An Interaction method about controlling the wheelchair by gaze tracking

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Introduction

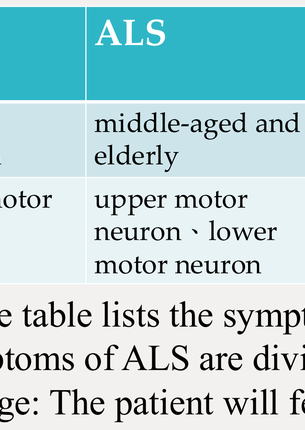
The first electric wheelchair was invented by Canadian inventor George Klein and his team of engineers while working at the National Research Council of Canada, a program to assist the return of wounded veterans after World War II. Electric wheelchairs were invented around the beginning of the 20th century, but the electric wheelchairs in the early days of the invention were not taken seriously because of the poor prognosis of severely disabled people, and the early electric wheelchairs were cumbersome, inefficient, and low reliability. In the 1960s and 1970s, the stability of the electric wheelchair improved controller, and some special control interfaces were also successfully developed. In the 1990s, the improvement of the wheelchair frame design was mainly carried out, including various frames and seats specially designed for electric wheelchairs. The design of the separation of the chair system and the transmission base, the design of the transmission wheels in different positions, etc.

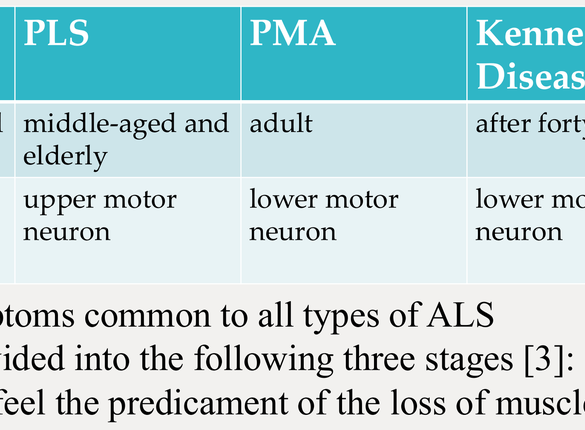
Design Theory

In the past, ALS has been ignored by the outside world. Although astrophysicist Hawking and former American baseball star Henry Louis Gehrig are patients with ALS, people generally do not know the existence of ALS. Patients with ALS all require the use of wheelchairs, targeting amyotrophic lateral sclerosis (ALS), progressive muscular atrophy (PMA), and Kennedy's disease (Kennedy's disease), which are caused by lower motor neuron degeneration or disease caused by death.

TYPES	ALS	PLS	PMA	Kennedy Disease
Disease population	middle-aged and elderly	middle-aged and elderly	adult	after forty
diseased motor neuron	upper motor neuron、lower motor neuron	upper motor neuron	lower motor neuron	lower motor neuron

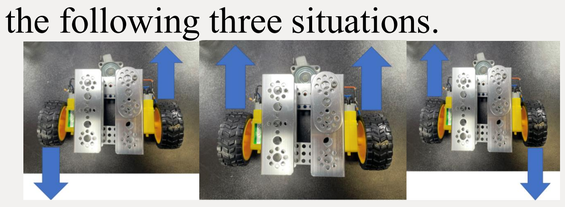
The above table lists the symptoms common to all types of ALS
The symptoms of ALS are divided into the following three stages [3]:
Initial stage: The patient will feel the predicament of the loss of muscle strength in his limbs. Standing for too long is easy to fall, and he cannot lift heavy objects as usual.
Mid-term: The patient will have stiffness in the limbs and need nursing care to assist in daily life, and cannot complete simple daily activities such as dressing, toileting, bathing, and walking alone. At this time, the patient is also prone to insomnia.
In the later stage: the patient will affect speaking, swallowing, and spontaneous breathing and the patient can only communicate with the outside world by turning or blinking his eyes, which greatly affects the quality of life. Death due to respiratory failure or malnutrition.
For people with gradual freezing in different periods, it can be concluded that the only eye movements can still move the whole body and can communicate with the outside world. Therefore, we identify the direction of eye movement.





Design Theory - Simple Eye Tracking Technique

Through analysis, the wheelchair has three movement directions: forward, left, and right. If it is used as an operation medium with eye movement, it can correspond to the following three situations.



Dividing the movement direction of the eyes into three blocks can correspond to the movement of the wheelchair in the corresponding direction.

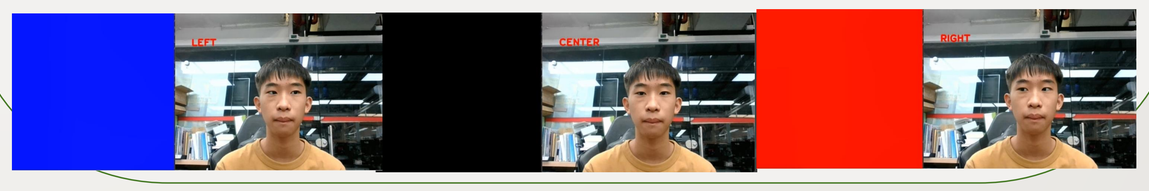
In the image, the structure of the eye that can be seen in the eye is divided into the pupil, the iris, and the sclera. The eye image is obtained by intercepting the image.

At this point, we need to analyze the direction of sight in the eye, divide the eye image into the left half and the right half, and after grayscale, analyze the proportion of the sclera in the left half and right half of the eye (that is, the white image proportion), you can calculate the direction of the eye's line of sight. This ratio can be calculated by the following equation 1.1:

$$The\ ratio\ of\ the\ direction\ of\ sight\ of\ one\ eye = \frac{the\ ratio\ of\ the\ left\ half\ of\ the\ sclera}{the\ ratio\ of\ the\ right\ half\ of\ the\ sclera} \quad (1.1)$$

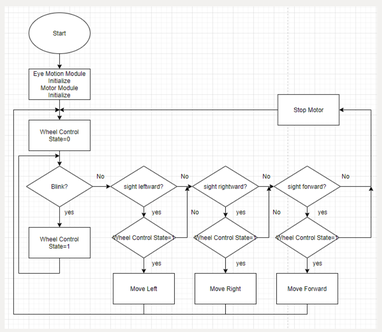
And the ratio of the line of sight direction of the two eyes is added and averaged to find the ratio of the line of sight direction of the two eyes, such as formula 1.2:

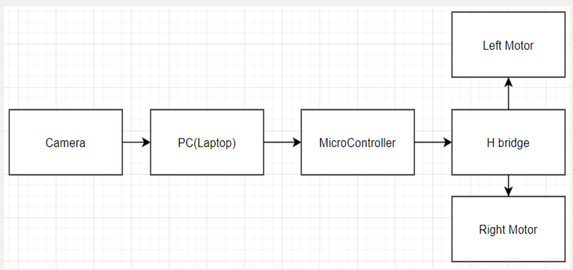
$$Eye\ gaze\ direction\ ratio = \frac{eft\ eye\ gaze\ direction\ ratio\ +\ right\ eye\ gaze\ direction\ ratio}{2} \quad (1.2)$$



Result and future work

After we successfully analyzed the direction of the eyes on the computer, we communicated with the controller and successfully controlled the direction and steering of the wheelchair. This simple method can greatly reduce the cost of using a wheelchair with eye-tracking technology for people with ALS, who only needs a laptop. The disadvantage is that each person's eyes are facing in different directions, and the threshold needs to be adjusted each time.
In the future, the algorithm will be connected to the wheelchair, and it is expected that the next step of data will be obtained to improve the method of controlling the wheelchair.





參考

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