An Interaction method about controlling the wheelchair by gaze tracking

Summary

Wheelchairs have always been an important means of transportation for the physically challenged. [1] According to the World Health Organization statistics, 1% (about 78 million) of the population needs to use wheelchairs. China is the most populous country in the world and the country with the largest elderly population in the world. According to data released by the National Bureau of Statistics, as of the end of 2019, the total population of mainland China was 1,400.05 million, and the population aged 60 and above was 253.88 million, accounting for 18.1% of the total population. According to World Health Organization data, 14,000,500 people in China need wheelchairs, but only 10% to 15% of them get a wheelchair to fit. China is a veritable country with a large demand for wheelchairs in the world. In the past, the design of wheelchairs focused on ergonomics. Later, to reduce the operating burden of users, loading power assistance became one of the very important functions. At present, most wheelchairs have loading power assistance.

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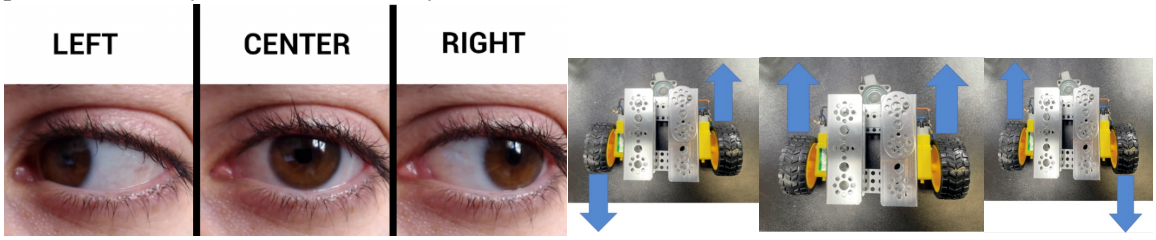
1 Introduction

[2] 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.

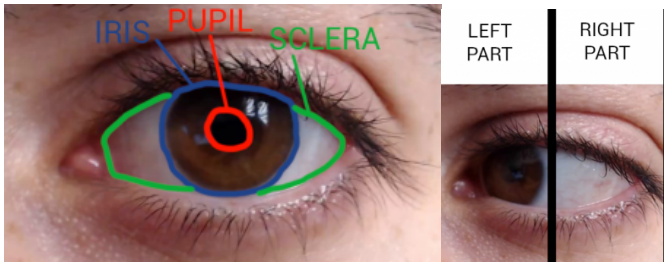
2 Theorems

Eye-tracking technology theory:

The wheelchair has three movement directions: forward, left, and right through analysis. If it is used as an operation medium with eye movement, it can correspond to the following three situations. This study was conducted on some severely paralyzed wheelchair users, some of whom can only manipulate their fingers and eyes, which may include patients with ALS ([3] amyotrophic lateral sclerosis), acute Spinal cord injury patients, etc. This research hopes to create a wheelchair for these patients that they can use so that they can achieve freedom.



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 time, we need to analyze the direction of sight in the eye, divide the eye image into the left half and right half and analyze the proportion of the sclera in the left half and right half of the eye (that is, the proportion of the white image), then Can calculate the direction of the eye's line of sight. This ratio can be calculated by the following formula:

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

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:

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

Since the frontal direction of each person's eyes is not necessarily forward, it is better to take the line-of-sight ratio of both eyes. And each person's situation is different, it is necessary to measure the value of the line-of-sight direction and adjust the threshold value, to achieve the purpose of accurate control.

Gesture Control Technology Theory:

Gesture control is the ability to recognize the human movement to interact and control computer systems without direct physical contact. The gesture control technology is based on gesture recognition, which can be seen as a way for computers to begin to understand human language.

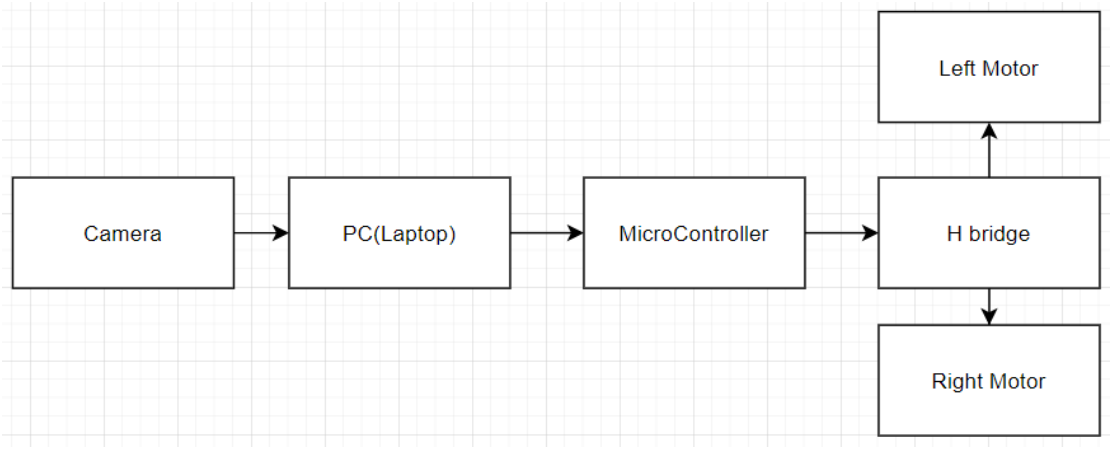
In terms of gesture control technology in this work, we use different gestures to control the advancement and direction of the wheelchair. We add a camera to the handle of the wheelchair to capture the gesture image of the wheelchair user, and then send it to the computer for analysis. Finally, the results of the analysis are used to control the direction of the wheelchair.

3 Result

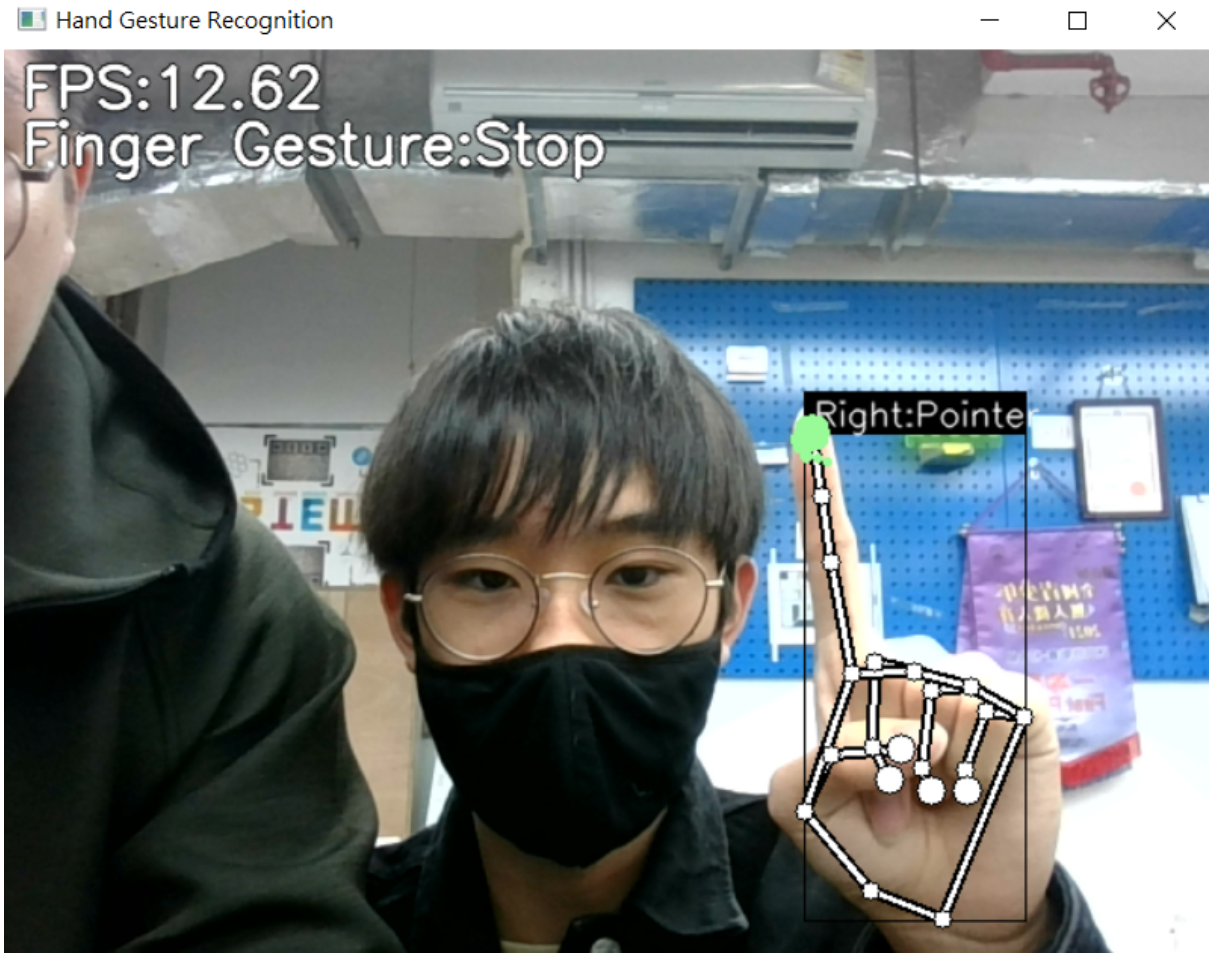
Eye-tracking technology:

The results after the test are as follows:

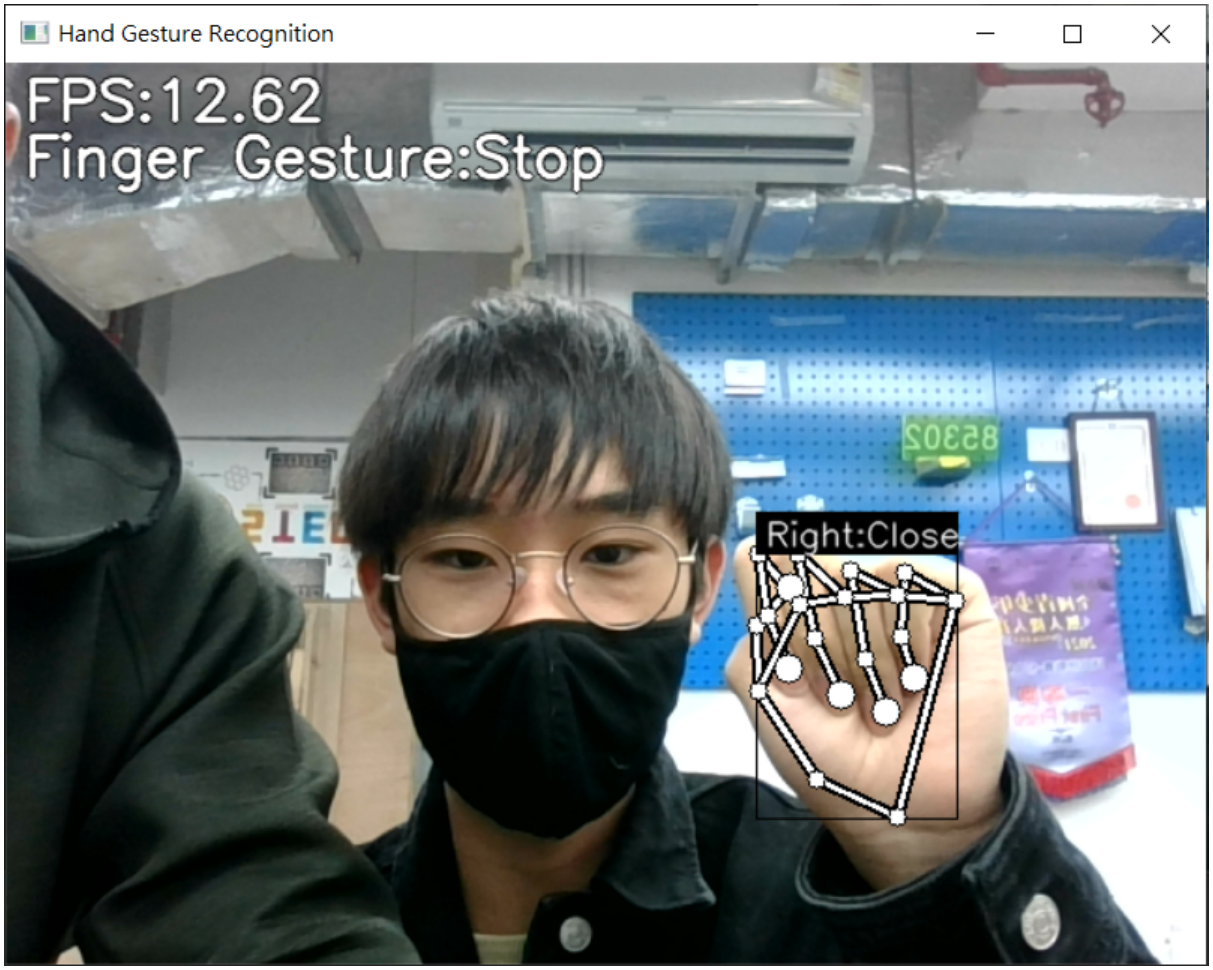
After we successfully analyzed the direction of the eyes on the computer, we communicated with the controller and successfully controlled the direction and steering of the wheelchair. This simple method can greatly reduce the cost of using a wheelchair with eye-tracking technology for people with ALS, 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.



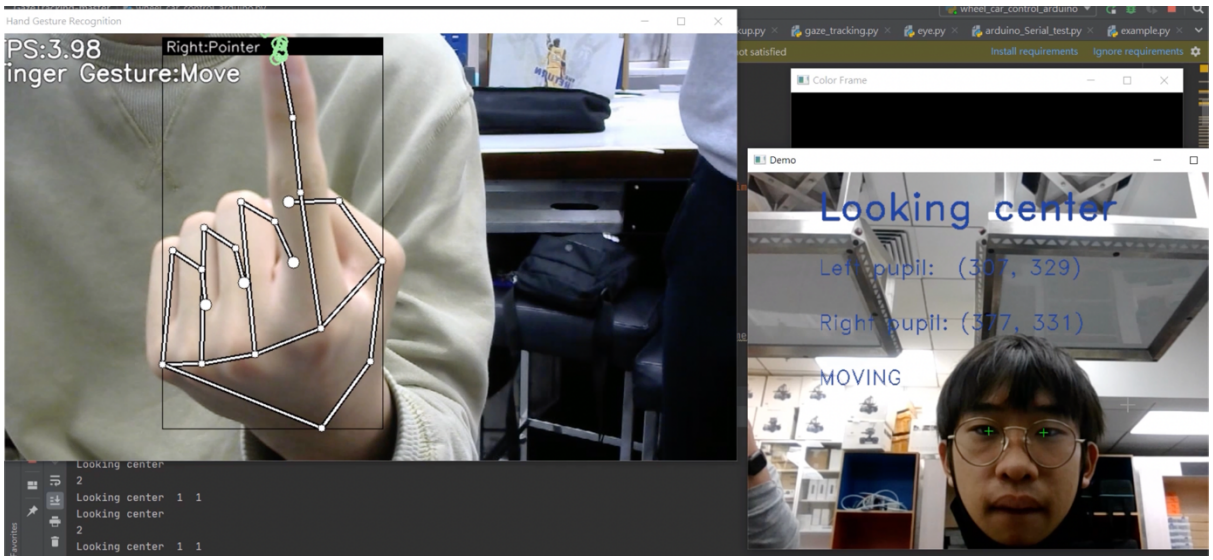
Gesture Control Technology:



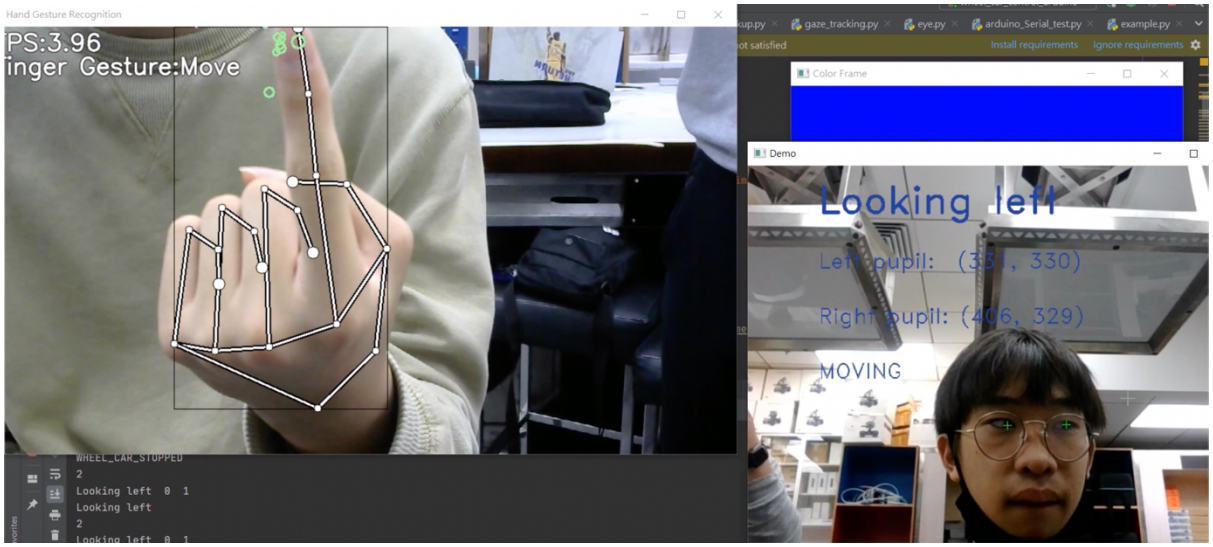
The picture above is a wheelchair moving forward



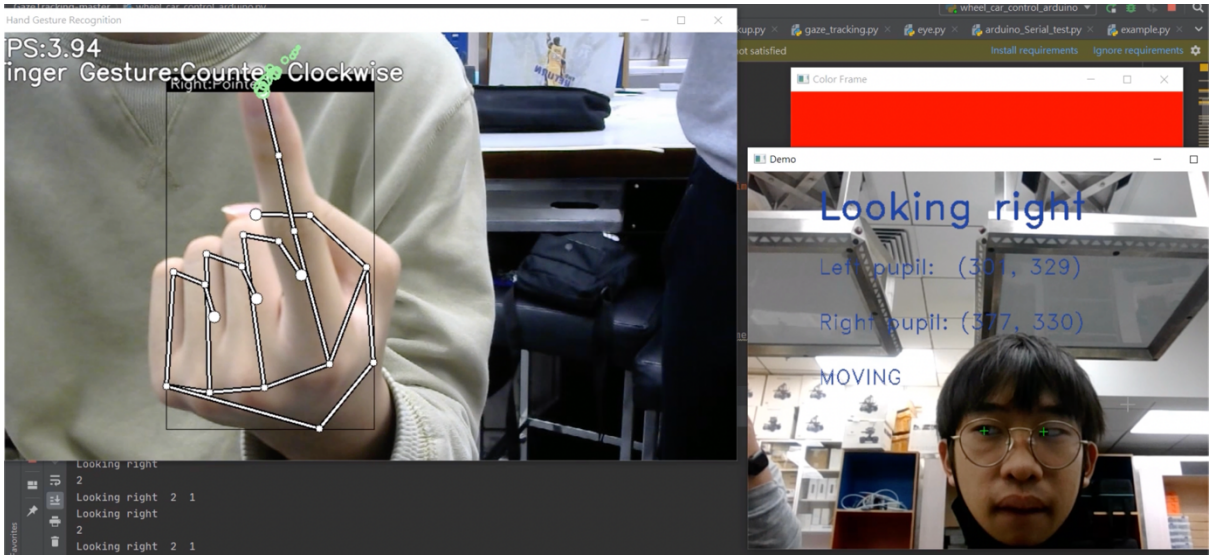
The picture above is to control the wheelchair to stop



The picture above is to control the wheelchair to move forward



The picture above is to control the wheelchair to turn left



The picture above is to control the wheelchair to turn right

4 Conclusions

- **The computer analyses the eye direction of the MND patients**
- **The wheelchair has successfully connected to the computer**
- **The MND patients can then control the wheelchair through computer commands.**
- **Able to control the direction and steering of the wheelchair without relying on motor muscles like hands and legs.**
- **Easy to use (wheelchair can relate to the computer easily)**
- **No complicated technology is required (using only simple formulas to calculate the eye ratios)**
- **Much lower cost compared to using other**
- **eyes-tracking wheelchairs**

5 References

[1]國家康復輔具研究中心 輔具情報研究第二期 我國輪椅發展的現狀及建議
時間：2020-12-08 10:13
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[3] 肌萎缩性脊髓侧索硬化症. (2021, December 18). Retrieved from 维基百科, 自由的百科全書
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6 Appendix (Python Code)