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COMPUTER VISION SYSTEM OF INTELLIGENT MOBILE WHEELCHAIR

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Nowadays advanced technologies in mechanical engineering lead to improving of mobile wheelchairs constructions. Recently, technologies based on machine learning methods have started to spread widely. Since some people with mobility impairments don't have ability to use manual controls, they require alternative ways to control the movement of their wheelchair.

There are some alternative methods of successful wheelchair motion control. The first way is founded on using of switch built into the back of the chair and controlling of movement by the head or chin [1].

Another way is voice control and BCI (Brain Computer Interface), which pick up signals from the brain through certain stimulation of eyes and control movement using brain signals [1], [2].

The most perspective way of control based on pattern recognition is related with a video cameras employment [3]. Today this technology is the most effective among the others, because it has fewer disadvantages related with imperfections in its construction [3]. A lot of research is dedicated to the development of new algorithms for image processing and decision-making for trajectory planning.

In this thesis the author provides a brief overview and analysis of technical solutions for computer vision systems for mobile wheelchairs.

One of the variants of using computer vision to control a wheelchair movement is the eye tracking system proposed in the article [3]. This system consists of an eye tracking database, preprocessing, eye movement direction estimation and a wheelchair motion control system.

A video camera located at a distance from the body is directed at a person sitting in a wheelchair and transmits his image in real time to the machine learning computing module. This module sends the processed image to the neural network to obtain the expected direction of eye tracking and transmits the signal to the motion controller. The mobile controller processes the received signal and, depending on the position of the eyes, generates a control signal to the electric wheel drive regulators.

Thereby, the angular speeds and rotation direction of the wheels are changing as well as the position of the wheelchair. The user's eyes conditions and the direction of wheelchair movement are updated on the display in real time [3].

A block diagram of a computer vision intelligent control system of a wheelchair based on eye tracking is shown in Fig. 1.

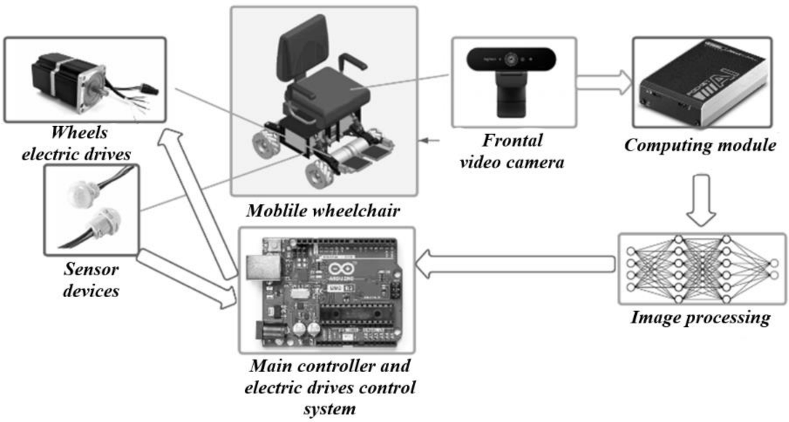

Fig. 1. Block diagram of an intelligent eye tracking system in a mobile wheelchair

After image processing by the mobile computer the command is sent to the main controller to transform the signal into the angular speed of the electric wheel drives and the wheelchair position.

The wheelchair navigation system with a video camera installed in front of the wheelchair user to collect control information is expressed through the horizontal glance direction to guide movement and the blink timing command for commands such as «move forward», «move backward» and «stop» [3].

The same principle proposed in the article [4] is based on egocentric wearable device – a webcam attached on a person's cap or another head-gears. To control a wheelchair movement using egocentric camera control, a person moves his head within a small range to control a virtual joystick. This joystick tracks head movement and shows information on the front-facing display.

The movement of the human head is insignificant. The front display provides feedback, helping the user to control the robot's motion state and affect it using voice input [4].

The advantage of egocentric control of the wheelchair video camera [4] is the camera ability to monitor the information in user's real-time.

In contrast, front-facing cameras make it very difficult to recognize gestures and faces in real time, and hands-free control methods require the user's full attention while moving.

The disadvantage of such computer vision systems with a front-facing video camera and the movement formation by assessing the glance or facial expressions of a person is the inability of the user to communicate with others while controlling the chair [1]. Also, there is a probability of unplanned wheelchair movement during a random change of the person's face position.

Thus, there are several types of computer vision solutions for autonomous movement control of intelligent wheelchair. The most promising direction in this field is an egocentric control of a video camera.

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