

Hand Gesture Recognition with Switching and Mouse Movement Using MATLAB

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Abstract- The main aim of this project is to design a Virtual switch operating on hand gesture. The controlling device of the whole system is an AVR Microcontroller. Relay driver IC and web camera are interfaced to the AVR Microcontroller. The data received by the web camera is fed as input to the AVR Microcontroller. The controller makes a decision according to the hand gesture of user. Hence we can turn on or off any appliances which we have interfaced with our circuit. . The maneuver of mouse pointer and performs various mouse operations such as left click, right click, double click, drag etc using gestures recognition technique. Recognizing gestures is a complex task which involves many aspects such as motion modeling, motion analysis, pattern recognition and machine learning.

Index Terms- Digital Image Processing, Hand gestures Recognition, Switching, Mouse Movement, AVR, Relay, and MATLAB.

I. INTRODUCTION

This project work presents a prototype system that helps to recognize hand gesture to normal people in order to communicate more effectively with the special people. Aforesaid research work focuses on the problem of gesture recognition in real time that sign language used by the community of deaf people. The problem addressed is based on Digital Image Processing using Color Segmentation, Skin Detection, Image Segmentation, Image Filtering, and Template Matching techniques.

Controlling the Electrical Appliances and Electronic Gadgets through an Infrared Remote Control is now in general. But the same controlling tasks can be done more easily. Primary motive of proposing the new system of Virtual Switch Control is to remove the need to look in to the hand held remote and to

search for a specific key for specific function. Here we present a novel system to control Various Appliances by just using hand gestures recognition like showing first finger will switch the first device. It uses real time image processing for hand gestures Recognition using a simple web-camera and microcontroller based embedded system.

This project proposes a possible solution to control the gadgets for physically challenged or people in industries, who can not touch electric panels too often during their work, so better they just by showing hand gestures, devices get controlled. There will be a computer application designed in MATLAB to have a real time image processing.

To move the mouse cursor on the screen without using hardware such as a mouse and only by moving the cursor through finger movements i.e. the process of gesture recognition. In this paper, we present a novel approach for Human Computer Interaction (HCI) where cursor movement is controlled using a real-time camera.

SIXTH SENSE TECHNOLOGY

All of us are aware of the five basic senses - seeing, feeling, smelling, tasting and hearing. But there is also another sense called the sixth sense.

Sixth Sense is a gesture-based wearable computer system developed at MIT Media Lab by Steve Mann in 1994 and 1997 (headworn gestural interface), and 1998 (neckworn version), and further developed by Pranav Mistry (also at MIT Media Lab), in 2009, both of whom developed both hardware and software for both headworn and neckworn versions of it. It comprises a headworn or neck-worn pendant that contains both a data projector and camera.

Headworn versions were built at MIT Media Lab in 1997 (by Steve Mann) that combined cameras and

illumination systems for interactive photographic art, and also included gesture recognition (e.g. finger-tracking using colored tape on the fingers).

Sixth sense technology is a set of wearable devices that acts as a gestural interface between the physical and digital world. Sixth Sense is a wearable gestural interface that augments the physical world around us with digital Information and lets us use natural hand gestures to interact with that information. The Sixth Sense prototype implements several applications that demonstrate the usefulness, viability and flexibility of the system.

II HARDWARE

WEB CAMERA



Fig (1) – Web Camera

A webcam is a video camera that feeds or streams its image in real time to or through a computer to a computer network. When "captured" by the computer, the video stream may be saved, viewed or sent on to other networks travelling through systems such as the internet, and e-mailed as an attachment. When sent to a remote location, the video stream may be saved, viewed or on sent there. Unlike an IP camera (which connects using Ethernet or Wi-Fi), a webcam is generally connected by a USB cable, or similar cable, or built into computer hardware, such as laptops. It is used to capture the images of the gestures which are further processed and used as commands by the system. Sensitivity of the mouse totally depends on the resolution of the camera. The webcam serves the purpose of taking real time images whenever the computer starts. On the basis of gestures and motion of fingers, system will decide the respective action.

ARDUINO UNO

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or breadboards (shields) and other

circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.



Fig (2) - Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

RELAY CIRCUIT

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they

repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.



Fig (4-a) -- Relay switch

Relays are switches that open and close circuits electromechanically or electronically.

Relays control one electrical circuit by opening and closing contacts in another circuit. A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays used are equal to devices used for switching. Relay is a device used for switching of AC appliances. Relay drivers IC is used for driving of Relays.

COLOR CAPS

They are primary requirement of user. Different color markers are used for different commands. Due to the clear distinction of the colors it will be faster and easier for the algorithm to process. Color caps have been used for fingers to distinguish it from the background color such as skin color. Thus recognizing the gestures various mouse events have been performed.



Fig (5.b) -- Selecting the color during snapshot

The proposed approach is based on detection of number of target colors (region of interest) that triggers the mouse event according to the gesture formed. At the beginning, snapshot is taken while keeping the hand in front of the camera. The user then selects the color cap which will be tracked during gesture formation to perform various mouse events. The color of cap can be varied and needs to

be selected when the snapshot of hand is taken as shown in fig (5.b).

USB to TTL SERIAL CABLE



Fig (6) -- USB to TTL Serial cables

The USB TTL Serial cables are a range of USB to serial converter cables which provide connectivity between USB and serial UART interfaces. A range of cables are available offering connectivity at 5V, 3.3V or user specified signal levels with various connector interfaces.

3.3V USB to TTL Serial Converter. Use this device to connect your PC to a serial (TTL level) device. Uses CP2102 chipset and has a standard 0.1" pitch terminal strip to connect directly to UART or I/O pins for easy access to your MCU. You can use this to program your Arduino Mini or ESP-12 Works at 3.3V UART Levels.

III SOFTWARE

MATLAB software

It is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

- Math and computation
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including Graphical User Interface building.

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include: Application development, including Graphical User Interface building.

Why should we use MATLAB (Matrix Laboratory)-? - MATLAB has several advantages over other methods or languages: Its basic data element is the matrix. Several mathematical operations that work on arrays or matrices are built-in to the MATLAB environment.

Image Processing Toolbox:-

Image Processing Toolbox provides a comprehensive set of reference-standard algorithms and workflow apps for image processing, analysis, visualization, and algorithm development. You can perform image segmentation, image enhancement, noise reduction, geometric transformations, image registration, and 3D image processing.

Image Processing Toolbox apps let you automate common image processing workflows. You can interactively segment image data, compare image registration techniques, and batch-process large data sets. Visualization functions and apps let you explore images, 3D volumes, and videos; adjust contrast; create histograms; and manipulate regions of interest (ROIs).

Image Acquisition Toolbox:-

Image Acquisition Toolbox provides functions and blocks that enable you to connect industrial and scientific cameras to MATLAB and Simulink. It includes a MATLAB app that lets you interactively detect and configure hardware properties. The toolbox enables acquisition modes such as processing in-the-loop, hardware triggering, background acquisition, and synchronizing acquisition across multiple devices.

Image Acquisition Toolbox supports all major standards and hardware vendors, including USB3 Vision, GigE Vision, and Genicom Gentle. You can connect to 3D depth cameras, machine vision cameras, and frame grabbers, as well as high-end scientific and industrial devices.

IV. DESIGN PROCEDURE

Input: Hand gesture. Output: Assigned action executed. Step I: Image capturing: Capture the input image from camera. Image will be taken as final if it has been occurred for 3 consecutive frames.

Step II: conversion of Image: Image captured by camera is in the RGB format, hence it is converted into gray image for processing.



Fig (7) -- RGB-gray conversion

Step III: Image pre-processing Image pre-processing is performed in which boundary detection, contrast enhancement; noise elimination, etc. are carried out.

Step IV: Extraction of marker color (Red) In order to extract the region of interest i.e red color finger, gray scale image is subtracted from red image. [Red image Gray scale image=Region of interest].

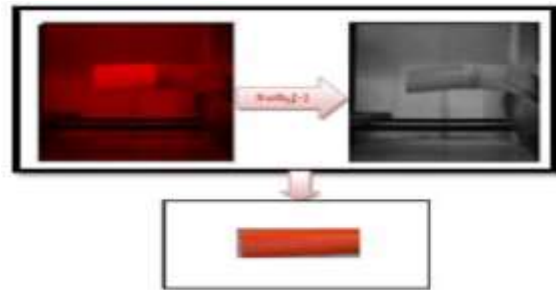


Fig (8) -- Extraction of marker color (red)

Step V: Thresholding process- Finally,user hand gesture get converted as white color and background as black color by using thresholding process. In thresholding, pixels having value greater than 110 will be decoded as 1(white) and pixels having value less than 110 will be decoded as 0(black background) as shown in figure.

| Threshold value | Pixel value | Pixel color |
|-----------------|-------------|-------------|
| 0-110 | 0 | Black |
| 110-255 | 1 | White |

Table (1) -- Thresholding process



Fig (9) -- GUI image

This image is processed for device switching. Hence, device get switched on the basis of object present in GUI image. Ex. If there is one object in GUI image, then device 1 will get switched.

FLOW CHART

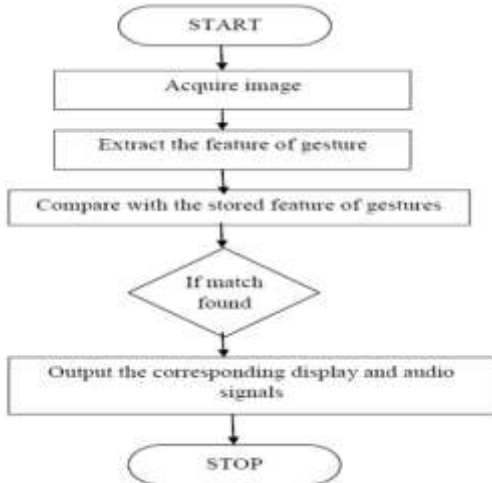


Fig (10) -- Flow Chart Of The System

The software run in a mobile or laptop having a frontal camera while a disabled person (who is in the front of the mobile or laptop) makes the signs This software recognizes these gestures of sign language, including letters and a subset of its words and produces text message for corresponding word or letter for normal people to understand Or perform that works which was assigned to the recognized latter.

CIRCUIT DIADRAM

Circuit of this project is very easy. Here we have used an Arduino UNO board and Relay Driver for driving relays. Three 5 volt SPDT relays are connected to arduino pin number 3, 4 and 5, through relay driver ULN2003, for controlling LIGHT, FAN and MP3 player. Circuit is connected to the laptop or computer by using USB to TTL converter cable.

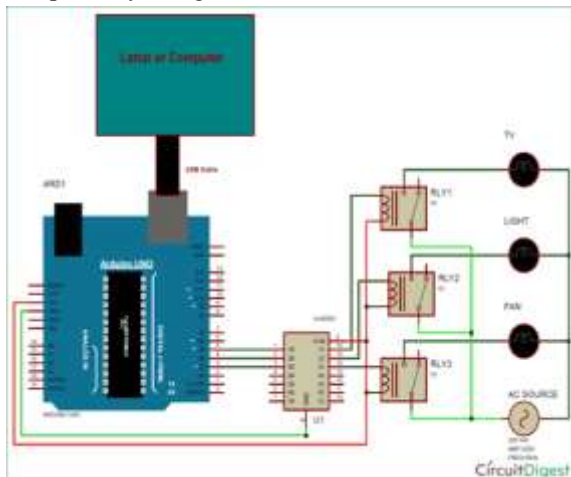


Fig (11) -- Circuit diagram of the system

ADVANTAGES

- Using color cap we can centralize the pc such as controlling volume , PPT etc
- Lower the communication barrier between the mute communities with the general public.
- Physically challenged or people in industries, who cannot touch electric panels too often during their work.
- Useful for deaf and dumb people.
- We can turn on or off any appliances which we have interfaced with our circuit.
- Industry, in home automation and for smart office also, it is very advantageous because of its durability, easy operation.

DISADVANTAGES

- Visibility issue may arise due to several reasons For instance, the camera where the user has to stay in position,
- The various environmental condition like lighting sensitivity, background color and condition, electric or magnetic fields or any other disturbance may affect the performance.

V. APPLICATION.

MP3 Controller:- With hand gestures we will recognize the alphabet and the task of playing MP3 player gave to that alphabet will perform the task.
 Centralization of PC:- The technique to perform numerous mouse operations thus obviating the need of hardware used for interaction between the user and computing device. The same approach can be applied to endless tasks such as browsing images, playing games, changing T.V channels etc.
 Control AC Appliance:- The controller makes decision according to the hand gesture of user. Hence we can turn on or off any appliances which we have interfaced with our circuit. Hand gesture controlled keyboard and mouse to interact with computer. Gesture controlled appliances like air conditioner.

VI. FUTURE SCOPES

Future works will include better methods for implementing mouse events and reducing the lag to almost zero during cursor movement. More features

such as zoom in, zoom out, shut down etc will be implemented.

In future automation will play an increasingly important part in the global economy and also in daily experience. At present, the purpose of automation has shifted from growing productivity and reducing costs to broader issues. For example: increasing quality and flexibility in the engineering process. Until now many projects have been designed in the field of automation by using android, Bluetooth technology, GSM etc. In the future this technology will commonly using technology in different fields such as medical field, industrial field, and in communication fields.

VII. CONCLUSION

The system architecture that has been proposed will completely change the way people would use the Computer system. Presently, the webcam, microphone and mouse are an integral part of the Computer system. This project will completely eliminate the necessity of mouse. Also this would lead to a new era of Human Computer Interaction (HCI) where no physical contact with the device is required. The use of object detection and image processing in MATLAB for the implementation of our proposed work proved to be practically successful and the movement of mouse cursor is achieved with a good precision accuracy.

The statistic of result of the implementation, it is therefore, concluded that the method is used for template matching and color segmentation work with high accuracy with hand gesture recognition

The results obtained are applicable, and can be implemented in a laptop. Finally, in this way, GUI image get processed and device will get switched according to the number of objects present in GUI window.

VIII. RESULTS

The purpose of this application is to recognize hand gesture. The design is very simple and the signer doesn't need to wear any type of hand gloves. Although this sign language recognition application can be run in an ordinary computer having a web camera, but ideally it requires Android Smart phone having frontal camera with at least 1GHz processor and at least 514MB RAM.

The algorithm can detect all the alphabets from A to Z with 100% recognition rate if the signer supplies the correct sign.

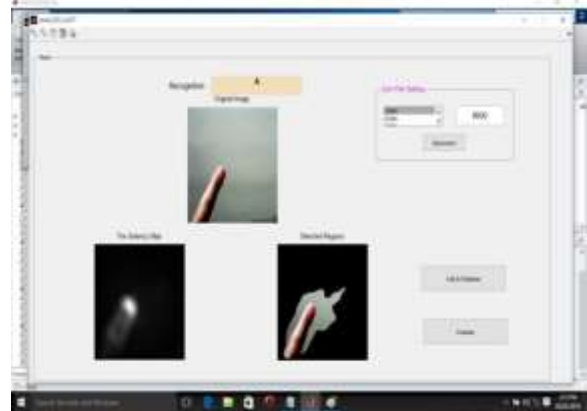


Fig (12-a) -- Result of Sign Recognition



Fig (12-b) -- Result of Green Color For Mouse Rotation



Fig (12-c) -- Result of Red Color For Mouse Double Click



Fig (12-d) --Result of Recognition and Switching AC Appliance

In our implementation the background is strictly black because shadow does not add noise in the image under the adequate light condition. We have chosen the input images as gray scale so as to save the time of conversion. The result of our implementation is shown in the figures. It consists of four figures A to D which will change state of the devices 1-4 as ON/OFF respectively depending on the gesture shown.

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