

APE HAND-A GESTURE-BASED CONTROL SYSTEM

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ABSTRACT

The paper while showcase a prototype from an Arduino and a pair of ultrasonic sensors, through this we can make gestures in mid- air. The gestures are then sent to the system which then performs the desired task. We will train the software to recognize the gestures that made by a human hand. The ultrasonic sensors will provide input to Arduino about the hand's 3D coordinates. Arduino then sends the data to a python script via attached micro-USB cable, together with a python library OpenCV, the system captures motion and transforms them into data which performs the required task. Once we train the system with a gesture numerous times, it will accumulate data to have an estimation of what the gesture is & how it performs. This gesture can then be assigned to perform a particular task on the computer.

KEYWORDS: Python, OpenCV, Keras, Feature extraction, Deep Learning.

1. INTRODUCTION

Today, human-machine interaction has become ubiquitous, approaching keyboards, mouse, USB drives and touch screens, and is much more in tune with the real environment. With the development of new technology to enhance the quality of life, the gap between human and robotics grows smaller with each passing day [1,3]. It enables a range of future advanced robotic arms designed to look like the human hand itself and easily controlled with hand gestures. For the same reason, gesture recognition systems used to control storage and display devices in remote environments are being researched. People often use gestures to communicate.

Gestures can be employed for anything from directing people's attention to communicating information about both temporal and spatial features. Gesture recognition is a topic of computer science, engineering, and language technology, intended to analyze human movements using mathematical algorithms [2] (a self-contained, step-by-step series of operations that are performed). So far there has been the use of gestures. For example, people from the 1st century to the present century were able to communicate using handheld gestures. Wave goodbye, nod, wink, etc. Gesture-based systems have exploited this fact by presenting systems that can copy and replicate human gestures with respect to the system they control.

As defined by Merriam Webster Dictionary, Gestures are movements of the body (especially hands and arms) that indicate or emphasize thoughts and feelings. However, recognizing and identifying posture and gait, praxeology, and human behavior are also targeting of gesture recognition techniques [3, 4]. With the help of gesture recognition, a computer can interpret the human body-language. As such, it provides a more comprehensive path to bridge the distance between machines and humans, that primitive textual or

GUIs and a touch screen system is not capable of performing. People and computers communicate easily with one other through gestures [5]. As a result, such gesture-based interfaces offer feasibility

not only to replace regular interface devices, but also as a improve their functioning. In the early days of robotics technology, communication with robots was possible only through programs.

This requires a lot of effort on the part of programmers and developers. Gesture-based recognition has emerged with the development of science and robotics [6]. Gestures arise from body movements and states, but usually from the facial structures and hands. Gesture recognition can be viewed as a medium for computers to understand human body-language. Thus, it minimizes the requirements for text interfaces, button-based controls, and GUIs [7].

2. LITERATURE REVIEW

2.1. Radhika Bhatt, Nikita Fernandes, A. Dhage, Computer Science, 2013 [1]

This research paper provided an approach for developing autonomous real-time hand gesture recognition that utilizes HCI (human-computer interaction), which is "vision-based" by usage of a webcam and computer vision algorithms. Additionally, it permits image processing which may recognize multiple hand gestures simultaneously. There are many functions for real-time hand gesture recognition, from simple uses including small applications to specialized domain-specific applications, as it can be used almost anywhere you interact with a computer.

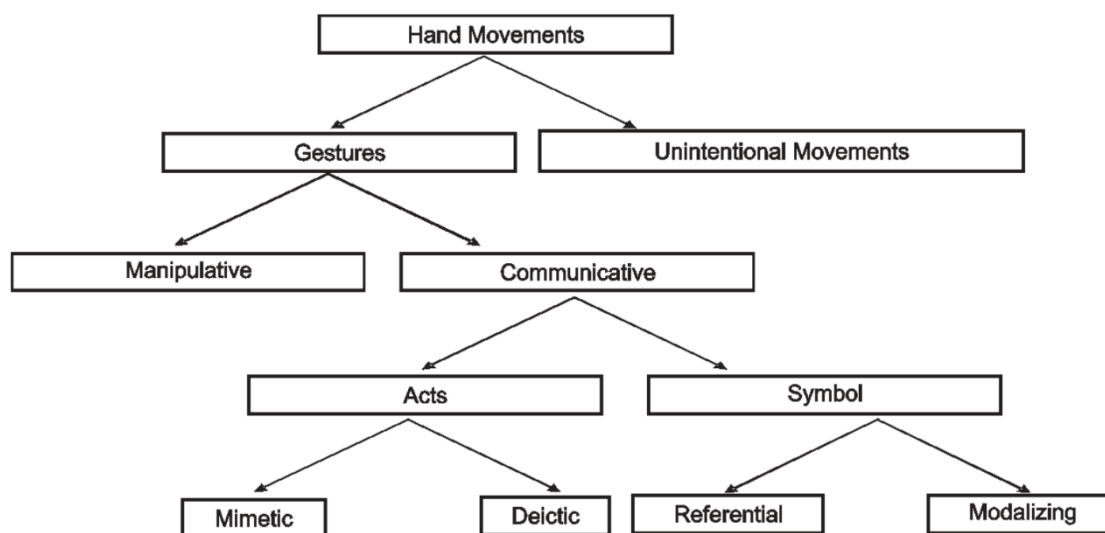


Fig.1: Taxonomy of Hand Gesture

Our research work demonstrates significant societal value and has the potential for further expansion into commercial applications. Gesture recognition is a prominent area of focus in computer vision research, with existing systems predominantly relying on hand recognition accompanied by various types of branding or markers. In contrast, our approach leverages concurrent handheld image recognition to enable gesture recognition using bare hands, without the need for any markers [8]. Our system exhibits high accuracy and robustness, performing calculations within seconds and accurately determining the intended gesture based on the user's hand movements.

2.2. D. Singh, International Conference on Communications and Signal Processing (ICCSP), Computer Science, 2015 [2]

Electronic devices are rapidly shrinking in size as new developments and innovations take place in the field of computer technology. Therefore, we need a form of input interface for interacting with machines, that can offer functionality at lower expense & predicts accurately. We are increasingly realizing the importance of Human Computing Interaction (HCI) and visual gesture and object recognition.

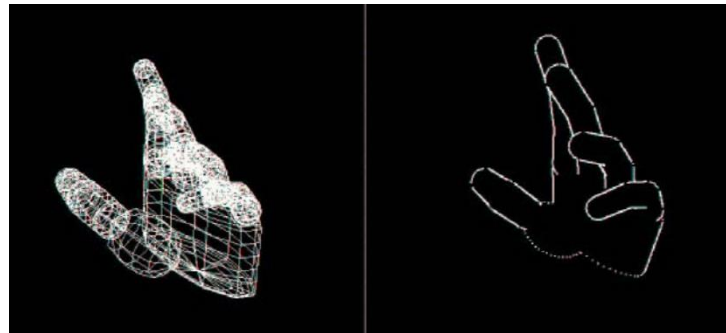


Fig. 2. The 3 D model (left) and its generated contour (right)

However, these interfaces take up space and cannot be used while on the move. Touchscreens are now the preferred user interface and are used in many applications around the world. Leveraging image processing technology and using natural hand gestures to control devices reduces the amount of workspace required.

2.3. S. S. Devkule, Lalit kumar P. Khairnar, Computer Science, 2018 [3]

A comparative study in this article focuses on different segmentation, feature extraction, and recognition tools that the gesture recognition is meant to detect and recognize derived from body movement, but usually comes from the face or with the hands.

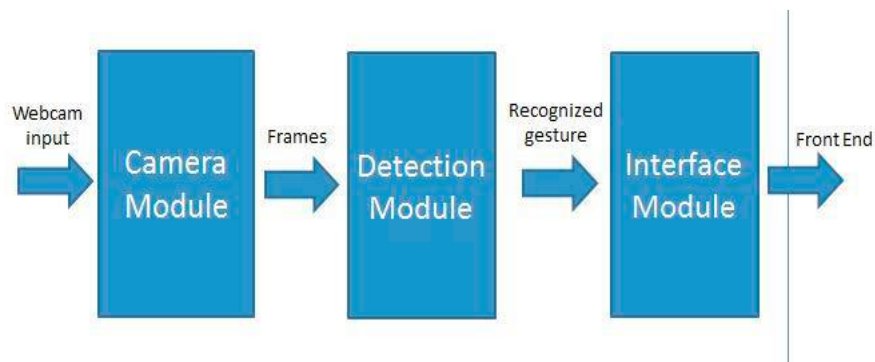


Fig. 3: System Block Diagram

Due to the limitations of these devices, the set of commands that can be used is also limited. Using hands directly as input devices is an innovative approach developed from text-based interfaces for creating genuine human-computer interaction, GUIs, and multimedia interface [7]. Human reproduction of the surrounding atmosphere causes it to interfere with each detail of this vast environment, deaf people gesture to each other to give a specific message, this mode of communication also draws double human focus to manifest it on human-computer interaction.

Gesture recognition allows humans to communicate with machines and correlation that occurs spontaneously and without the use of mechanical means or devices [2, 8]. Gesture recognition has a wide range of applications, from sign language through medical diagnosis to practical necessity.

2.4. Vandit Gajjar, Viraj Mavani, Ayesha Gurnani International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI), Computer Science, 2017 [4]

In this article, we explore the concept of machine learning-based hand gesture recognition, which enables users to interact with applications without physically touching their devices.

By employing computer vision techniques, presenting a wide range of gesture applications have been developed. hand gesture recognition based on machine learning is presented, with the utilization &

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implementation of computer vision, different types of gesture applications have been created [2]. The suggested system for recognizing gestures is based on a probabilistic framework that enables the effective identification of image regions associated with human hands by utilizing multiple information cues.

With the development of the current computing of things, the methods of a user's day-to-day interactions with mouse, keyboard, stylus, and more. not enough anymore [1,3]. Because of developments in computer vision, machine learning, and other forms of technology, the use of hands or hand gestures as input methods has grown in popularity. This technology allows users to connect with applications directly with their hands, allowing for more natural and immersive engagements. [9].

2.5. G. R. S. Murthy & R. S. Jadon, International Journal of Information Technology and Knowledge Management, 2009 [5]

The essence of presented paper is to introduce the automation era to gesture recognition as an intuitive method for interacting with them. Since the dawn of dependency & sudden infusion of machines in the society, it is widely considered as a thought that present modes of human-machine interactions with mouse's, keyboards & trackpads [1] will become a bottleneck in the effectively utilizing the flow of information between humans & machines. This technology has the capabilities of an artificially strong means allowing effective and natural interaction between humans & machines.

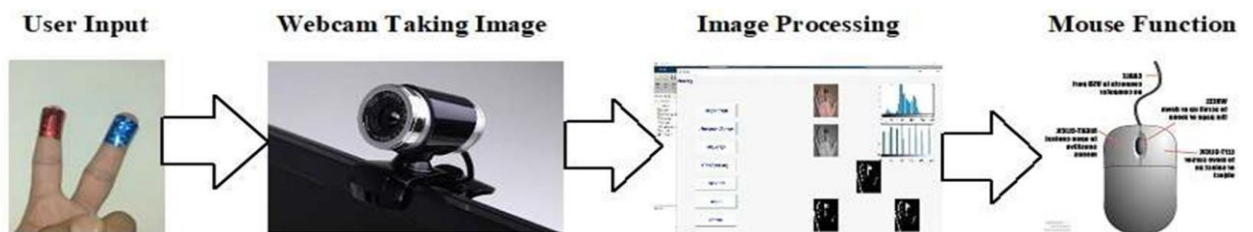


Fig. 4: Overview of system Human Computer Interaction

Visual elucidation of using hand gestures can help in achieving the simplicity and spontaneity envisioned for Human Computer Interaction (HCI) [10]. The area of computerized hand gesture analysis and interpretation using vision has become an extremely active research field, inspiring numerous researchers to delve deeper into its intricacies. We were able to develop a comprehensive gesture detection system that didn't depend on markers, making it easier to use, pleasant and cost effective. We wanted to give gestures that covered practically all areas of HCI, such as system functionalities.

Table 1: Comparative study of 5 Research Papers

PAPER TITLE	AUTHOR(S)	IDEA	CONCLUSION
[1] Vision Based Hand Gesture Recognition for Human Computer Interaction, Computer Science, 2013	Radhika Bhatt, Nikita Fernandes, A. Dhage	Reviewed several existing methods for supporting vision-based human-computer interaction based on the recognition of hand gestures.	Analysis of existing research on gesture recognition systems to facilitate effective and quick Human Computer Interaction (HCI), including categorizing it in different situations and enabling greater features.
[2] Recognizing hand gestures for human computer interaction	D. Singh	Understanding the significance of Human-Computer Interaction (HCI), specifically the skill to recognize gestures & objects using vision.	Novel approach that uses a video-capture device to control the laptop using gestures.

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[3] Vision Based Hand Gesture Recognition	S. S. Devkule, Lalit kumar, P. Khairnar	A brief comparison of vision-based hand motion techniques and their implementations as translator for humans using sign language for communication	To achieve the ultimate objective of enabling humans to interact with machines on their own terms naturally, it is necessary to conduct research on feature extraction, classification methods, and gesture representation.
[4] Hand Gesture Real Time Tool - Box	Vandit Gajjar, Viraj Mavani, Ayesha Gurnani	Directly using of hands or hand gestures as an input device is a method to attract people with providing the applications, through Machine Learning and Computer Vision, enhancing Human-computer interaction.	A technique for recognizing hand gestures using Machine Learning is introduced, which has led to the creation of various gesture applications utilizing Computer Vision.
[5] A review of Vision-based Hand Gestures	G. R. S. Murthy & R. S. Jadon	It is commonly assumed that the currently preferred method of computer interaction will become an impediment in the efficient use of the flow of data between machines and us. This is due to the ever-increasing proliferation of computers into society.	Without the use of any markers, it is possible to design an efficient gesture detection system that is more user-friendly and less expensive.

3. PROBLEM STATEMENT

The majority of our recent prior studies on gesture recognition utilized computer vision methods. Nevertheless, the effectiveness of these vision-based methods is highly dependent on the lighting conditions and camera orientation angle [11] which severely limits its applications in intelligent environments.

Human hand gestures can be used to take human-computer interaction to the next pedestal and reduce input hardware costs. Gesture images are extracted from the video and certain keyframes are selected based on a specific range of skin tone pixels present in these images [2,11]. In addition, these images as well as those captured by the webcam are processed and go through different stages such as image processing, hand tracking, hand gesture recognition, and such. In the upcoming sections, a comprehensive breakdown of each step will be provided for better understanding and clarity:

- Video processing: -
 A video file with the extensions “.mpg”, “.mpeg”, or “.avi” will be used for video processing. The video file that is selected is chosen from the several sets of videos [12]. Consequently, the video is viewed using a video reader, which reads all of the movie's constituent frames and saves each frame into a particular folder. In this assignment, a video clip will normally output 30 frames every second.
- Image acquisition: -
 Image Acquisition connects cameras to MATLAB, allowing vision-based hand gesture detection. Processing, backdrop acquisition, and synchronizing acquisition across many devices are all image acquisition modes[13]. After obtaining the image, multiple processing methods are used to the image in order to recognize the hand gesture.

4. FUTURE SCOPE

An efficient hand gesture recognition system has been developed to address the challenge of extracting frames from video and processing them. In a future context, diverse hand gestures can be accurately
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identified and utilized as input for computers. Furthermore, hand gestures representing numerical values can be converted into commands to execute relevant real-time tasks. Enhancing recognition capabilities under varying lighting conditions, which posed a significant obstacle, holds promising prospects in future research.

There has been an overview of vision-based hand gesture recognition systems given. Considering the relative youth of vision-dependent, amazing advancements have been accomplished [14]. To maintain this momentum, more research in the disciplines of feature extraction, classification algorithms, and gesture modelling is certainly required to achieve the absolute goal of people interacting on their individual organic terms with machines.

5. CONCLUSION

The ongoing research endeavour is still undergoing refinements and enhancements as it aims to generate commands based on the real-time motion of the palm, thereby making it more user-friendly. This progress paves the way for the development of an advanced gesture recognition system capable of interpreting intricate and sophisticated hand gestures.

Our research heavily leverages the potential of Machine Learning and OpenCV, enabling us to delve deeper into the realm of gesture recognition and manipulation. The integration of these technologies brings about significant benefits and advancements in our exploration.

The creation of orders based on the fluid movement of the hand is one fascinating potential outcome. Users would be able to engage with the software more naturally and fluidly as a result of this. We plan to expand our gesture recognition system to deal with complex and intricate motions by exploring various machine learning algorithms and harnessing the capabilities of OpenCV. This combination of technologies provides a strong foundation for our ongoing research endeavour.

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