family. The family members can understand the situation at any time through the image. When the trouble situation occurs, APP will issue a warning message to inform the family members in time such that even if the family

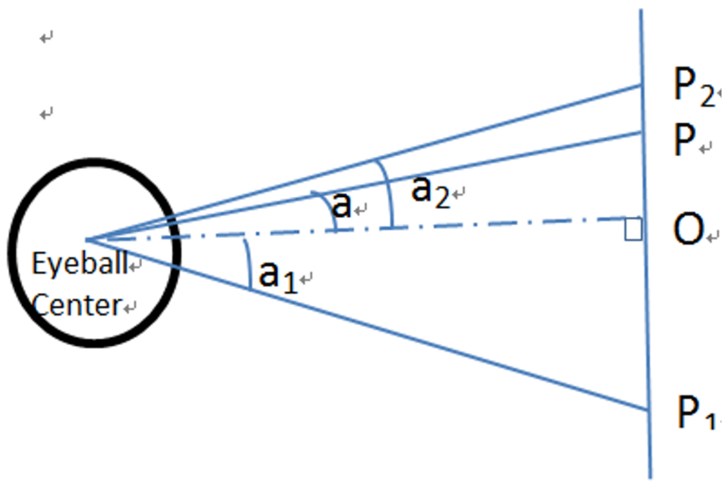

FIGURE 1. Calculation of gaze direction [5]

can feel at ease. We use eye tracker as a control device to measure the location of the eyes in computer side control interface [2-3]. The user just stares at the target. The operation is quite easy. This is why we use it as a major factor in the study.

2. System Overview.

2.1. Eye Tracker Control Screen. The basic eye tracking components are illuminators, cameras, processing unit containing the image detection, 3D eye model and gaze mapping algorithms [4]. Eye tracker are applied in a variety of fields such as psychology, medicine, marketing, engineering, education and gaming as well as for enhancing human computer interaction by using the eyes for navigation and controls.

2.1.1. *Estimation of gaze direction.* First, let users see some known points on the plane as corners and other anchor points. Record the corresponding angle of the eye and the iris center. These points are regarded as calibration points. Next, we construct a two-dimensional linear mapping between vectors eye and iris center to gaze angle. Gaze directions in consecutive frames are calculated by the following equation interpolation. For example, if user is looking at angles and calibrate from the corner of the eye to the iris center points P1, P2 are respectively $(\alpha_1, \beta_1), (x_1, y_1)$ and $(\alpha_2, \beta_2), (x_2, y_2)$, then if we observe a corner-iris vector (x, y), the corresponding gaze angle is calculated as following Eq. (1) and Eq. (2)[5].

$$\alpha = \alpha_1 + \frac{x - x_1}{x_2 - x_1}(\alpha_2 - \alpha_1) \tag{1}$$

$$\beta = \beta\ _1 + \frac{y - y_1}{y_2 - y_1}(\beta\ _2 - \beta\ _1) \tag{2}$$

The presentation is shown in Figure 1. We do not need to know the gaze angle, using α and β as coordinates, which reduces the time required for the calibration process.

2.1.2. *Eye Tracker Calibration.* When the point on the screen changes its position, it takes some time for the human brain to react and to initiate eye movement. In addition, it happens the first saccade is misplaced and the fixation point must be corrected. They were entering a calibration model. For this purpose, Katarzyna et al. [6] used the $E_(deg)$error

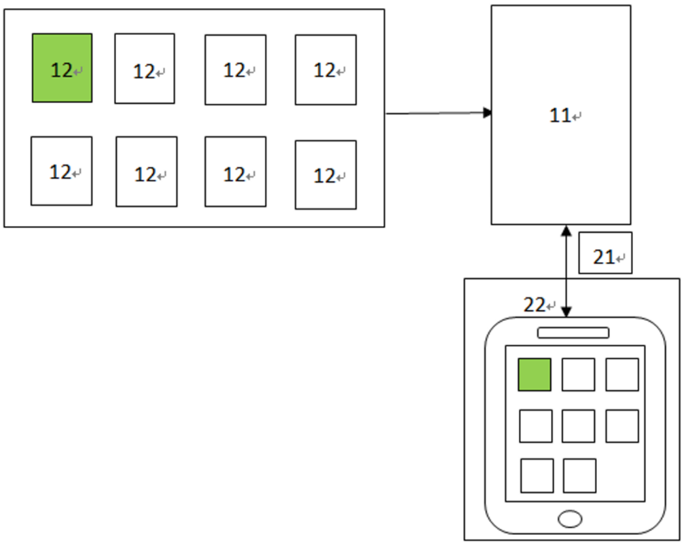

FIGURE 2. The system control architecture of the mobile device

to represent a degree distance between calibration points and their locations calculated by the three given methods, and it was defined as the following Eq. 3.

$$E_{deg} = 1/n \times \sum \left((x_i - (\widehat{x_i}))^2 + (y_i - (\widehat{y_i}))^2\right) \tag{3}$$

where x_i, y_i represent the observed values and x_i, y_i values calculated by the model.

2.2. **Control Model.** In network and communication generation, smartphones are carried by almost everyone. Therefore, Wi-Fi, LTE and other wireless, telecommunications network smartphone-controlled Internet of Things (IoT) device is a promising technology. Therefore, this research combined with microprocessors to achieve a remote smart phone Internet of Things appliances through the Wi-Fi module. Moreover, the remote control framework can be used to control other household appliances such as refrigerators, washing machines and air conditioners to achieve the purpose of facilitating control of smart appliances [7]. Figure 2 shows the system control architecture of the mobile device. When the user wants to control the home electric appliance 12 without the remote control device, the user can focus on the electric device icon through the eye tracker. The icon will change colors display the current device is on / off, and upload the current state of the power on / off message 21 to the database 11, and then obtain instant information by the smart mobile device 22, the smart mobile device 22 can remotely control the electrical switch and cancel emergency notification.

2.2.1. *WiFi Model.* We use TCP connection with the WiFi Model ESP8266 through the local area network, when the computer uses the appliance, it will send a packet to WiFi Model ESP8266 to control the appliance on / off, and the current status is uploaded to the server.

$$C = B \times \log_2 \times (1 + S/N) \tag{4}$$

C = maximum number of bits that can be transmitted per second
B = the channel bandwidth (Hz)
S = the power of the Signal received by the receiver (in W)

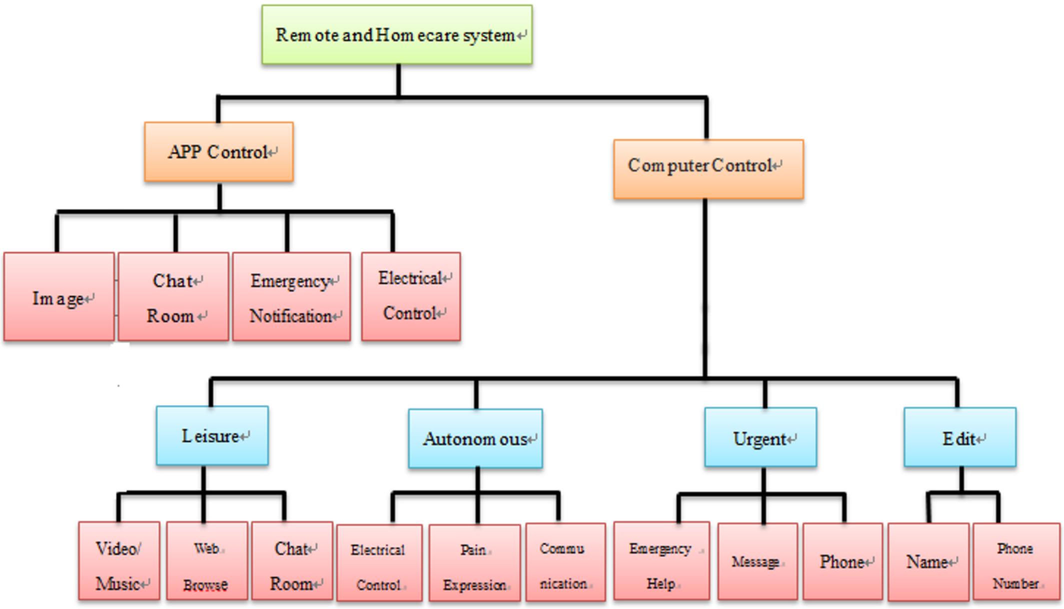

Figure 3. The system architecture diagram

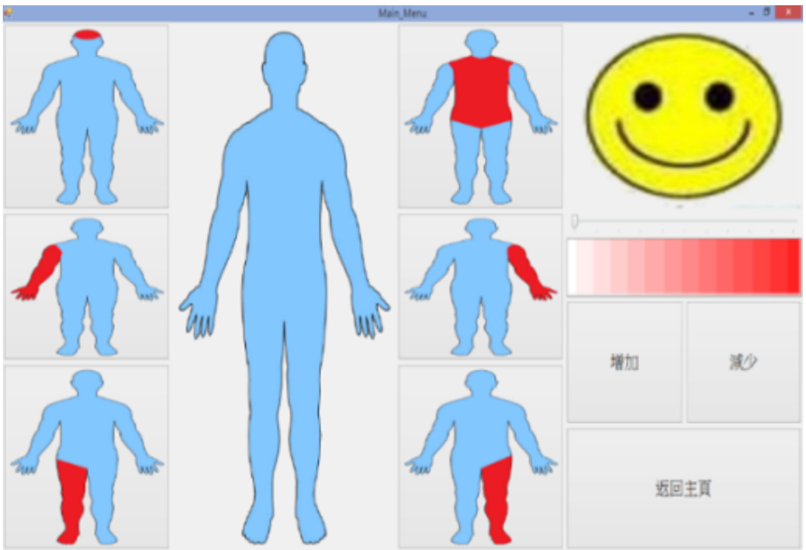

Figure 4. TPain expression interface

N = the power of the Noise present at the receiver, a function of B (in W) [8]

3. **Experimental Results.** The architecture is divided into two parts: the computer control side and APP control side. The FIGURE 3 is the system architecture diagram.

3.1. Computer control side function.

3.1.1. *Pain expression.* This function allows the patient to express his pain position and pain index so that care givers understand the patient's physical condition. The following FIGURE 4 shows the pain expression interface

FIGURE 5. The language communication interface

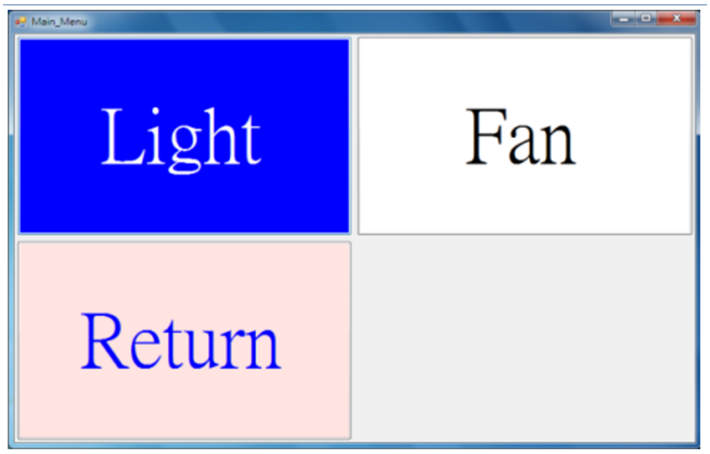

FIGURE 6. The electrical equipment control interface

3.1.2. *Language communication.* When patients want to communicate with the care giver, they can use the built-in keyboard to input the text. The system automatically transfers the text into voice to the care givers [9]. The following FIGURE 5 shows the language communication interface.

3.1.3. *Electrical equipment control.* After selecting the control option, the patient can control the appliance via wireless or infrared [10-11]. The following FIGURE 6 shows the electrical equipment control interface.

3.1.4. *Digital multimedia.* The family pre-inputs the movie or music into the folder. When the patient wants to listen to music or watch the movie, he or she can select the music or film which he wants to select. The following Figure 7 and Figure 8 are respectively for the video player interface and music player interface.

3.1.5. *Chat room.* Patients can chat with friends and family through this function. The following Figure 9 shows the chat room interface.

3.1.6. *Web browsing.* The patient can browse the web. The following Figure 10 shows the web browsing interface

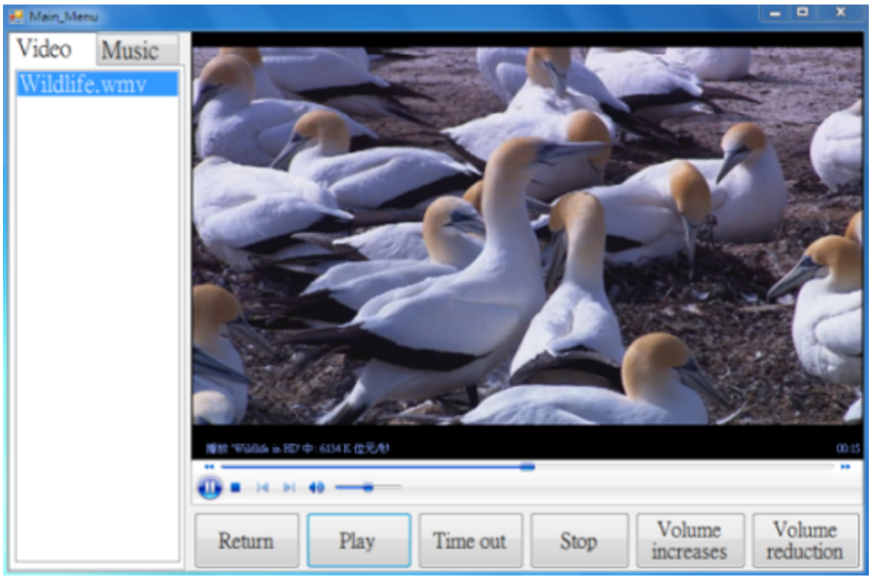

FIGURE 7. Video player interface

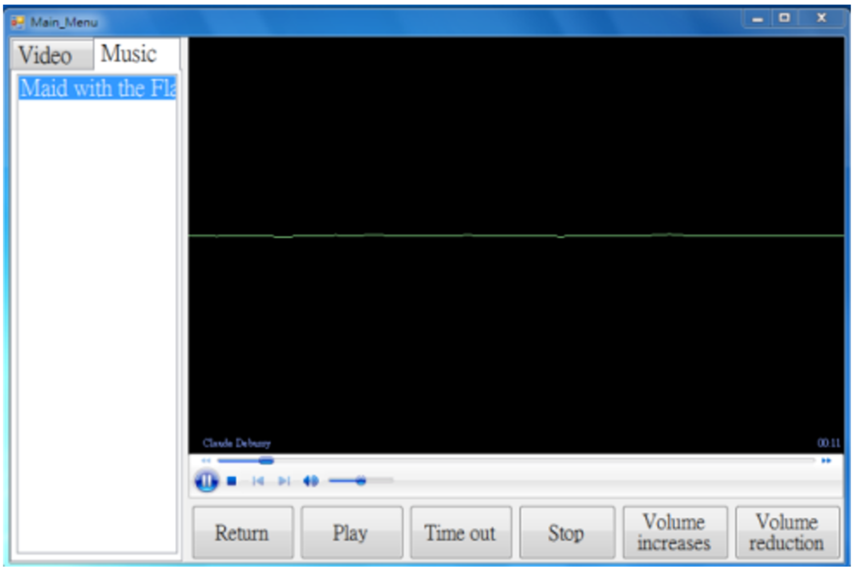

FIGURE 8. Music player interface

3.1.7. *Emergency help.* The patient can send an emergency notification to his/ her family can use three ways. They are APP alerts, send text messages and call notifications for emergency contacts [12]. Figure 11 is the emergency assistance interface.

3.1.8. *Intelligent control.* When the ambient temperature reaches a pre-set temperature, the home appliance switch automatically (for example: air-condition) [13]. Figure 12 is the intelligent control interface.

3.2. **APP function.**

3.2.1. *Electrical appliance control.* The system provides remote control of home appliances [14]. The following Figure 13 shows APP end appliance control interface.

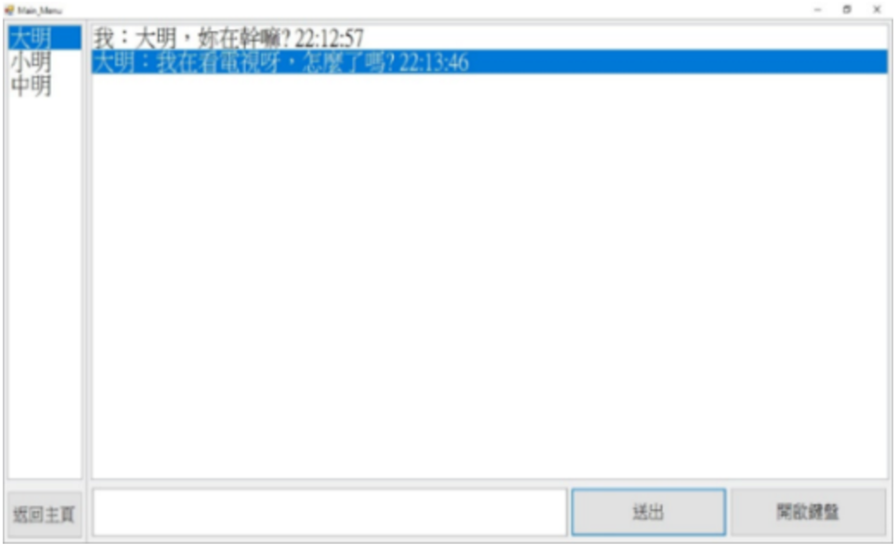

Figure 9. The language communication interface

Figure 10. The web browsing interface

3.2.2. *Instant image.* This system provides immediate images for family members or caregivers can monitor patient status at any time [15]. The Figure 14 shows the instant image screen.

3.2.3. *Playback image.* The system provides video function. The family members or caregivers can play back images. The Figure 15 shows the playback image.

3.2.4. *Emergency Help.* When the patient presses the emergency help button, the system will inform APP users that the patient needs help. The following Figure 16 shows the emergency help notification screen.

4. **Discussion and comparisons.** The computer control side of this research provides an assistance interface for disability. The following table 1 is the comparisons between

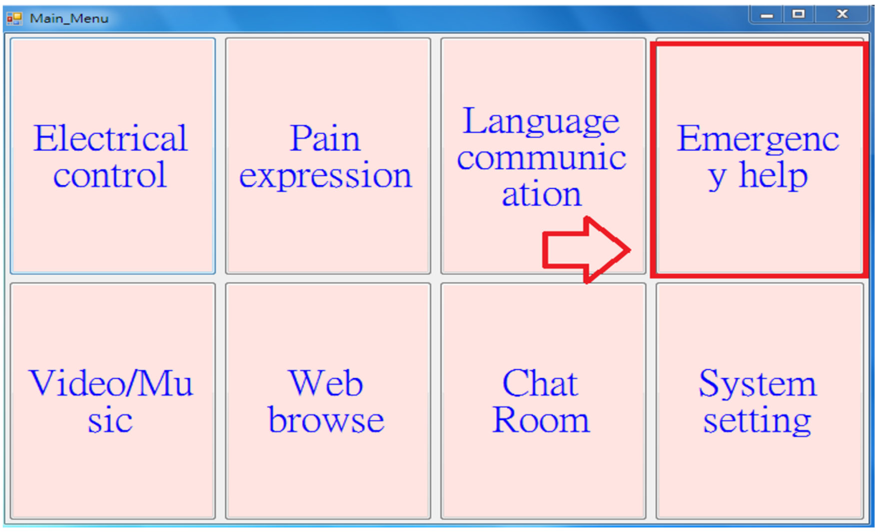

FIGURE 11. The emergency assistance interface

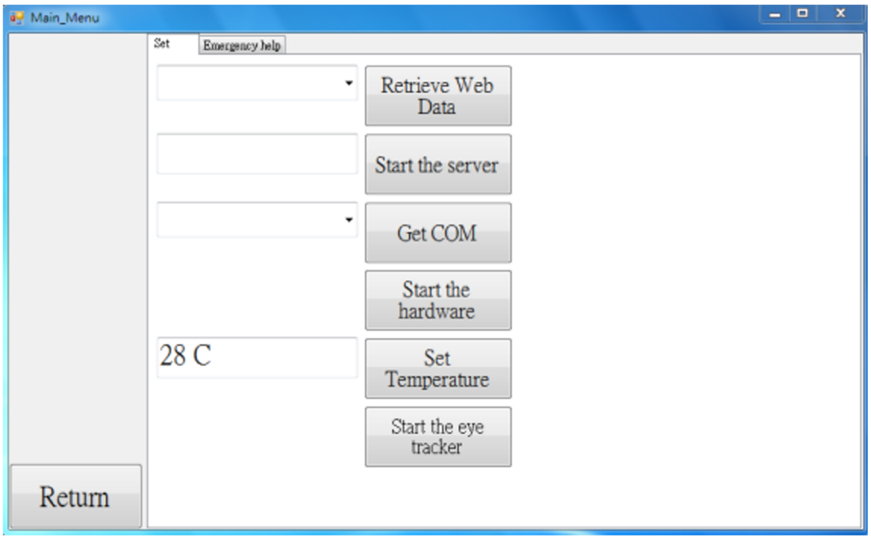

FIGURE 12. The intelligent control interface

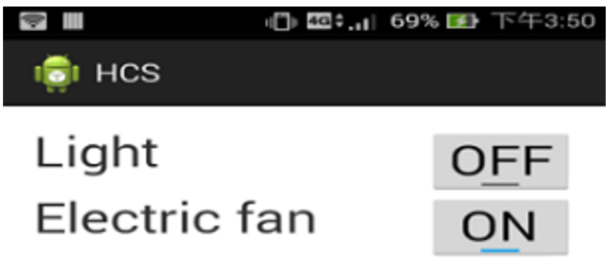

FIGURE 13. APP control interface

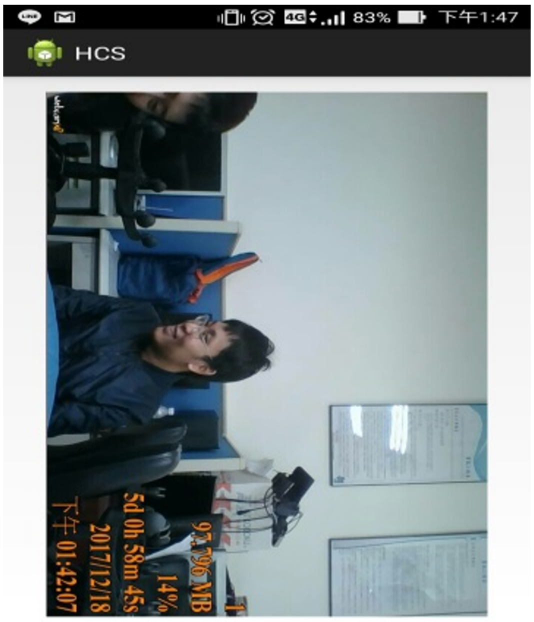

Figure 14. Instant image Screen

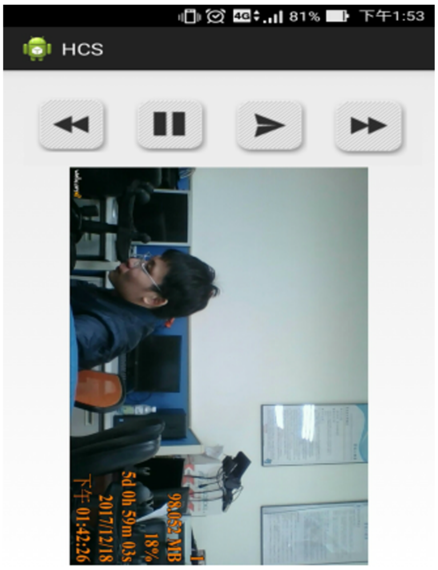

Figure 15. Playback image Screen

brain wave instrument and eye tracker. Because of the relaxation and focus are not well controlled, it is difficult to have a standard for each measured results. So, to use brainwave instrument as a control interface is not a good option. It does not meet the interface as a demand of disability. And the use of eye tracker only focuses the position of the fixation point through the eye. The disability just can use eye tracker as a mouse function. The interface is very suitable to be an interface requirement of the disability. We compare with other home care systems in table 2.

The following are the main contributions of this research to remote control home care systems and other home care systems:

(1) According to the remote and home care system, our system can control more home

Figure 16. Emergency help notification

Table 1. Comparisons between brain wave instrument and eye tracker

	Brain wave instrument	Eye Tracker
Control Type	Brain wave instrument can measure the brain wave the front of the brain wave sensor, issued by the micro-wave mode and frequency.	The eye movement is tracked by measuring the position of the fixation of the eye or the movement of the eye relative to the head.
Detection Method	Relax, Focus	Gaze
Application	Fatigue detection, Education Training, Emotional control	Reading, Polygraph, Shopping

Table 2. Comparisons of the remote and home care systems with other home care systems

Item	Our scheme	Other
Control	Eye Tracker	Eye Tracker
Appliance control	Yes	No
Entertainment	Provide web browsing, multimedia	Provide web browsing, multimedia
Text input, Communication, Chat room	Yes	Yes
Emergency	Provide SMS, Phone and APP notifications	No
Remote control	Provide APP	No
Remote monitoring	Yes	No

appliances for disability to choose more home appliances control via the use of wireless access.
(2) This project provides APP to the family members, when the family has to leave, the family members can monitor the status of disability via wireless at anytime and anywhere.
(3) The computer control side is controlled by the disability. When the disability suffers from an emergency, the emergency signal is sent by the computer control side, and then sent to the care givers. The care givers will receive the information via SMS, telephone and APP notification.
(4) The system provides web browsing function in video and music options of entertainment such that the disability more fun.

5. **Conclusions.** In this study, we use the eye tracker to develop a remote home care application system. It can provide the disable mobility to care himself / herself in life, entertainment, emergency and other functions. The proposed functions can reduce the burden of family care the disability. In the future, we hope that we can cooperate with medical institution, long-term care institutions and nursing homes via their professions to assist us in design of our improved system. We will add the new functions commonly used in medical care to our system such that the intelligent ward management system can provide a perfect care environment for the patient. The final stage of the study is to improve the patients' life quality and reduce the burden of family care. If we can cooperate with the long-term care and nursing homes, we hope to achieve good communication between family members and institutions. The proposed system can meet the requirements of long-term care and nursing homes to provide related forms for care givers to fill in and upload it. The family members can see the patients' status via the APP side of the health data, physical condition, diet status and other information. In the future, we hope to establish institutions and family member's connections. The family members can understand the state of the caregiver via the APP.

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REFERENCES

[1] X. C. Wang, J. J. Liu, Y. Y. Zhang, F. Liu, Bairong Shen, Bioinformatics Analysis of Amyotrophic Lateral Sclerosis Associated Amino Acid Mutations, *3rd International Conference on Bioinformatics and Biomedical Engineering*, pp. 1-4, 2009.
[2] V.Divya, J. Amudha, C. Jyotsna, Developing an application using eye, *2016 IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*, pp. 1518-1522, 2016.
[3] Y. Zhang, M. Juhola , On Biometrics With Eye Movements, *IEEE Journal of Biomedical and Health Informatics*, pp.1360-1366, 2017.
[4] How do Tobii Eye Trackers work? https://www.tobiipro.com/learn-and-support/learn/eye-tracking-essentials/how-do-tobii-eye-trackers-work/
[5] J. Zhu, Jie Yang, Subpixel eye gaze tracking, *Proceedings of Fifth IEEE International Conference on Automatic Face and Gesture Recognition*, pp.124-129, 2002.
[6] K. Harezlak, Pawel Kasprowski, Mateusz Stasch, Towards Accurate Eye Tracker Calibration – Methods and Procedures , *Procedia Computer Science*, vol. 35, pp. 1073-1081, 2014.
[7] W. C. Tsai; Y. J. Shih; T. M. Tsai, IoT-type Electric Fan: Remote-Controlled by Smart-Phone, pp.12-15,2016.
[8] P. Schwyter, Philipp Schneider, Smart, Utility-Grade Wi-Fi Mesh for Distribution Grids, *Conseil International Des Grands Reseaux Electriques International Council on Large Electric Systems*, 2013.

[9] A.a Istiqomah Arrahmah, Aulia Rahmatika, Samantha Harisa, Hasballah Zakaria, Richard Mengko, Text-to-Speech device for patients with low vision, *2015 4th International Conference on Instrumentation, Communications, Information Technology, and Biomedical Engineering (ICICI-BME)*, pp.214-219, 2015.

[10] C. Radovan, Papp Istvan, Majdak Aleksandar, Vranić Nikola, Realization control of smart outlets using Wi-Fi network, *2013 21st Telecommunications Forum Telfor (TELFOR)*, pp.533-536, 2013.

[11] L. F. F. Brito Palma , da Silva A. R. F. , Remote control of a DC motor using infra-red radiation, *1998 IEEE International Conference on Electronics, Circuits and Systems, Surfing the Waves of Science and Technology (Cat. No. 98EX196)*, vol. 3, pp. 313 – 316, 1998.

[12] B. Joy, K. P. Dipin , P. Nagaraju Srimanu, V. G.Vivek , A two way emergency medical monitoring system with a computing device fitted on a rotating holder, *2012 Annual IEEE India Conference (INDICON),* pp.597-602, 2012.

[13] F. Mei, J. Liancheng, The design of automatic control system for and high-pressure reaction tank, *2017 IEEE International Conference on Mechatronics and Automation (ICMA)*, pp. 933-937, 2017.

[14] Y. Kyohei, K. Yukiko, K. Koichi, K. Motoki, J. Koji , K. K., T. Kyoichi, T. S. Mohammed, Remote operation of a robot for maintaining electric power distribution system using a joystick and a master arm as a Human Robot Interface medium, *2016 International Symposium on Micro-NanoMechatronics and Human Science (MHS)*, pp.1-7, 2016.

[15] K. Rahman Fahmidur, M. A. Hossain Munaim, M. Sadiq Tanvir, S. Ahmad Sayem, Internet controlled robot: A simple approach, *2016 International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT)*, pp.1190-1194, 2016.