

Design of Dementia Prevention System using Motion Recognition Sensor Drone

Sung-Jin Jeoung, Bong-Hyun Kim

Abstract: *The population of elderly people with dementia is increasing rapidly as they enter the aging society all over the world. Considering the increase in the number of demented elderly people and the increase in the expenditure cost per demented elderly person, the economic burden is expected to increase continuously. In the end, it is essential to prevent dementia in advance in an aging society. Therefore, in this paper, a dementia prevention system is designed by linking motion recognition technology and drone flight control technology among ICT convergence technologies. That is, motion recognition technology is applied among various methods for controlling the drone flight. In order to prevent dementia of the elderly, it is designed to control the drone flight by sending sensor data by motion recognition. In this paper, we propose a drone flight control system to prevent dementia using motion recognition technology based on data input from motion sensor. At this time, the linkage between the motion recognition part and the drone flight part is performed by the controller. The controller uses the integrated module to envision the entire system environment. The motion recognition sensor transmits the currently input motion data to the controller. The Drone receives the Controller command and provides the Drone control command. In this paper, we have designed a system to prevent dementia through drone flight control using motion recognition. That is, the motion recognition sensor receives the motion of the elderly person and controls the drone flight.*

Index Terms: *Drone, Motion recognition, Dementia prevention, Gesture recognition, Sensor network.*

I. INTRODUCTION

In modern society, due to the development of medical technology, the life span and the birth rate have been decreasing resulting in a population unbalance in the middle aged and this phenomenon has caused the increase of dementia patients. Dementia causes a decrease in cognitive function and disability in daily life due to various causes. The initial symptoms of dementia begin with a decline in memory and gradually affect basic daily life movements. Typically, it progresses slowly over a period of months to years, with the first symptom being mild but eventually leading to severe memory loss. In addition, difficulties in communicating or recognizing others, performing complex tasks, or decreasing judgmental abilities can also occur [1], [2].

Dementia may be due to degenerative brain diseases or cerebrovascular diseases, such as memory, language ability,

leadership ability (judgment), ability to perform and ability to be degraded. Because of this, the multiple disabilities that are the cause of disruption in everyday life cause many inconveniences and harm to the people as well as the people around them. It is one of the major problems of many developed countries that have become aged society. At present, 9% of the elderly in Korea over 65 years old is high enough to be called dementia.

Alzheimer's disease is the most common cause of dementia based on the elderly population, followed by vascular dementia associated with stroke, as well as rheumatic dementia, frontotemporal dementia, Parkinson's dementia, and alcoholic dementia. If not elderly, there are various causes such as brain infections (encephalitis, brain abscess), brain tumors, dementia caused by head trauma, and dementia related to brain metastasis, but the most common is alcoholic dementia [3], [4]. The incidence of these diseases is not age related.

Dementia is not easy to cure once it develops. Therefore, it is important to prevent it in advance through individual health habits or medical management. Dementia caused by stroke can be prevented by blood pressure control, exercise, and weight control through eating habits. Alcohol-related dementia can also be controlled by drinking alcohol or drinking alcohol. Traumatic dementia can be prevented by using seat belts, helmets, and protective gear to prevent head injury [5]. As a result, maintaining a mental or physical activity while exercising a disciplined physical exercise and brain exercise helps prevent intelligence decline and delay memory loss [6].

Dementia is not a natural phenomenon due to aging. Dementia is more common in old age, and memory is gradually declining with age. However, memory loss due to dementia and aging is different, and dementia is not a natural phenomenon due to aging. If you have dementia, you will have more pronounced and obvious memory loss, which may be accompanied by mood changes or poor judgment. Dementia is caused by a disease of the brain. Dementia is a bundle of symptoms, which includes memory and other impairments of cognitive function. These symptoms are caused by brain diseases. The most common disease is Alzheimer's disease, and many other diseases can cause dementia. Dementia affects other functions besides memory. The most common symptom of dementia is memory impairment. In many cases, the first symptom is memory loss. However, it does not mean that memory degradation occurs. In addition to memory,

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cognitive functions such as language and judgment can also deteriorate, affecting mood, personality, and behavior. If you have dementia, it becomes difficult to communicate with others and live as usual [7], [8]. However, as new findings about dementia are discovered every year with new research, there are more and more ways to get help.

Therefore, in this paper, we designed a system to prevent dementia by applying ICT technology. For this purpose, we applied dragon flight game using motion recognition to prevent dementia. Game training using ICT technology has been found to improve the cognitive control ability of the elderly. In other words, playing games steadily for about one hour a day can improve the aging of the cognitive function. In this paper, we apply a method that induces interest by using drones rather than simple digital games. As a result, it is a method of generating a drone control signal based on motion data of the elderly. Also, it is a method to control the drone by connecting with Ground Control Station (GCS) with the generated signal. When the elderly wears the motion recognition sensor and proceeds with the motion, the corresponding motion data is measured. The motion data is converted into data usable in the drone. Then, the conversion data is transmitted to control the drone. By applying these methods, it is possible to prevent dementia by controlling the drones by motion. Figure 1 shows a general outline of the dementia prevention system of the elderly applying the dragon flight control method through motion recognition.

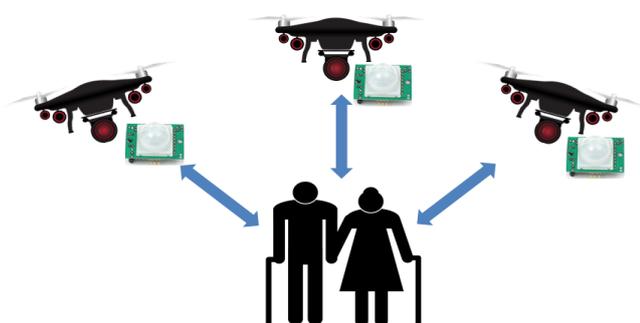


Figure 1 Outline of dementia prevention system through motion recognition

II. RELATED REVIEW

A. Drone Technology

The drones industry is rapidly becoming a market that is called the technology of the future industrial development. A variety of technologies are being developed through the combination of the parts industry that makes up the drones, the combination of camera and sensor technology, virtual reality, autonomous navigation, and V2X technology. Also, supply and demand of drones are increasing in various fields such as toys, industry, and agriculture [9], [10].

The core technology required for drones requires a variety of technologies that can be regarded as an abbreviation of advanced technology. In other words, there is a material technique for making the weight-reducing frame while maintaining the stability and strength of the drones to extend

the flight time of the drones. There is also battery technology that provides power to the drone [11]. Also, the materials and equipment for gas fabrication such as unmanned navigation system based on the motion model of aviation, circuit and motor technology for attitude and altitude control, flight controller (FC) development, hardware design and production technology for control, communication technology, and so on. Especially, recently, the drone industry is developing in combination with various technologies [12], [13]. Depending on the purpose, such as virtual reality (VR), autonomous driving, and logistics, various technologies are required depending on the production purpose.

Drone's core technology has FC control technology for drone internal control. To control the drones in FC, we mainly use a method of controlling three axis moments called roll, pitch, and yaw. As shown in Figure 2, three axis moments can be defined with reference to the front of the drone, and the directions of horizontal and vertical movements are defined as roll, pitch and yaw, respectively [14].

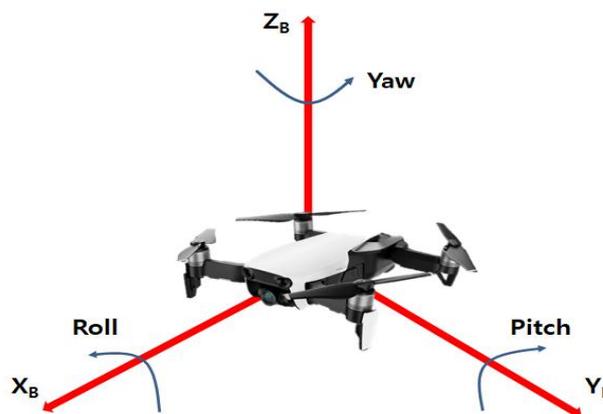


Figure 2 Drone system moment direction

By controlling these three moments, it is possible to fly freely from place to place, hovering, forward, backward, left / right. In this case, the sensors used to control the position and velocity attitude of the drone are IMU sensor for measuring the three-axis velocity, angular velocity and acceleration of the gas, and an air pressure sensor for measuring the altitude as a difference in atmospheric pressure. Based on the measured sensor data, various control techniques and filtering techniques are used to control the gas [15].

In order to control the drone, a sensor convergence technique is used, which processes image information acquired using a camera through image processing, or uses control techniques such as filtering and acquiring sensor information, and then issues control commands. Sensor convergence techniques are also used to control drone flight through motion recognition. Therefore, in this paper, motion recognition method is applied rather than camera recognition method to prevent dementia. In other words, the system to prevent dementia was designed by controlling the droning flight while



recognizing the movement of the elderly.

Among the core technologies of drones, it is necessary to connect sensors that recognize the surrounding environment. The most common drones are GPS (Global Positioning System), Lidar sensor and Sonar sensor. The GPS sensor is a method of informing a GPS receiver of the position from a satellite, and is mainly used outdoors. It is used when the size of the drone is large or you want to know the location of the drone accurately on the ground. If you use the GPS, you can correct the actual position of the drone in real time and you can find it stable. Lidar sensors and Sonar sensors are used to detect near obstacles by laser scanning and ultrasonic waves, respectively. In particular, the Sonar sensor is not suitable for judging obstacles because it recognizes a short distance compared with the Lidar sensor. However, since it has a low price feature, it is necessary to prevent the drone from landing suddenly when landing. It is also used for judging purposes.

B. Motion Recognition Technology

For motion recognition technology, a sensor is needed to input the gesture performed by the user. First, there is a contact method in which a user directly contacts the body of a sensor or device to acquire data. Second, there is a non-contact method of acquiring data using remote and near-field sensors. In recent years, various types of wearable sensors that can be worn by users have been developed. Since the user does not directly touch the sensor, they are classified in a noncontact manner [16]. It is a field where researches are going on because it does not limit the radius or place of the user's behavior.

The contact-type method can acquire relatively accurate motion information because the user touches the integrated sensor. However, there is a need for the user to contact the sensor or the apparatus. In addition, the non-contact type is convenient to use because the user does not touch the sensor or the equipment, and the user's operation is natural. However, depending on the sensor, the radius and distance of the user are limited, and the accuracy of the obtained data is influenced by the sensor and the environment. Therefore, researches and developments of wearable sensors which have advantages and disadvantages of the two methods are being developed [17]. Figure 3 shows the products that have been applied to non-contact motion recognition technology which is widely used recently.



Figure 3 Non-contact motion recognition

Motion recognition technology is classified according to which part of the body it recognizes. That is, hand gestures, full body gestures, full body motion recognition technology, motion recognition in image / video. First, recognition of hand motion is recognized by using various sensors, using hand position, shape, and trajectory information. In order to analyze the time series data, we use models such as HMM (Hidden Markov Model), DBN (Dynamic Bayesian Network) and CRF (Conditional Random Field) or its change model. In the case of using the hand shape information, analysis is performed by analyzing the three-dimensional information measured from the TOF (Time of Flight) or the stereo camera and using the structural features of the hand or boosting the shape information of the hand [18].

Next, it is necessary to analyze the relationship between human body components in order to recognize the whole body motion. To do this, we model the joint information of the body in a graph structure using Kinect sensors or various types of sensors. Next, full-body motion recognition technology is a method used to generate motion for 3D movies, game characters, and the like. That is, several markers are attached to the body, and the movement of the person is measured by the sensor. In recent years, interest in virtual reality has been increasing, and studies have been actively conducted to recognize human actions and apply them to virtual spaces [19].

Finally, motion are recognized in images and movies. Recently, due to the increase of CCTV, researches for detection of abnormal behavior and specific behavior pattern of 2D images have been conducted. Deep learning technology is applied to solve this problem. Modified models of Convolution Neural Network used for image analysis are used. In addition, it is utilized in the field of image annotation (Image Annotation) for searching desired images in a vast



amount of images existing on the Internet or the like.



Figure 4 Various experience activities using motion recognition

In order to popularize and generalize such motion recognition technology, several issues must be solved. First, it provides convenience for product use. Since the contact type method inconveniences the user, it is necessary to develop a non-contact type or wearable sensor which can replace the contact type method. Second, the accuracy of motion recognition technology is improved. We must strive to diversify the applications of motion recognition technology by increasing the accuracy of motion recognition rate. Third, it should be applicable in various environments. It is necessary to develop a technology that can be used in various constrained environments such as motion data generation and smartphone touch, in various environments. Fourth, multimodal convergence is needed. Convergence between various sensors and convergence between various motion recognition technologies and convergence with other interface methods such as voice are needed. Fifth, development of convergence platform for NUI is needed. In order to develop the current motion recognition technology, the SDK provided by the sensor developer is used. However, this approach requires a unified platform for this because of the different ways that manufacturers use it.

III. DESIGN OF DEMENTIA PREVENTION DRONE

The proportion of the elderly population is rapidly increasing due to the rise in the economic level and the increase in the average life span due to the development of medicine and the decrease in the birth rate due to social / cultural changes. In the meantime, the importance of the discovery of dementia and the early intervention has been highlighted. Dementia causes a great deal of mental, physical, and economic burdens not only for the patient but also for the caregiver. In addition, the proportion of medical expenses for patients with dementia is increasing at the national level.

Therefore, in this paper, we designed a system to prevent dementia by applying ICT technology. For this purpose, we applied dragon flight game using motion recognition to prevent dementia. Game training using ICT technology has been found to improve the cognitive control ability of the elderly. In other words, playing games steadily for about one hour a day can improve the aging of the cognitive function. The system proposed in this paper processes motion data and

processes it with a drone instruction. That is, it connects with the drone through wireless web communication and displays the processing result to the user. The system consists of motion recognition sensor, drone, controller, and integrated module.

Controller, which is the most important parameter in motion recognition drone, receives motion data through motion recognition sensor. It also processes the input data and sends a command to the Drone. The controller uses the integrated module to envision the entire system environment. The motion recognition sensor transmits the currently input motion data to the controller. The Drone receives the Controller command and provides the Drone control command. Figure 5 shows the overall system structure.

The drone control process in the system designed in this paper is as follows. Connection is made through wireless communication to control the drone which is the default state. When the connection is successfully completed, the Drone becomes Connected State. In order to take off the connected state Drone, input motion recognition data through motion sensor. The inputted motion data sends the flight command to the drone through the Controller Application. To control the movement of the flying state Drone, enter the Drone control motion in the Integration Module. The drone performs a given function, such as a fixed flight or a motion tracking flight, in response to a command received from the controller. To land the flight state Drone, enter the corresponding motion. The controller assists the safe landing of the drone and the drone performs the landing function. After that, the drone, sensor and controller that have finished the function are disconnected.

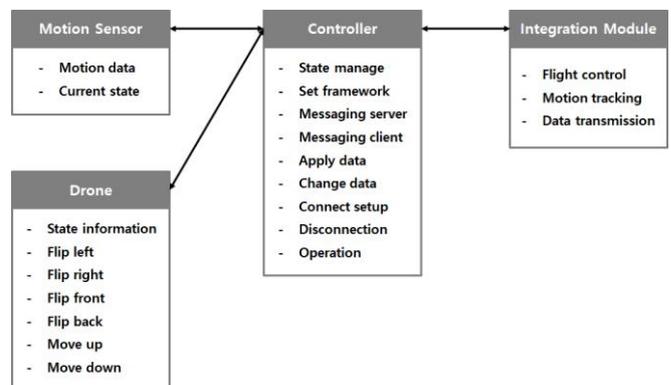


Figure 5 Overall system structure

The drone control by motion recognition proceeds through pitch, yaw, throttle, and roll. That is, the method of operating the drone moving direction and the point of view is distinguished by the drone control. At this time, the direction of flight according to the motion recognition may be changed. That is, when the forward pitch command is transmitted, an error may occur in which the forward flight based on the drone point is performed instead of advancing according to the motion of the drone pilot. In order to solve such a problem, when the pitch and the roll are manipulated, it is necessary



to perform the operation of matching the dowel's yaw to the moving direction.

In the designed system, when the controller transmits the backward pitch command, it transmits a 180° rotation yaw command. Also, when transmitting a roll command, the 90-degree yaw instruction is transmitted in the case of the rightward movement direction, and the -90° yaw instruction is transmitted in the case of the leftward movement direction. The speed of rotation is set to be within a few seconds so that the user can sense the rotation when each motion command is transmitted.

In this system, the default value is set to 1 second. This allows the drone to always advance in a direction that matches the direction of the operator's motion in an easy-to-navigate manner. At this time, the viewpoint of the drone is automatically switched and rotated in accordance with the traveling direction. Therefore, a user who is not accustomed to using the drone can control the drone more intuitively by matching the steering direction and the view point, like an existing car or an airplane game. The intuitive direction and viewpoint matching method described above is designed using a motion recognition sensor. The data obtained through the motion recognition sensor is controlled through the motion data obtained by the motion detection in the environment of the three-dimensional space. The movement direction control for the drone is implemented based on the center of the XY plane of the three-dimensional space. Further, the direction of the drone is determined in the direction of the center of motion. Finally, Figure 6 shows the design of a drone flight control system based on a motion recognition sensor for dementia prevention.

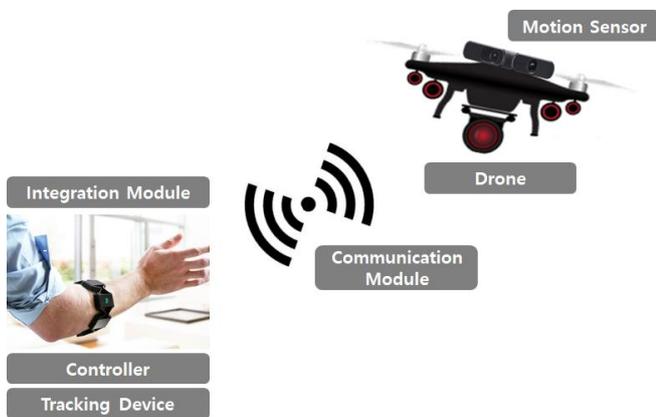


Figure 6 Motion recognition drone control system for prevention of dementia

IV. CONCLUSION

The surge in dementia due to aging is a worldwide phenomenon. The number of patients with global dementia is expected to increase by more than three times in 35 years, reaching 45.36 million in 2013, 75.62 million in 2030, and 135.46 million in 2050. In the case of Korea, an aging society is progressing so fast that it is difficult to find an analogy in the world. It is predicted that it will take only 26 years from the entry into the aging society (2000) to the entry into the aged society (expected in 2026). This is 3-4 times faster than

in developed countries. The total cost of dementia worldwide in 2015 is estimated at \$ 818 billion (\$ 210,848 billion). This is a 35.4% increase from 2010's \$ 604 billion (699 trillion 311.2 billion won). In 2015, it accounts for 1.09% of global GDP, and in the Netherlands, Indonesia and Turkey, the GDP is similar to the national GDP.

Therefore, it is necessary to prevent and cope with dementia using ICT technology convergence. Drones are being actively studied for use in various fields such as defense, security, and industry. For example, logistics transport in the logistics sector, sowing and fertilizer operations in the agricultural sector, and aerial imaging for disaster relief. It is also used for leisure and sports as a personal hobby. However, unlike the various applications of the drones, it is not often that individuals possess drones. One of the reasons why drones do not spread to the public is the inconvenience of piloting drone. When the user first touches the drone, it is difficult to control the movement of the drone in consideration of the viewpoint of the drone. There are two ways to manipulate the direction of movement and the viewpoint through pitch, yaw, throttle, and roll, which are drone control operations. As a result, the driver feels uncomfortable due to the discrepancy that is inconsistent with the user's gaze when operating the drone. Even if you are skilled in drone manipulation, periodic physical pressure must be applied to the controller, since you have to determine where to move through the steerable maneuver.

Therefore, in this paper, we designed a system to prevent dementia by applying ICT technology. For this purpose, we applied dragon flight game using motion recognition to prevent dementia. Game training using ICT technology has been found to improve the cognitive control ability of the elderly. In other words, playing games steadily for about one hour a day can improve the aging of the cognitive function. The system proposed in this paper processes motion data and processes it with a drone instruction. That is, it connects with the drone through wireless web communication and displays the processing result to the user. The system consists of motion recognition sensor, drone, controller, and integrated module.

REFERENCES

1. Park K. Y., Park S. Y., Jeong W. M., Park S. H., Hwang Y. J., & Youn J. C. (2016). An Analysis of Clinical Features in Individual with Alzheimer's Dementia Living in the Community using the Allen Cognitive Levels. *Indian Journal of Science and Technology*. 9(25), 1-7.
2. Blundon G., Smits E. (2015). Cognitive rehabilitation: A pilot survey of therapeutic modalities used by Canadian occupational therapists with survivors of traumatic brain injury. *Canadian Journal of Occupational Therapy*. 67(3), 184-196.
3. Springate B. A., Tremont G. (2014). Dimensions of caregiver burden in dementia: Impact of demographic, mood, and care recipient variables. *American Journal of Geriatric Psychiatry*. 22(3), 294-300.
4. Kim K. W., Kim B. J., Kim S. Y., Kim S. G., Kim J. R., & Kim T. H. (2012). Nationwide survey on the epidemiology of Korea. *Korea Ministry of Health & Welfare: Seoul*. 2(1), 27-36.
5. Lyketsos C. G., Colenda C. C., Beck C., Black K., Doraiswamy M.P., & Kalunian D.Y. (2016). Position statement of the American Association for Geriatric Psychiatry regarding principles of care for patients with dementia resulting from Alzheimer disease. *American*



- Journal of Geriatric Psychiatry.* 14(9), 808.
6. Lee J. H., Lee K. U., Lee D. Y., Kim K. W., Jhoo J. H., & Kim J. H. (2002). Development of the Korean version of the consortium to establish a registry for Alzheimer's disease assessment packet (CERAD-K): Clinical and neuropsychological assessment batteries. *The Journal of Gerontology: Psychological Sciences.* 5b(1), 47-53.
 7. Brooker D. J., Woolley R. J., & Lee D. (2007). Enriching opportunities for people living with dementia in nursing homes: An evaluation of a multi-level activity-based model of care. *Aging & Mental Health.* 11(4), 361-370.
 8. Kim J. H., Lee D. Y., Lee S. J., Kim B. Y., & Kim N. C. (2015). Predictive relationships between BPSD, ADLs and IADLs of the elders with dementia in Seoul, Korea. *Journal of Korean Gerontological Nursing.* 17(1), 1-9.
 9. Gitlin L. N., Hauck W. W., Dennis M. P., & Winter L. (2005). Maintenance of effects of the home environmental skill-building program for family caregivers and individual with Alzheimer's disease and related disorders. *Journals of gerontology Series A, Biological Sciences and Medical Sciences.* 60(3), 368-374.
 10. Cobano, J. A., Martinez-de Dios, J. R., Conde, R., Sanchez-Matamoros, J. M., & Ollero, A. (2010). Data retrieving from heterogeneous wireless sensor network nodes using UAVs. *Journal of Intelligent & Robotic Systems.* 60(1), 133-151.
 11. Tekdas, O., Isler, V., Lim, J., & Terzis, A. (2009). Using mobile robots to harvest data from sensor fields. *IEEE Wireless Communications in Robotic Networks.* 16, 22-28.
 12. Kim B. H. (2016). Development of Young Children Coding Drone using Block Game. *Indian Journal of Science & Technology.* 9(44), 1-4.
 13. Melekhova A, Vinnikov V. (2015). Cloud and grid. Part I: Difference and convergence. *Indian Journal of Science and Technology.* 8(29), 1-10.
 14. An B, Papavassiliou S. (2001). A mobility-based clustering approach to support mobility management and multicast routing in mobile ad-hoc wireless networks. *International Journal of Network Management.* 11(6), 387-395.
 15. Sivakumar R, Maheswari A, & Pushpa P. (2014). Zig bee-based wireless electronic scale and its network performance analysis for the application of smart billing system in super markets. *Indian Journal of Science and Technology.* 7(3), 352-359.
 16. Hurkmans H. L., Van D. B., & Stam H. J. (2010). Energy expenditure in adults with cerebral palsy playing Wii sports. *ArchPhys MedRehab.* 91(10), 1577-1581.
 17. Cho W. R., Park E. H. (2013). The effects of virtual reality based game using Wii on Boccia throwing of students with physical disabilities disabilities. *Korean Journal of Physical, Multiple and Health Disabilities.* 56(1), 124-140.
 18. American Occupational Therapy Association. (2014). Occupational therapy practice framework: domain and process. 3rd. *American Journal of Occupational Therapy.* 68(1), 1-48.
 19. Jack D., Boian R., Merians S., Tremaine M., Burdea G. C., Adamovich S. V., et al. (2001). Virtual reality-enhanced stroke rehabilitation. *IEEE Transactions on Neural Systems and Rehabilitation Engineering.* 9(3), 308-318.

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