

SIMPLE GESTURE RECOGNITION TO ASSIST IN CONTROLLING A POWERED WHEELCHAIR

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Abstract

This short paper describes some initial work to create a simple hand gesture recognition system for a powered wheelchair. It is employed to assist people with mobility issues to drive a powered wheelchair. It replaces a standard joystick with hand gestures. Infrared sensors detect simple gestures and they are categorized in order to assist in driving a powered wheelchair. Some initial technical testing and results are described.

Key words: Wheelchair, Assist, Driving, Sensor, Infrared, Gesture.

Introduction

This short paper describes some initial work to create a simple hand gesture recognition system for a powered wheelchair. It replaces a standard joystick with hand gestures. Some initial technical testing and results are described.

Almost all powered wheelchairs are provided with a standard joystick controller but users often need a bespoke interface. Joysticks can only be used by someone able to apply enough force to move it in a controlled way in any direction.. An alternative is gesture based detection. Gesture based detection and classification has been successfully used for human computer interaction in various applications such as robot control, computer gaming, editing text and controlling vehicles.

There are a few papers about camera based hand gesture recognition [Zhang *et al*, 2011; Garg *et al*, 2009]. Those systems needed an expensive and complex system for image processing.

In this paper a new simple concept for a low cost approach is presented. Discussion with wheelchair users, clinicians and carers in the NHS suggested that the main factors considered when deliberating on whether to provide a powered wheelchair or not were functional ability and potential for return to normal life and work.

Wheelchairs controlled by a joystick are not suitable for some stroke patients and some spinal cord injury patients. Patients with acute quadriplegia take time to recover motor control in their hands. The simple system described here can be used by patients who are only able to move their hands a little.

Because powered wheelchairs with joysticks are not always appropriate, clinicians tend to suggest the use of manual wheelchairs. It is unusual to suggest modifications to a powered wheelchair to create a bespoke solution, especially as that can make a powered wheelchair more expensive.

Background

Many gesture recognition systems have been reported in the literature [Ahmad *et al*, 2011; Kaustubh & Bhiksha 2009; Perrin *et al*, 2004; Wang *et al*, 2010]. Several algorithms and methods have been proposed to interpret gestures [Igorevich *et al*, 2010; Hanning *et al*, 2004; Miners *et al*, Mu-Chun, 2000; Songmin *et al*, 2012; Ghosh & Ari, 2011; Tuan *et al*, 2011; Wang *et al*, 2010; Yamato & Ohya, 1992; Yamato & Ohya, 1992].

According to the stroke Association, roughly 15 million people worldwide are affected by stroke and 80% of them have mobility issues. In addition, 250,000 to 500,000 people suffer a spinal cord injury every year.

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A lack of basic mobility is a factor resulting in the exclusion of people with a spinal cord injury from participating fully in society. The World Health Organisation suggests the use of suitable assistive devices to help them with basic everyday activities. There are about 400,000 spinal cord injury patients in the USA, with about 15,000 new injuries every year [Hasan Al-Nashash, 2009].

Assistive devices tend to be either generic or bespoke. There are systems based on movement of the tongue [Lund *et al*, 2010; Xueliang & Maysam, 2009], head [Ahmad *et al*, 2011; Zhang-fang *et al*, 2010; [Montesano *et al*, 2010], brain [Ituratte *et al*, 2009; Kyuwan *et al*, 2006], electrooculography and eyes [Chern-Sheng *et al*, 2006; as well as joysticks. Research presented here could create a low cost infrared sensor based assistive device that would fit between these two extremes.

The prototype system described in this paper can detect the movement of any part of the body, for example head, fingers, hands, arms etc. If movement can be detected then a powered wheelchair can be controlled by it.

The infrared sensors needed to interpret four simple gestures to control a wheelchair: forward, reverse, right and left.

Sensors

Infrared sensor technology is used in wide range of applications [Garcia *et al*, 2004; Singh *et al*, 2010; Rakshit & Chatterjee, 2010]. In this work, the motor drives were controlled from an infrared sensor array based on the principle of reflection from an incident surface.

Infrared LEDs emit continuous beams of infrared. When a reflecting surface is in front of the infrared receiver (a photodiode) then the infrared rays reflect back and are captured by the photodiode, which generates a current. The amount of current generated was proportional to the amount of infrared rays reflected. A part of a user's body serves as a reflecting surface.

When the user places a part of the body in front of the array, then software attempts to identify a gesture.

When a gesture is identified, the system responds with a movement of the wheelchair: forward, Right, Reverse or Left.

Testing and results

Response timings were compared in the laboratory with those of a joystick. The new system was slower but successfully steered the wheelchair.

A group of 13 volunteers were then asked to rate the use of the gesture system compared to using a joystick. All the volunteers preferred the use of the joystick but all were able to steer the wheelchair with both.

After using the prototype, volunteers rated the new system as very good, good, satisfactory, unsatisfactory and poor. The average rating was satisfactory.

The success rate of the prototype in identifying correct gestures was low. Overall success rate in recognizing gestures was 29.5%, although in some cases the percentage was as high as 70%.

For any gesture change, the response time was around one second. That was slower than all the joysticks considered.

Discussion

Although the new system was slower and all the volunteers preferred the use of the joystick, it did successfully steer the wheelchair and the average rating was satisfactory.

A main problem was that the success rate was low so that gestures needed to be repeated. That needs to be improved. Response times were slow compared to a joystick and that also needs to be improved.

Response time for gesture change was about one second and that was too slow so that the new systems will not be suitable for everybody with impaired mobility. That said, it could be another alternative to existing control methods.

Future work will concentrate on improving recognition and response times.

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