Raspberry Pi Based Gesture Photography

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Abstract: In this paper, we introduce a way to eliminate the traditional way of information access, storage and manipulation i.e. the information from paper, screen and digital storage. Although there have been many advancements in technologies that enables us to connect the digital world to physical world, there aren't any technologies as of now which bridge the gap between the digital world and physical interaction with the real world. Our paper aims to bridge this gap. We make use of Raspberry Pi hardware as the heart of the device and a USB camera to capture images from the real world. The camera captures images based on hand gestures; manipulates it and stores the final image in the main workstation which is connected via the Wi-Fi network. Hence, this technology allows us to interact with digital information using hand gestures.

Keywords: Gesture recognition, Computer Vision, Wearable interface, Hand Gesture Interface.

I. INTRODUCTION

In this paper, we present a computer-vision based wearable and gestural information interface that augments the physical world around us with digital information and also proposes natural hand gestures as the mechanism to interact with the information. We here do not aim to present an alternative to mobile based cameras or SLR based cameras, but rather to research on a not seen before technology, free-hand gestural interaction with the real world that this work proposes.

A USB camera connected to the Raspberry Pi hardware, which forms a pendant like wearable device; allows the computer to see the real world. The Raspberry Pi hardware is connected to a router network via a Wi-Fi module.

This enables the hardware to be connected to the outer world and also enables the captured image to be sent from one device to another within this network. Since the file transfer can occur only within the connected workstations, this enables authenticity and privacy simultaneously.

II. IMAGE PROCESSING TECHNIQUE

A digital image processing algorithm usually constitutes: input, processor and output (Fig. 1). The image is captured by USB camera in the input stage, sent to the raspberry pi board for processing, and then its output is produced and stored in a particular location in the Micro SD card.
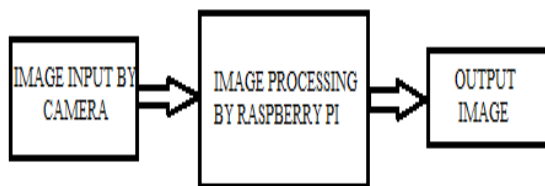

Fig. 1: Image Processing Block diagram.

We make use of Python programming language and Open CV application library for image processing. Open CV is an application library in python that is very similar to MATLAB Image Processing, but without any GUI.
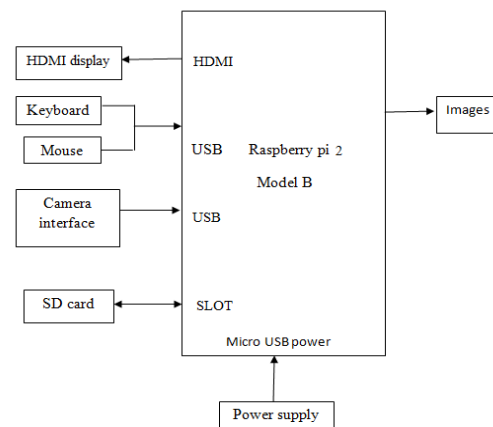
III. HARDWARE DESIGN

Fig. 2: System Block Diagram

The Raspberry Pi board is the central processing unit which is responsible for image capturing, gesture recognition, image processing and sending the final processed image to the required workstations. We make use of the USB interface to connect with different components such as USB camera, Wi-Fi module, mouse and keyboard (Fig. 2). It can also be connected to an external display using the HDMI slot provided.

A. The Raspberry Pi Hardware

The Raspberry Pi hardware (Fig. 3) belongs to a class of single-board computer (SBC) which is a computer built on a single small circuit board, with microprocessor(s), memory (M), built-in input/output (I/O) ports and other basic features required in a functional computer. It is a credit card-sized single board computer (SBC) developed by the Raspberry Pi Foundation. The Raspberry Pi 2 model B is the latest released version, based on the Broadcom BCM2836 Arm7 Quad Core Processor system on a chip (SOC) running at 900 MHz, 1GB LPDDR2 extended RAM, Fully HAT (Hardware Attached on Top) compatible, 40pin GPIO, ability to connect a Raspberry Pi camera and touch screen display (each sold separately),

10/100 Ethernet Port and a Micro SD slot for storing information and loading operating systems.

The device runs smoothly when connected with a 5V 2A power adapter, which can be a good mobile charger too. The system runs on Raspbian Linux, Ubuntu Mate or NOOBS (New Out Of The Box Software) operating systems which are available for download. Python, one of the powerful programming languages is for the Raspberry Pi programming. Open CV (Open Computer Vision) application library is used in python for image processing technique. This application enables us to edit, cut, crop, resize etc. to an image, similar to that of MATLAB Image Processing.
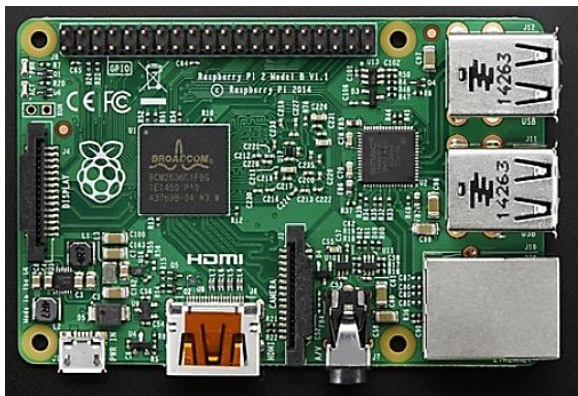

Fig. 3: The Raspberry Pi 2 model B

B. The Camera Interface

We make use of USB camera (webcam) for capturing images from the external world (Fig. 4). This type of camera is used instead of Raspberry Pi camera for the work to be cost effective and the former also provides sufficient cable length compared to the later. The camera module is plugged into the Pi and it captures 20MP clear resolution images, which is suffice for general applications.

Fig. 4: An USB camera for Image capture

IV. DESIGN METHODOLOGY

Once all the required peripherals are obtained, the raspberry pi can be initialized and the required operating system can be installed.
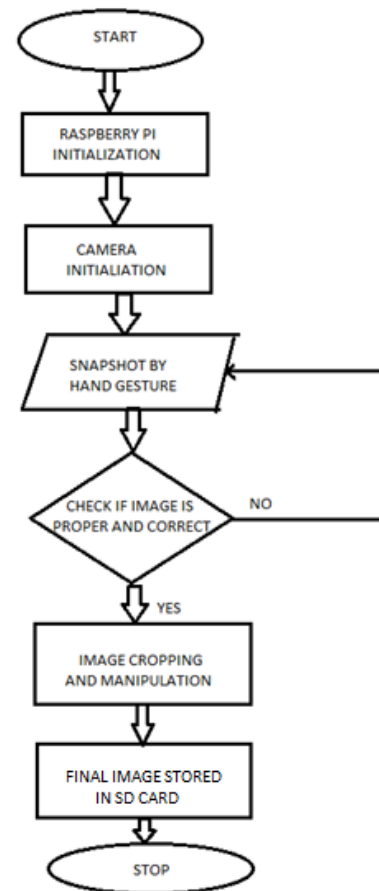

Fig. 5: Proposed System Flow Chart

After installing the OS and rebooting to the raspberry Pi desktop, we need to update the OS by connecting to the internet either via Ethernet or by Wi-Fi module. Since python is used here for programming, we need to upgrade that too and install all the required packages such as Scipy, Numpy and Matplotlib etc. The step by step process for installing each application can be found in the internet. Here is a list of some of the installation commands used:

1. sudo apt-get update
2. sudo apt-get upgrade
3. sudo apt-get install fswebcam
4. sudo apt-get install libopencv-dev python-opencv
5. sudo apt-get install build-essential cmake –j4
6. sudo apt-get install python-numpy
7. sudo apt-get install python-scipy

Once all the required software and applications have been installed without error, the system is ready to run. Running the python code will capture an image and store it in a particular location in the SD card. Then this image is taken by the Open CV library to identify the gesture used.

If a correct gesture for photography is identified, the system will crop the image as required and then manipulate it and store the final image in a particular location in the SD card. The captured image can then be manually transferred to a remote workstation via the Wi-Fi module. The proposed method implementation is as shown in the flow chart (Fig. 5).

V. RESULT AND DISCUSSION

For real time simulation purpose, we used the latest updated NOOBS OS with an updated version of python 2.7 and Open CV 3.0 for yielding the best results. Figure 6 to figure 11 gives the complete work for capturing and cropping an image and then storing it in a particular location. We make use of colour markers attached to our fingers, so as to identify the gesture and the computer automatically crops he image. We use green, red and yellow colour markers in our system for colour marker identification. However the choice of colour depends on the user's interest. The whole image is masked for green, red and yellow and then cropped.
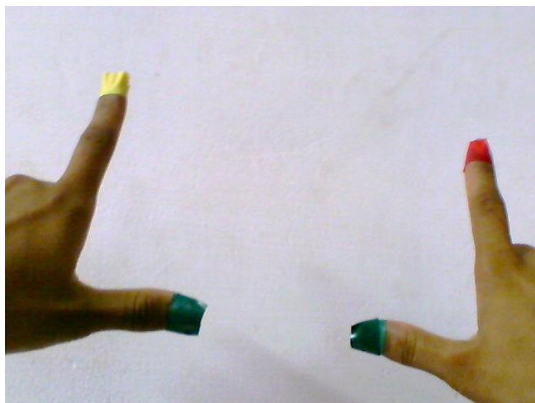

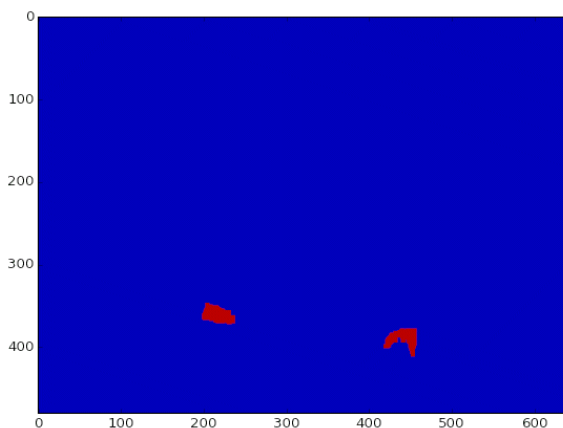Fig. 6: Original captured Image

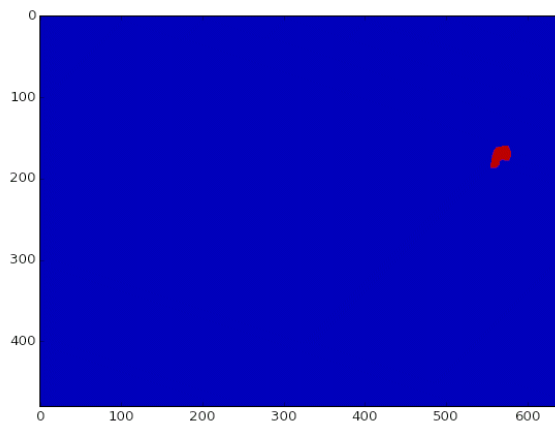Fig. 7: Image Masked with Green

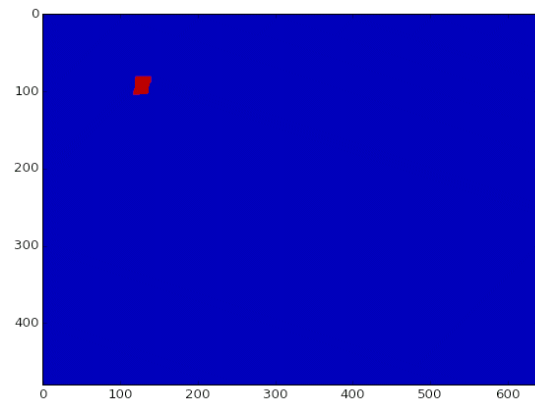Fig. 8: Image Masked with Red

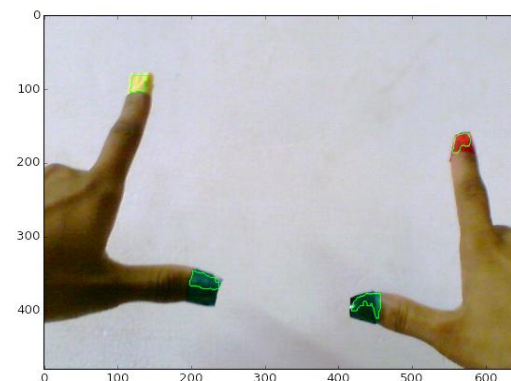

Fig. 9: Image Masked with Yellow

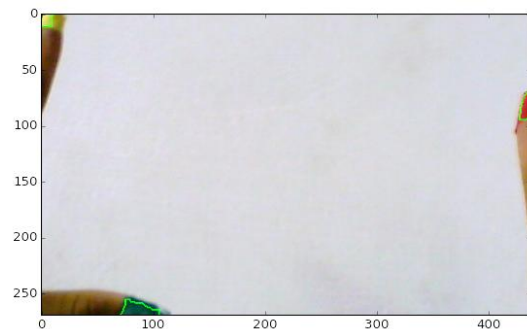Fig. 10: Regions within green border needs to be cropped

Fig. 11: Final cropped enhanced image to be stored

The image is captured with a resolution of 640x480 and the RGB value of each pixel in the captured image is extracted. The image is stored in the form of an array and the whole image is masked individually for RGB values of Red, Green and Yellow. Each pixel in the original image is compared with the given RGB values so as to obtain the masked region. Then the image is automatically cropped within the masked region. The final image is then stored in particular location in SD card for transferring when required.

To transfer the captured image via the Wi-Fi module, one can use any application that allows FTP (File Transfer Protocol). This work uses two applications, PuTTY and WinSCP. PuTTY session is used to obtain the Raspberry Pi's desktop remotely and to run the commands in terminal remotely while WinSCP allows files to be

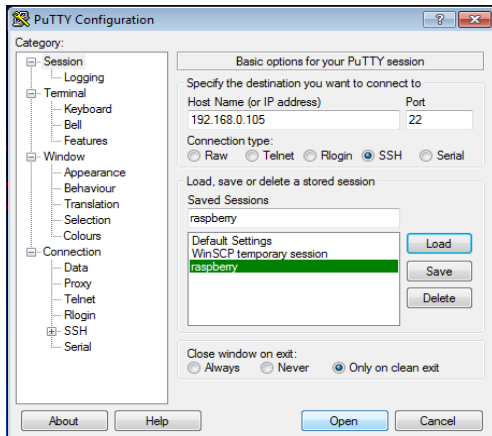transferred remotely. Using WinSCP, one can synchronize the folders in remote directory and local directory.

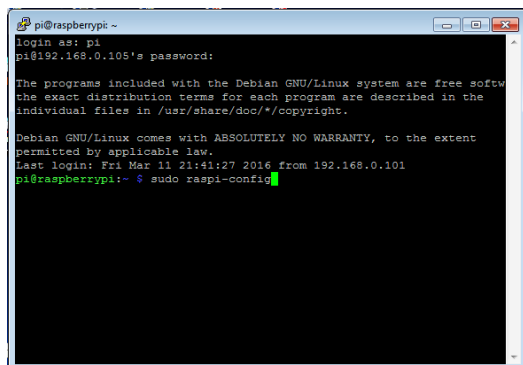
Fig. 12: PuTTY Configuration Screen
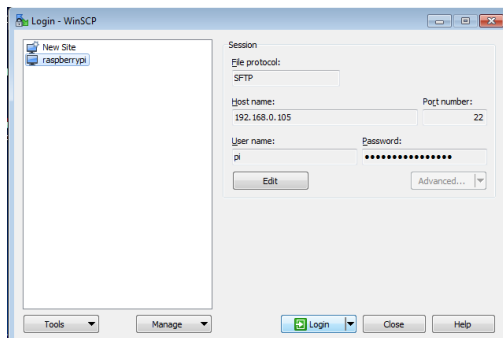

Fig. 13: PuTTY Session after Login
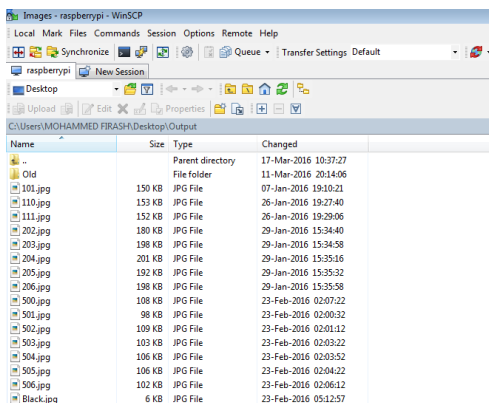

Fig. 14:WinSCP Login Screen

Fig. 15: WinSCP Session after Login

VI.   CONCLUSION

We implemented an algorithm to capture an image from the real world using hand gestures and then input it to the computer for cropping and other improvements and to transfer the final image to remote workstation when required. It was found that the algorithm developed for Raspberry Pi executed successfully and hence can be used for wide variety of applications in the near future.

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BIOGRAPHIES

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