Global Scientific JOURNALS

GSJ: Volume 8, Issue 7, July 2020, Online: ISSN 2320-9186
www.globalscientificjournal.com

HAND GESTURE COMMAND TO UNDERSTANDING OF HUMAN-ROBOT INTERACTION

K.K.L. Herath, E.D.G. Sanjeewa, B.G.D.A. Madhusanka, H.D.N.S. Priyankara
Department of Mechanical Engineering, Faculty of Engineering Technology, The Open University of Sri Lanka, Nawala, Sri Lanka

KeyWords
Human-Robot interaction, hand gesture recognition, gesture classification, human-machine interaction

ABSTRACT

The concept of human and robot interaction has been raised in many ways, such as social, economic, medical, and military. Human and robot collaboration is the new direction that allows humans to perform tasks efficiently. Communication between humans and robots is limited due to robot-human interfacing difficulties. This study provides an overview of hand gesture recognition to understand robot-human interaction by providing methods to identify gesture models, objects, and persons by using image processing techniques. The study aims to develop an interactive service robot eye which is capable of the vision-based system to identify the human hand gesture. In this study, Microsoft Kinect Camera Sensor was used to capture the hand gesture. The efficiency of the system was found that approximately 90% within the optimal distance of 4-5 feet from Kinetic Sensor.

INTRODUCTION

Due to industrial and military applications, the advancement of robot innovation has expanded for a long time. Many robots have been used in many areas such as healthcare, transportation, communication, industrial and military, but intelligent robots need to be modified for day-to-day use. The area of Human-Robot Interaction (HRI) is described as an area which aimed at the advancement of systems between human beings and robots. The development of robots should have the capability to work in a real-world scenario [1]. The visions of robots are personal development in the 20th century.

The engineers developed a way to program a robot to see the real world through the machine vision techniques which are inspired by the human eye. The camera system is the counterpart of the human eye which provides numerous abilities to see the real world. Robot systems are programmed with an algorithm to take and process through photography or videography. These actions are highly required when robots interact with humans in the workstation. Vision can also be used in non-robotic ways such as the cameras can be placed on the conveyor line. The images were taken on a conveyor line compared with the specific datasets to accept or reject products in the way of quality control. Modern computer vision innovations are an expansive portion of human-robot interaction [2-4]. There are many robot systems manufactured for industrial, domestic, and scientific purposes.

The World Health Organization states that over one billion people are suffering from disabilities. Sri Lanka Ministry of Health states that the count of disabled persons in Sri Lanka will be increased by 24.2% by 2025 [5]. The field of robotics in medicine and health care plays an important role nowadays. There are many robots developed to helps handicaps peoples. For verifiably detecting, more visual consideration is required. Also, it is fundamental in conditions of oddity location, the visual consideration is continually agent under "enlightened" conditions, and the framework is recognized and found in dull conditions. A gesture is a means of nonverbal communication or non-vocal communication in which observable body acts transmit clear signals, either in place or in tandem with speech. Figure 1 illustrates some examples of service robots that are available nowadays.

Figure 1: Categories of service robots

LITREATURE REVIEW

A. Type of Robot Applications

Today, robots perform several different activities in many fields, and there is a steady rise in the amount of work assigned to robotics [6]. Separation by its function is one of the easiest ways to separate the robots into groups. Type of robot application is divided as the field of industrial, domestic, and military applications.

Field of Industrial: manufacturing robots are robots which are used in an industrial system of development. They are typically articulated arms primarily designed for applications such as welding, material processing, and lighting, among others. Unless we judge only by use, some autonomous guided vehicles and other robots may also be included in this category [7].

Field of Domestic uses: robotics which is used at home. There are several various products of this category of robotics, such as robotic vacuum cleaners, robotic pool cleaners, sweepers, gutter cleaners, and other robotics that can handle specific tasks. Additionally, particular security and telepresence robots may be called household robots if used in this context [7].

Field of Military: Combat robots-robots used in army operations. This category of robotics includes bomber deactivation robotics, various transport robots and unmanned reconnaissance aircraft. Robots developed initially been for military uses may also be used in law enforcement, search and rescue, and other similar areas [7].

The combination of robot applications with vision technology can make for a powerful automation solution with far greater capabilities than either technology achieves on its own. Robot vision systems come in many forms and can be used in a wide range of applications. Robotic vision systems typically consist of one or more cameras, application-specific lighting, proprietary software, one or more robots, at times with the camera mounted directly on the end of the robot. Initially, most robotic vision systems were in 2D, but recently 3D vision has emerged as a more robust vision solution, opening new possibilities in robotics. In this study is used the Microsoft Kinect Camera Sensor to capture the hand gesture command to the understanding of human-robot interaction.

B. Related Works

Kinect Camera was a line of input movement detection devices produced by Microsoft for Xbox 360 and Xbox One video game consoles and Microsoft Windows computers. Based on a complementary peripheral webcam style, it enabled users to control and interact with their console or computer through a natural user interface that uses gestures and spoken commands without the need for a game controller.

Pei Xu has been engaged in a project to design a hand gesture-based, real-time human-computer interaction system. Almost 3200 gesture images were collected to test the CNN classifier, and he was demonstrated that the CNN classifier could rec-

ognize gestures with high accuracy in real-time, in combination with their image processing steps. The framework built has only been to support static movements [8].

Rong Wang et al. has been developed an older companion robot based on the Kinect sensor [9]. According to them, the robot system was able to intelligently follow the user with the effort of improving Kinect's detection accuracy. Voice control feature provides the consumer with another way to monitor the robot rather than default mode when Kinect fails goal consumer [9].

For human-robot communication, Hongyi et al. has been suggested a concept of gesture recognition. According to them, the concept of gesture recognition for human-robot communication includes four important technological components: sensor technology, gesture detection, gesture monitoring, and gesture classification [10]. According to them, algorithm combination improves the efficiency of research.

Sharma et al. has been developed the static hand gesture images based on hand shapes and orientations that are extracted from the input video stream recorded in stable lighting and simple background conditions. They have recognized gestures based on this vision to control multimedia applications that run on a computer using various gestural commands [11].

Some researchers are used Microsoft Kinect sensors devices as a sensor to provide input to the personal computers in their research. According to Piana et al. [12] have been used Microsoft Kinect sensor for the significant variance to track the movement of every element of the human body. It is essential that by using this sensor, it can recover the skeletal information to identify the gesture of pointing and estimate the aiming positions. This sensor is a commercial product and is very easy to acquire and install. It has very few requirements in the acquisition environment.

Earlier research studies related to the vision systems focused on hand gesture recognition was performed with just one orientation of hand gestures. Hence, it cannot get a strong response from those who are deaf and elderly since they are more miserable than average citizens. Therefore, in this study was to train various hand movement orientations to understand intelligent systems appropriately and correctly to provide the best human-robot experience. A desktop computer as an intelligent device can be used to power the whole operation such as Intel [13] graphics for the needs of graphics and computation.

© GSJ

METHODOLOGY

The identification and monitoring of objects within the field of computer vision are considered essential concerns. A modern and excellent opportunity to change object detection algorithms has been generated by the proliferation of high-definition images, fast computing machines and the increasing rise in demand for highly accurate automated video analysis. This study is used Kinect camera to capture the human hand gesture. The development of gesture- based HRI system was running with fixed frames per second.

There are primarily two approaches for understanding the hand and object movements which are known as Artificial Neural Networks and Fuzzy Logic. Fuzzy logic helps to make concrete assumptions based on incomplete or unclear results. Still, neural networks seek to integrate the mechanism of human thinking to solve problems by mathematically modelling them. Although both methods can be used to solve nonlinear problems and problems that have not been specified correctly, they are not related.

In contrast to Fuzzy logic, a neural network tries to apply the thought process in the human brain to solve problems. Also, neural networks include a learning process that involves learning algorithms and requires training data. The data was classified from the algorithms for the recognition of gestures using neural networks.

Selection of components in this study is very critical. Many of them will complete the inquiry on schedule for software that are readily available, reduce preliminary budgets, achieve high accuracy and reliability for the study. Microcontrollers, Personal Computers, Microsoft Kinect Camera sensor and Actuators are devices used in the research study. After capturing the image by the camera, the system works, as shown in Figure 2.

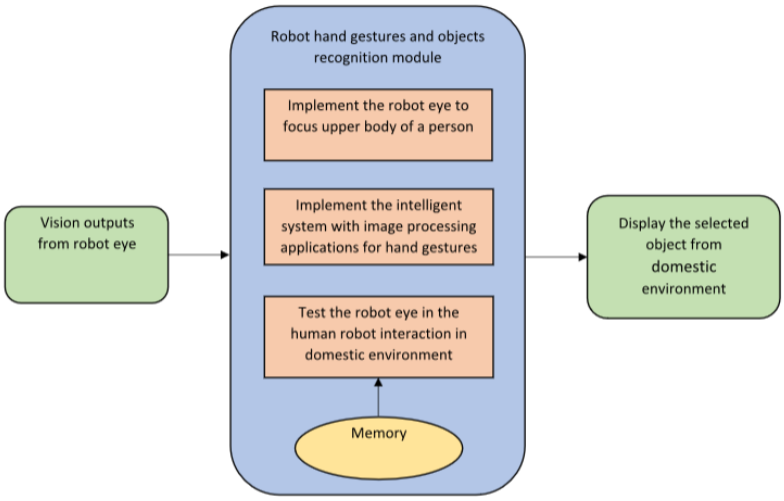

Figure 2: Hand gesture and object recognition module

Gesture extraction required preprocessing before performing hand segmentation. Preprocessing is to register the depth of image, RGB colour segmentation [14] and process the spatial stratification of depth distance. Hand segmentation is to extract the hand area at different distances from the complex background.

Figure 3: Consider two fingers shape to calculations

Figure 3 is shown the geometric details between two fingers. Following procedure was performed when developing the hand gesture algorithm by assuming: The angle A would be less than 90°, the lengths would be more than 30 pixels.

1) Using line length finding formula can get the length of the lines.

2) Using cosine rule can calculate the angle between the two fingers.

3) Angle between two fingers not going to be more than 90°

4) Fingers length of the binary image more than 30 pixels because to reduce small defect detect.

RESULTS

Using image processing algorithms from OpenCV Library, a hand gesture recognition system was developed to detect numbers according to the gesture displayed. Hand Detection involves the Identification of Segmentation and Edge. Once the hand gestures are segmented, an edge traversal algorithm is applied to the segmented contour of the hand to remove unwanted background noise.

A. HAND GESTURE AND DIRECTURE RECOGNITION

The OpenCV libraries were used to create the hand gesture algorithm [15-16]; the blue circles were used to indicate the defect of the binary picture of hand when detecting hand movement is reflects number [17-19]. Through counting those flaws, the system is counting the subject's toes.

Figure 4: Hand gesture for the finger count recognition

The major problem of colour-based segmentation is the colour of human skin varies greatly across human races or even between individuals of the same race [20]. Figure 4 illustrates the results of detecting finger count while the subject was performing in front of the camera. Figure 5 shows the proposed algorithm for hand gesture recognition algorithm. When the device acquires the source image, RGB picture was submitted to the phase of filtering and conversion of colours. The next step is to undertake for contours of seeking and form of the hand. The features are extracted after hand form identified movement extraction process. The findings show the count of fingers and direction due to the behaviour of the consumers.

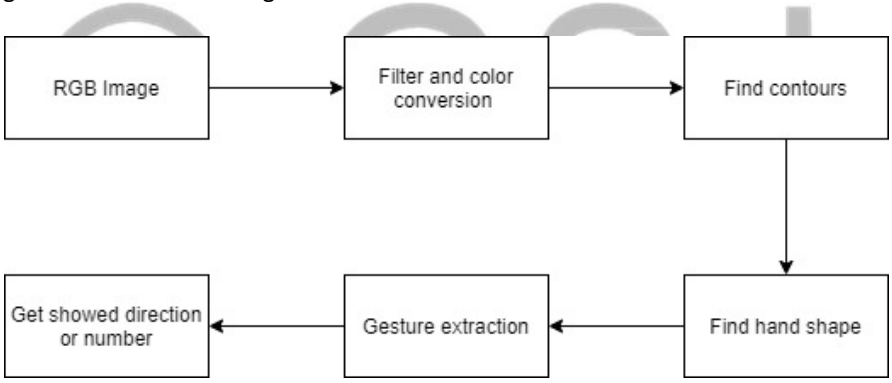

Figure 5: Hand gesture algorithm

Direction recognition was identified while subject performing in front of the camera. When the subject was pointed to the left direction system was identified as left direction. As shown in Figure 6, the Right direction was also identified by the system.

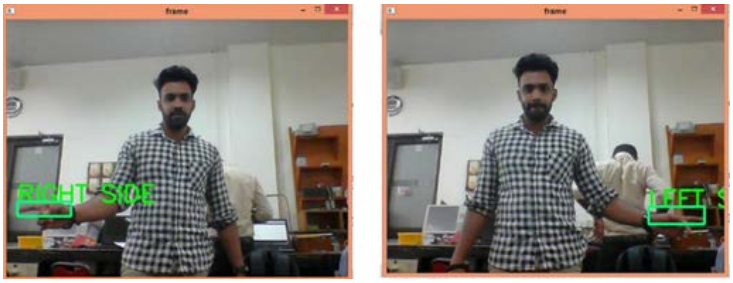

Figure 6: Direction gesture detection

B. OBJECT RECOGNITION

Haar Cascade Algorithm [21] was used to detect the above three objects. By configuring necessary libraries, feeding 1000 positive images and 2000 negative images as a dataset from each object and training the system to train the system. The lighting on the objects must be bright enough so that the camera sensor does not introduce noise. There also needs to be enough light to provide enough contrast for the recognition algorithm. Many of these systems require at least 300 to 500 lux of illumination where a typical domestic working environment. Figure 7 shows the output image after detect Cup, Flask and First aid box.

Figure 7: Objects detection results

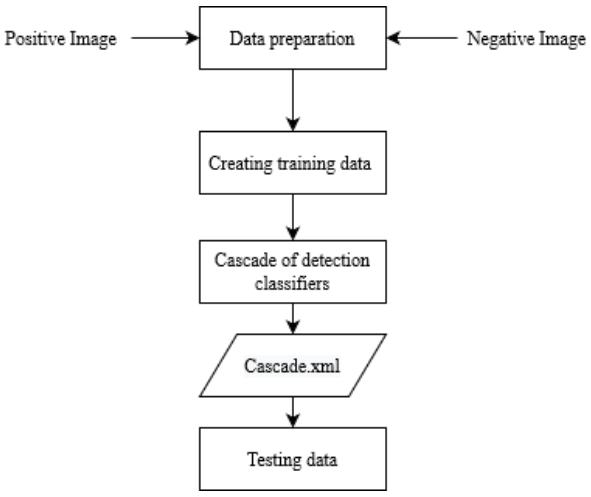

Figure 8: Object recognition algorithm

Figure 8 shows the object recognition algorithm's program flow chart. Once the process of preparing the data acquires the image, it is created for the dataset. Classifier Cascade Detection was used to identify features.

CONCLUSION

This study was aimed to develop an interactive service robot eye which is capable of the vision-based system to identify the human hand gesture. The efficiency of the system was found that approximately 90% within the optimal distance of 4-5 feet from the Kinect Sensor. The Kinect sensor could work for a vision-based system with high efficiency. According to the results, gesture recognition, direction recognition and object recognition were performed efficiently with the aid of OpenCV.

REFERENCES

[1] Salvini P. et al. (2012) Teaching with Minirobots: The Local Educational Laboratory on Robotics. In: Rückert U., Joaquin S., Felix W. (eds) Advances in Autonomous Mini Robots. Springer, Berlin, Heidelberg
[2] B. Maimone and H. Fuchs, "Encumbrance-Free Telepresence System with Real-Time 3D Capture and Display Using Commodity Depth Cameras, Proc. IEEE Int'l Symp. Mixed and Augmented Reality (ISMAR), IEEE CS Press, 2011, pp. 137_146.
[3] T. Starner and A. Pentland, Real-time american sign language recognition from video using hidden markov models. Motion-Based Recognition. Springer Netherlands, 1997: 227-243.
[4] W. Li, Z. Zhang, and Z. Liu, "Action Recognition Based on A Bag of 3D Points, "Proc. IEEE Int'l Workshop on CVPR for Human Communicative Behavior Analysis (CVPR4HB), IEEE CS Press, 2010, pp. 9_14.
[5] Herath, Kasun & de Mel, W.R.. (2019). ELECTROENCEPHALOGRAM (EEG) CONTROLLED ANATOMICAL ROBOT HAND. 10.6084/m9.figshare.9759248.
[6] Lewis, M., 2013. Human Interaction with Multiple Remote Robots. Reviews of Human Factors and Ergonomics, 9(1), pp.131–174.
[7] Ben-Ari, M. & Mondada, F., 2017. Robots and Their Applications. Elements of Robotics, pp.1–20.
[8] Xu, Pei. "A real-time hand gesture recognition and human-computer interaction system." arXiv preprint arXiv:1704.07296 (2017).
[9] Wang, Rong, Huiguo Zhang, and Cyril Leung. "Follow me: A personal robotic companion system for the elderly." International Journal of Information Technology (IJIT) 21, no. 1 (2015).
[10] Liu, H. & Wang, L., 2018. Gesture recognition for human-robot collaboration: A review. International Journal of Industrial Ergonomics, 68, pp.355–367.
[11] Sharma, R.P. & Verma, G.K., 2015. Human Computer Interaction using Hand Gesture. Procedia Computer Science, 54, pp.721–727.
[12] Piana, Stefano & Staglianò, Alessandra & Odone, Francesca & Verri, Alessandro & Camurri, Antonio. (2014). Real-time Automatic Emotion Recognition from Body Gestures.
[13] Anon, Data Center Solutions, IoT, and PC Innovation. Intel. Available at: https://www.intel.com/content/www/us/en/homepage.html [Accessed July 4, 2020].
[14] Herath, Kasun. (2016). RICE GRAINS CLASSIFICATION USING IMAGE PROCESSING TECHNICS.
[15] A framework for dynamic hand Gesture Recognition using key frames extraction - IEEE Conference Publication. 2015. A framework for dynamic hand Gesture Recognition using key frames extraction - IEEE Conference Publication. 42
[16] Gesture mimicry in social human-robot interaction - IEEE Conference Publication. 2017.
[17] The Robot Report. (2017). Service Robots for Personal and Private Use. Robot Report [online]. Available at: https://www.therobotreport.com/directory/service-robots-for-personal-and-private-use/P200 [Accessed 13th May.2017] Wikipedia. (2012). Service Robot [online]. Available at: https://en.wikipedia.org/wiki/Service_robot [accessed 13th May.2017]
[18] M. M. Islam, S. Siddiqua and J. Afnan, Real time Hand Gesture Recognition using different algorithms based on American Sign Language. Imaging, Vision & Pattern Recognition (icIVPR), 2017 IEEE International Conference on. IEEE, 2017: 1-6.
[19] E. J. Ong and R. Bowden, A boosted classifier tree for hand shape detection. Automatic Face and Gesture Recognition, 2004. Proceedings. Sixth IEEE International Conference on. IEEE, 2004: 889-894.
[20] J. Fritsch, S. Lang, A. Kleinehagenbrock, G. A. Fink and G. Sagerer, improving adaptive skin color segmentation by incorporating results from face detection. Robot and Human Interactive Communication, 2002. Proceedings. 11th IEEE International Workshop on. IEEE, 2002: 337- 343.
[21] Q. Chen, N. D. Georganas and E. M. Petriu, Real-time vision-based hand gesture recognition using haar-like features. Instrumentation and Measurement Technology Conference Proceedings, 2007. IMTC 2007. IEEE. IEEE, 2007: 1-6.