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Mapping study of computer vision tools applied to aid in wheelchair control

Abstract

Driving a motorized wheelchair at first glance seems like a simple activity to the. In reality, however, the ability to drive the wheelchair independently requires specific motor, visual and cognitive skills, and Attempting to the so without proper preparation and knowledge may pose a risk, not only to the user in question, but Also to the Individuals around him. Thus, computer vision can assist in the wheelchair control process through various tools. From this perspective, this paper presents a systematic review of references Aimed at the application of computer vision in wheelchair driving. The research sources Were the Following indexed databases: IEEE Xplore, Science Direct and PubMed. Thus, the systematic mapping in the elaboration of the review allowed us to identify the main gaps for the development of new research, in addition to directing the main publications related to the study. Finally, the results show That It is a constantly expanding area with great potential for development and applications.

Keywords: index terms- wheelchair, systematic mapping, computer vision

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Introduction

New modern clinical practice, a wide range of information from the human body can be read routinely. Through the use of appropriate monitoring equipment, engineers and health professionals have access to many phenomena bioelectrical with relative facility. Among these phenomena are the following electrocardiogram (ECG), eletrooculogram (EOG), electroencephalogram (EEG), electromyogram (EMG) biopotential among others.[1]

In addition, computer vision has been widely used to help control process for wheelchair, for example, that, in turn, is very useful for temporary or permanent rehabilitation treatments. To try to make these more attractive and effective treatments to patients, it is common to use virtual environments for training, where we use a virtual environment to create a consistent model with reality in conducting a virtual wheelchair. Such models (called simulator) has as main function to allow interventions in some scenarios that could not be done in a real situation, without providing some kind of risk or other adverse characteristics. Thus, the use of simulators can provide a secure environment for training, learning and adaptation, until the user is ready to deal with the real situation properly.[2]

Conceptually, an environment involves a certain space and an enclosed situation, and includes all the components that they carry, as the set of objects and likely condition to be perceived and with which you can interact. In this line of reasoning, a virtual environment is an interactive environment, generated by a computer and made available through a virtual reality system.[3] According to[4] are features that should be considered for the development of a virtual environment:

Synthetic: the environment must be generated in real time and not be a recording such as multimedia systems;

Dimensional: the environment surrounding the user is represented in three dimensions (3D), giving the user the impression of depth;

Multisensory: it uses more than one way to represent the environment, such as vision, hearing, spatial perception (deep), user reaction to the environment, among others;

Immersive: refers to the impression that it is within the environment produced computationally. Normally, an immersive system is obtained with the use of visualization helmets, but other senses such as sound and reactive controls, can also collaborate with immersion;

Interactive: is the ability to detect user input and instantly modify the virtual world and the actions performed on it;

Realistic: involves the precision with which the virtual environment reproduces the real objects, interactions with users and the environment of the model itself.

In this context, the objective of this work is to check the overview of related research on the application of computer vision in control of wheelchairs, featuring a systemic study of what has been published for that aspect.

The purpose of this systematic mapping to analyze the references of the work carried out involving the theme on computer vision tools applied to control wheelchairs. And with that, check the rise of this research today.

This work is organized and structured in the following sections: Section 2, the methodology and the development of systematic review was discussed, detailing the research carried out. Section 3 corresponds to the results obtained by means of graphs and tables, which are analyzed and commented. Finally, we present the findings

of systematic research on computer vision tools applied to aid in control of wheelchairs.

Materials and methods

In order to make up the literature review established by the worker, systematic mapping (Study mapping) was performed according to the methodology proposed by[5] and,[6] consisting of a search for registered studies on databases by means of logical operators for the selection of items, from the selection of key words or expressions.

Databases considered for this study were: IEEE Xplore,[7] Science Direct[8] and PubMed,[9] which are bases available at the Federal University of Uberlândia. It is necessary to emphasize that only periodic were analyzed peer-reviewed articles.

The logical expressions used to search the bases were "computer vision" and "wheelchair". These strings were chosen to seek work involving machine learning applied in health care. Then filters were applied to reduce the scope of the search. For example, as the language (English and Portuguese), type of publication (journal article peer-reviewed) and year of publication (from 2013 to 2018, representing six years of search space). Applied filters in each database, a reading was made of the securities in order to select which were in accordance with the logical expression selected. It also observed the possible duplicates between databases, and articles that fit the inclusion criteria have any duplicates removed.

Finally, the final stage of selection of items consisted in directing for applications involving machine learning in health. Thus, it was made from the reading and analysis of titles and abstracts, to exclude those jobs that did not relate directly to the subject being studied, and the review of the literature developed from this result. In this sense, different studies that addressed topics were discarded, such that addressed work machine learning oriented application in other areas, for example.

Results and discussion

After completion of the searches on the databases, the results were organized in tables and charts in order to present them in a more practical manner. Table 1 shows the total results of the mapping, given keywords and cited the deadline of December 2018.

Table 1 Summary of results obtained in the research

Database	Number of articles	
	initial	with title adherent
PubMed	5	4
IEEE Xplore	53	27
Science Direct	89	5
Total	147	35

Thus, through the systematic mapping a database was created with 35 (thirty five) databases of references to the combination of strings "computer vision" AND "wheelchair".

The evolution of the annual publication of selected papers in the international pursuit can be seen in Figure 1, where it is possible to note that articles involving the subject matter in this work have been published in recent years. Thus, it is observed that the subject is recent and large fields of possibilities to explore. 35 (thirty five) selected works included in the references of this study.[10–44] However, they are not mentioned in the text due to the extensive amount.

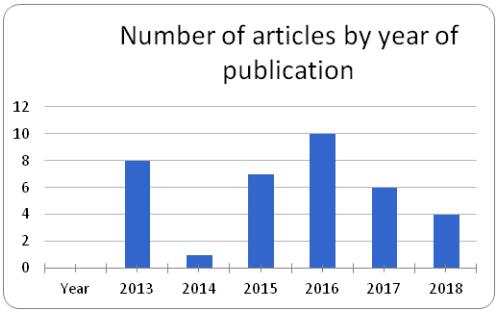

Figure 1 Number of articles per year of publication.

Figure 2 shows the number of journal articles published by countries. The published works are from different countries such as: Argentina, Australia, Bangladesh, Brazil, Chile, China, South Korea, Spain, USA, France, India, Indonesia, Italy, Japan, New Zealand and Romania. Thus, it appears that most found jobs that involve the use of computer vision applications for wheelchairs are from developed countries, including found only one study that addresses this issue in Brazil.

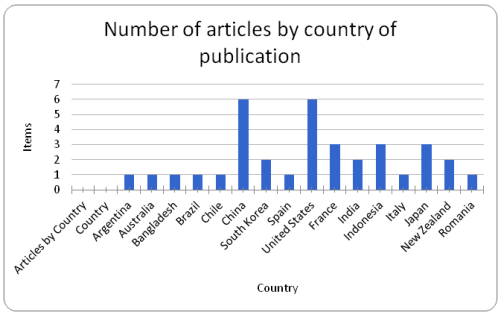

Figure 2 Number of articles by country of publication.

Figure 3 shows the number of items found depending on the type of rehabilitation, which were: muscular dystrophy, limiting the upper limbs, cerebral palsy and tetraplegia. But unfortunately, most of the works selected for the systematic mapping did not report the type of rehabilitation used to use computer vision to control wheelchairs.

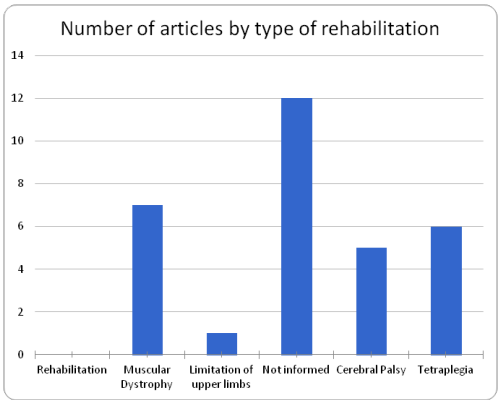

Figure 3 Number of articles by type of rehabilitation.

Figure 4 shows the number of items selected according to the technology used for the application of computer vision to control

wheelchairs, which were varied, among which we mention: AdaBoost face detection algorithm; customized; Blob detection; Color detection with OpenCV; detection of gestures and objects; Face detection and face angle; fuzzy controler and virtual reality; HOG (Histogram of Oriented Gradients) with OpenCV; kinematic model and iris movement; Monocular visual odometry; OpenCV, OpenNI and gesture recognition; PCL (Point Cloud Library); VR (virtual reality) and FOV (field of view); SLAM (Simultaneous Localization and Mapping) based on vision; TensorFlow; egocentric computer vision; stereo vision; monocular vision; detection and mapping of obstacles.

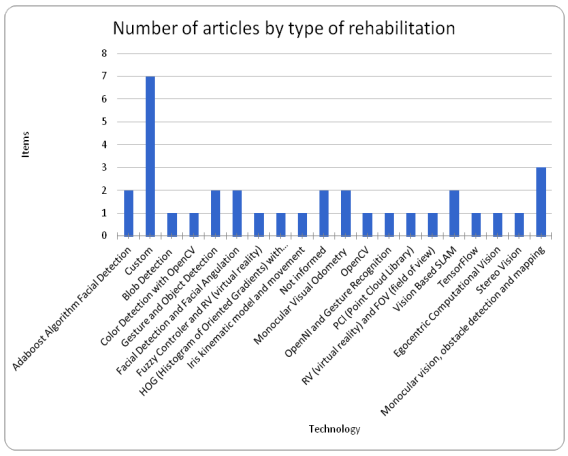

Figure 4 Number of articles for technology.

Figure 5 shows the quantity of items found on the type of equipment used in work on computer vision to control wheelchairs, namely: Camera; binocular camera and emotiv epoc; stereo vision camera; camera and robotic arm; camera and laser line;

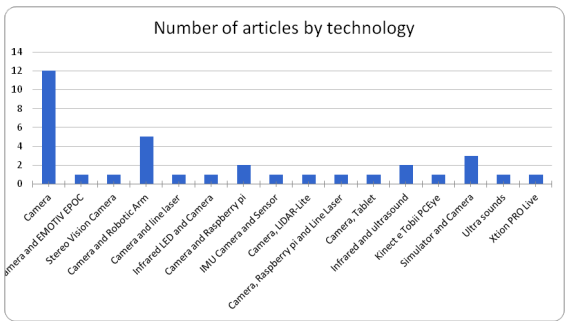

Figure 5 Number of articles per unit.

Technology

Camera and infrared LED; camera and raspberry pi; camera and IMU sensor; camera and LIDAR-Lite; camera, raspberry pi and line laser; camera and tablet; infrared and ultrasound; Kinect and Tobii PCEye; simulator and camera; ultrasound; Xtion PRO Live. Thus, it is noticed that the camera was the most used equipment in the selected works on the theme researched this systematic mapping.

Figure 6 shows the number of found items according to the purpose of application of labor, namely: monitoring /evaluation, accident prevention, rehabilitation and training. In this sense, it can be observed that most of the work seeks to prevent accidents, since it is something very important for people who use wheelchairs, the elderly and people with disabilities, for example, to avoid further damage to your health.

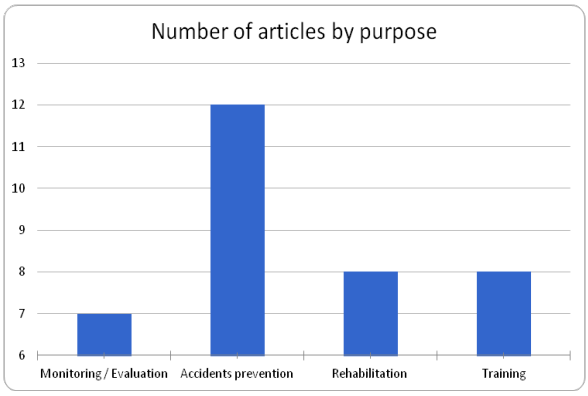

Figure 6 Number of items per order.

Figure 7 shows the percentage of articles that did experiments with participants. Thus, it is observed that most (69% of the work) conducted this procedure. This demonstrates the need for testing to prove the results and effectiveness of applications, and help in making improvements and maintenance of the systems.

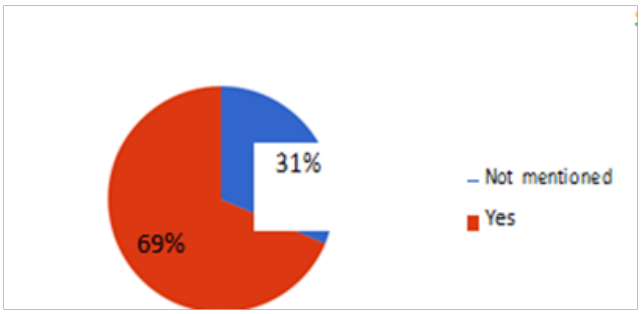

Figure 7 Percentage of articles that did experiments.

Conclusion

Through the mapping done, we found that there was an increase in the study of the application of computer vision to control wheelchairs, since it is a new and very efficient technique.

Thus, it is worth noting that the application of systematic mapping in the development of literature review identifies the main gaps in the development of new research. In addition, it directs to the main publications related to the study.

Because of what was presented in this paper, it appears that there is growing interest in researching and publishing in this area related to control wheelchairs using computer vision, seeking help in rehab, treatment, training or preventing people from accidents with various diseases.

Therefore, we see the need to promote this research area to offer this audience with limited dexterity access to computer vision techniques as a treatment, acquisition of knowledge, motivation, entertainment or even inclusion. In this way, you can obtain a greater maturity on the results and thus promote a systematic employment of computer vision in helping to promote the well-being of these people.

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Conflicts of interest

The authors declare that there is no conflict of interest.

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