Real Time Object Detection Using Raspberry Pi

R.Sudarshan[1], U.Pradeep[2], V.Hariprasath[3], Mrs.B.Elakkiyachandran[4]
[1, 2, 3] Dept of ECE
[4]assistant Professor, Dept of ECE
[1, 2, 3, 4] Veltech Hightech Engineering College, Avadi, Chennai-600062

Abstract- *The aim of this thesis is to explore different methods for helping computers interpret the real world visually, investigate solutions to those methods offered by the open-sourced computer vision library, OpenCV, and implement some of these in a Raspberry Pi based application for detecting and keeping track of objects. The main focus rests on the practical side of the project.*

The result of this thesis is a GNU/Linux based C/C++ application that is able to detect and keep track of objects by reading the pixel values of frames captured by the Raspberry Pi camera module. The application also transmits some useful information, such as coordinates and size, to other computers on the network that send an appropriate query. The source code of the program is documented and can be developed further.

Keywords- Raspberry pi,GNU/Linux, camera module, Python

I. INTRODUCTION

The goal of object detection is to detect all instances of objects from a known class, such as people, cars or faces in an image. Typically only a small number of instances of the object are present in the image, but there is a very large number of possible locations and scales at which they can occur and that need to somehow be explored. Each detection is reported with some form of pose information. This could be as simple as the location of the object, a location and scale, or the extent of the object defined in terms of a bounding box. In other situations the pose

Information is more detailed and contains the parameters of a linear or non-linear transformation.

For example a face detector may compute the locations of the eyes, nose and mouth, in addition to the bounding box of the face.

Related Works

In the existing system, object recognition can be done using any of the Image processing Algorithm like SIFT, SURF. But that kind of techniques has lots of limitations, make more difficult to recognize the object.

Since the development of technology, the application for latest technology has been growing exponentially. But even with modern technologies, we sometimes fail to see the basic requirement for many sections of the society. Navigating tools for blind is one among the many. But recent trends show various development in blind navigation-based system for people and wearables are making an entry into the market.
Countries like US, Australia, Canada, New Zealand are still using guide dogs for partially impaired or fully blind people, where they use dogs to guide them to the destination. With Cloud computing and Machine learning improvising every day, it can pathway to build latest gadget for blind to navigate freely. Most of the blind navigation system involves ultrasounds .

All blind navigation system as far as now work on the principle of sound reflection using ultrasounds. Sonic Pathfinder, Mowat-Sensor, and Guide-Cane are called obstacle detectors or clear path indicators since the blind can only know whether there is an obstacle in the path ahead. These devices are used to search for obstacles in front of the blind person, and they operate in a manner similar to a flashlight, which has very narrow directivity.

SonicGuide and NavBelt , however, are called an environment sensor since it has wide directivity enabling it to search for several obstacles at the same time.

The motivation of this project was to develop a portable navigation aid for blind pedestrians coupled with human identification. The most widely used primary mobility aid today is the long cane. This has several limitations such as a range limited sensor, typically one pace ahead of the user, difficulties detecting overhanging obstacles, and difficulties storing in public places .

Proposed System

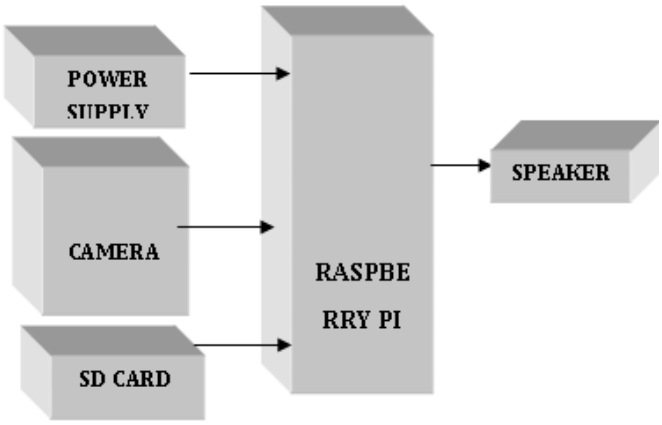
In this project, the suggested navigation system involves a microprocessor with speech output. It is a self-contained portable electronic unit. It can supply the blind

person with assistance about walking routes by using spoken words to point out any obstacles or person standing in front of them. On the other hand, and in order to overcome the imperfections of existing electronic travel aids, the proposed not only looks out for objects but also does a facial recognition of people and try to map them to existing database for identification.

SYSTEM WORKING

The system consists of a high definition Raspberry pi camera module, Raspberry pi running Raspbianoswith Python 3.9, Haptic feedback speaker. Initially, camera is used for object detection, which uses computer vision for that purpose. Upon finding an object, that object is then captured by the camera for further analysis. These analyses include human recognition, where the captured image is analyzed for facial features and if found to be human face, then it is say human with accuracy percentage. The part where obstacles are detected include, These signals are strong enough to detect objects within 2 meter and as low as 2 cm. It starts off by sending a pulse wave of ultrasound.

Block Diagram



II. HARDWARE & SOFTWARE DESCRIPTION

- RASPBERRY PI 3 B+
- SD CARD
- POWERSUPPLY UNIT
- CAMERA
- HEADPHONE
- CONNECTING WIRES
- SOLDERING KIT

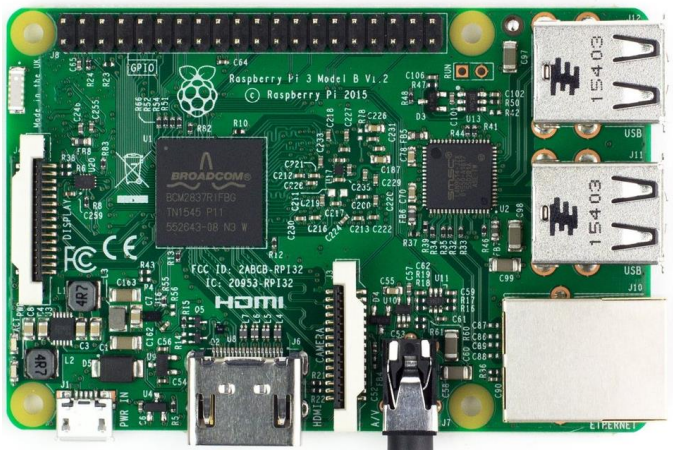
Software

- PYTHON
- LINUX OS

RASPBERRY PI 3

DESCRIPTION

The Raspberry Pi 3 Model B is the third generation Raspberry Pi. This powerful credit-card sized single board computer can be used for many applications and supersedes the original Raspberry Pi Model B+ and Raspberry Pi 2 Model B.



Whilst maintaining the popular board format the Raspberry Pi 3 Model B brings you a more powerful processer, 10x faster than the first generation Raspberry Pi. Additionally it adds wireless LAN & Bluetooth connectivity making it the ideal solution for powerful connected designs.

FEATURES

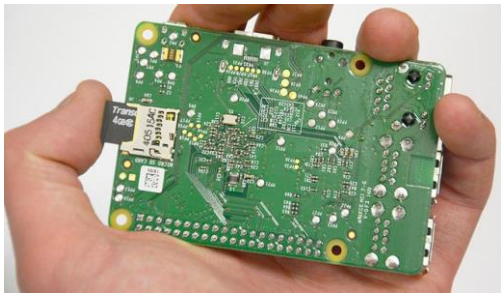
- A 1.2GHz 64-bit quad-core ARMv8 CPU
- 802.11n Wireless LAN
- Bluetooth 4.0
- Bluetooth Low Energy (BLE)
- 1GB RAM
- 40 GPIO pins
- Ethernet port

SD CARD PORT

DESCRIPTION

- Secure Digital (SD) cards are removable _ash-based storage devices that are gaining in popularity in small consumer devices such as digital cameras, PDAs, and portable music devices. Their small size, relative simplicity, low power consumption, and low cost make them an ideal solution for many applications.

- This application note describes the implementation of an SD Card interface for the Texas Instruments MSP430, a low-power 16-bit microcontroller . This interface, combined with the MSP430, can form the foundation for a low-cost, long-life data logger or media player or recorder.



The SD card standard is a standard for removable memory storage designed and licensed by the SD Card Association . The SD Card standard is largely a collaborative e_ort by three manufacturers, Toshiba, SanDisk, and MEI and grew out of an older standard, MultiMediaCard (MMC). The card form factor, electrical interface, and protocol are all part of the SD Card speci_cation. The SD standard is not limited to removable memory storage devices and has been adapted to many di_erent classes of devices, including 802.11 cards,Bluetooth devices, and modems

SD CARD PIN DETATILS

The SD 1-bit protocol is a synchronous serial protocol with one data line, used for bulk data transfers, oneclock line for synchronization, and one command line, used for sending command frames. The SD 1-bit protocol explicitly supports bus sharing. A simple single-master arbitration scheme allows multiple SD cards to share a single clock and DAT0 line.

The SD 4-bit protocol is nearly identical to the SD 1-bit protocol. The main di_erence is the bus width _ bulk data transfers occur over a 4-bit parallel bus instead of a single wire. With proper design, this has the potential to quadruple the throughput for bulk data transfers. Both the SD 1-bit and 4-bit protocols by default require CRC protection of bulk data transfers. A CRC, or Cyclic Redundancy Check, is a simple method for detecting the presence of simple bit-inversion errors in a transmitted block of data.

In SD 4-bit mode, the input data is multiplexed over the four bus (DAT) lines and the 16-bit CRC is calculated independently for each of the four lines. In an all-software implementation, calculating the CRC under these conditions can be so complex that the computational overhead may mitigate the bene_ts of the wider 4-bit bus. A 4-bit parallel CRC is trivial to implement in hardware, however, so custom ASIC or programmable-logic solutions are more likely to bene_t from the wider bus.

BLOCK READ

The block read command is a bulk data command. The command response is followed by a delay, then followed by a _start of block_ token, and then followed by the actual block itself.

In order to make the most efficient use of resources and enable fast block transfers, the block read function uses the DMA (Direct Memory Access) controller on the MSP430. First, the command is sent and the response is received. Then, the function waits until the start token is received. When it is received, the function starts a DMA transfer. Since SPI requires that a byte be sent for a byte to be received, two DMA units are used to complete the transfer.

DMA0 is triggered by a UART receive. The source for the DMA transfer is the USART receive buffer, U0RXBUF.

The source is set to byte-wide, no increment. The destination for the DMA transfer is the data buffer. Thedestination is set to byte-wide, with an increment. The count is fixed at 512, the default block size for a typicalSD card.

DMA1 is also triggered by a UART receive. The source for this register is a constant 0xFF (the idle bus condition).

The output is the USART transmit buffer, U0TXBUF.

DMA priorities ensure that a byte will be received before a new 0xFF (idle byte) is sent. Since both DMA unitsuse the same trigger, DMA0 will always be serviced before DMA1.

Finally, the receive and transmit interrupt flags are reset and the entire block transfer is triggered by manuallysending a single idle byte.

The function sd_read_block() implements the block read. The function will return immediately and normal program execution can continue while the block transfer finishes. sd_wait_notbusy() can be used to synchronouslywait for any pending block transfers to finish.

BLOCK WRITE

The block write is similar to the block read function in that it uses a DMA transfer and also starts with a datatoken. However, since no bytes need to be received during the block transfer, the block transfer only requires oneDMA trigger
.

DMA0 is triggered by a UART send. The destination for the DMA transfer is the USART receive buffer,U0RXBUF. The destination is set to byte-wide, no increment. The source for the DMA transfer is the data buffer. The source is set to byte-wide, with an increment. The count is fixed at 512, the default block size for a
typical SD card.

Finally, the receive and transmit interrupt flags are reset and the entire block transfer is triggered by manuallysending a single idle byte.

The function sd_write_block() implements the block write. The function will return immediately and normalprogram execution can continue while the block transfer finishes. sd_wait_notbusy() can be used to synchronously wait for any pending block transfers to finish.

PI CAMERA PORT

DESCRIPTION

The Raspberry Pi camera module can be used to take high-definition video, as well as stills photographs. It's easy to use for beginners, but has plenty to offer advanced users if you're looking to expand your knowledge. There are lots of examples online of people using it for time-lapse, slow-motion and other video cleverness. You can also use the libraries we bundle with the camera to create effects.

If you're interested in the nitty-gritty, you'll want to know that the module has a five megapixel fixed-focus camera that supports 1080p30, 720p60 and VGA90 video modes, as well as stills capture. It attaches via a 15cm ribbon cable to the CSI port on the Raspberry Pi. It can be accessed through the MMAL and V4L APIs, and there are numerous third-party libraries built for it, including the Pi camera Python library.
The camera module is very popular in home security applications, and in wildlife camera traps.

PI CAMERA

The Raspberry Pi Camera Module is a 5MP CMOS camera with a fixed focus lens that is capable of capturing still images as well as high definition video. Stills are captured at a resolution of 2592 x 1944, while video is supported at 1080p at 30 FPS, 720p at 60 FPS and 640x480 at 60 or 90 FPS.The camera is supported in the latest version of Raspbian, Raspberry Pi's preferred operating system.

HDMI PORT

DESCRIPTION

- HDMI (High-Definition Multimedia Interface) is a proprietary audio/video interface for transmitting uncompressed video data and compressed or uncompressed digital audio data from a HDMI-compliant source device, such as a display controller, to a compatible computer monitor, video projector, digital television, or digital audio device. HDMI is a digital replacement for analog video standards.
- HDMI provides an interface between any audio/video source, such as a set-top box, DVD player, or A/V receiver and an audio and/or video monitor, such as a digital television (DTV), over a single cable. HDMI supports standard, enhanced, or high-definition video, plus multi-channel digital audio on a single cable

USB PORTS

DESCRIPTION

The Raspberry Pi Model B is equipped with two USB2.0 ports. These are connected to the LAN9512 combo hub/Ethernet chip IC3, which is itself a USBdevice connected to the single upstream USB port on BCM2835. On the Model A, the single USB2.0 port is directly wired to BCM2835.

AUDIO JACK

DESCRIPTION

The Model B+ features a new 3.5mm audio jack which also includes the composite video signal. This has allowed for the removal of the composite video socket found on the Model B.

The new jack is a 4-pole socket which carries both audio and video signals and is often found on other multimedia devices such as iPods, MP3 players and smartphones. It now used on the A+, B+, Pi 2 and Pi3.

AUDIO JACK PORT

This style of connector is sometimes referred to as "TRRS", which stands for "Tip-Ring-Ring-Sleeve".

Cables are readily available but they don't all follow the same standard so you need to be careful before assuming it will work with your Pi.

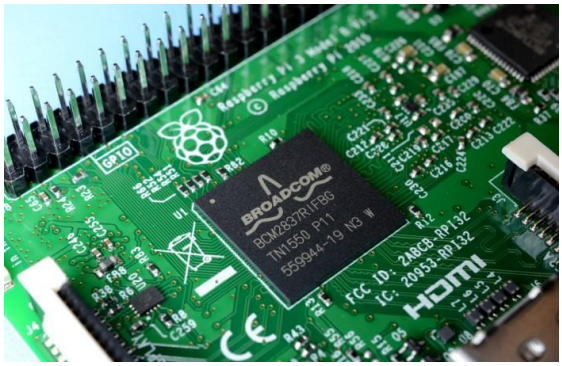
The good news is that many will still work but you may need to swap the video cable for one of the audio channels. Cables where the ground connection is different are the ones that should be avoided.

BROADCOM BCM 2835 PROCESSOR

DESCRIPTION

The Broadcom BCM2835 SoC used in the first generation Raspberry Pi is somewhat equivalent to the chip used in first generation smartphones (its CPU is an older ARMv6 architecture), which includes a 700 MHz ARM1176JZF-S processor, VideoCore IV graphics processing unit (GPU), and RAM.

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundationto promote the teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside of its target market for uses such as robotics. Peripherals (including keyboards, mice and cases) are not included with the Raspberry Pi. Some accessories however have been included in several official and unofficial bundles



The Broadcom BCM2835 SoC used in the first generation Raspberry Pi is somewhat equivalent to the chip used in first modern generation smartphones (its CPU is an older ARMv6 architecture),[19] which includes a 700 MHz ARM1176JZF-S processor, VideoCore IV graphics processing unit (GPU),[20] and RAM. It has a level 1 (L1) cache of 16 KB and a level 2 (L2) cache of 128 KB. The level 2 cache is used primarily by the GPU. The SoC is stacked underneath the RAM chip, so only its edge is visible.

The Raspberry Pi 2 uses a Broadcom BCM2836 SoC with a 900 MHz 32-bit quad-core ARM Cortex-A7 processor, with 256 KB shared L2 cache.[21]

The Raspberry Pi 3 uses a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache

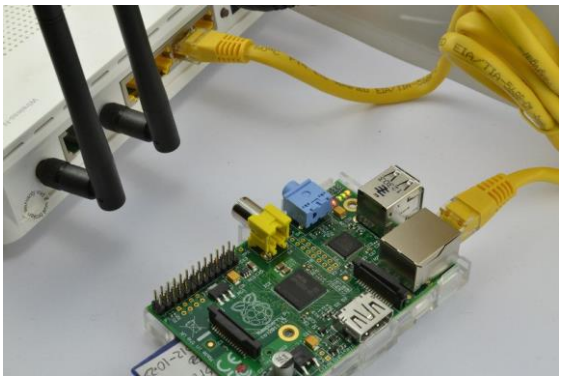
On the older beta Model B boards, 128 MB was allocated by default to the GPU, leaving 128 MB for the CPU. On the first 256 MB release Model B (and Model A), three different splits were possible. The default split was 192 MB (RAM for CPU), which should be sufficient for standalone 1080p video decoding, or for simple 3D, but probably not for both together. 224 MB was for Linux only, with only a 1080p framebuffer, and was likely to fail for any video or 3D. 128 MB was for heavy 3D, possibly also with video decoding (e.g. XBMC). Comparatively the Nokia 701 uses 128 MB for the Broadcom VideoCore IV. For the new Model B with 512 MB RAM initially there were new standard memory split files released(arm256_start.elf, arm384_start.elf, arm496_start.elf) for 256 MB, 384 MB and 496 MB CPU RAM (and 256 MB, 128 MB and 16 MB video RAM). But a week or so later the RPF released a new version of start.elf that could read a new entry in config.txt (gpu_mem=xx) and could dynamically assign an amount of RAM (from 16 to 256 MB in 8 MB steps) to the GPU, so the older method of memory splits became obsolete, and a single start.elf worked the same for 256 and 512 MB Raspberry Pis.

The Raspberry Pi 2 and the Raspberry Pi 3 have 1 GB of RAM. The Raspberry Pi Zero and Zero W have 512 MB of RAM.

ETHERNET CABLE

DESCRIPTION

The Model A, A+ and Pi Zero have no Ethernet circuitry and are commonly connected to a network using an external user-supplied USB Ethernet or Wi-Fi adapter. On the Model B and B+ the Ethernet port is provided by a built-in USB Ethernet adapter using the SMSC LAN9514 chip. The Raspberry Pi 3 and Pi Zero W (wireless) are equipped with 2.4 GHz WiFi 802.11n (150 Mbit/s) and Bluetooth 4.1 (24 Mbit/s) based on Broadcom BCM43438 Full MAC chip with no official support for Monitor mode but implemented through unofficial firmware patching and the Pi 3 also has a 10/100 Ethernet port.



SOFTWARE DESCRIPTION:

a large standard library and easily extensible interpreter stemmed from his frustrations with ABC, which espoused the opposite approach.

While offering choice in coding methodology, the Python philosophy rejects exuberant syntax (such as that of Perl) in favor of a simpler, less-cluttered grammar. As Alex Martelli put it: "To describe something as 'clever' is *not* considered a compliment in the Python culture." Python's philosophy rejects the Perl "there is more than one way to do it" approach to language design in favor of "there should be one—and preferably only one—obvious way to do it".

Python's developers strive to avoid premature optimization, and reject patches to non-critical parts of CPython that would offer marginal increases in speed at the cost of clarity.When speed is important, a Python programmer

can move time-critical functions to extension modules written in languages such as C, or use PyPy, a just-in-time compiler. Cython is also available, which translates a Python script into C and makes direct C-level API calls into the Python interpreter.

An important goal of Python's developers is keeping it fun to use. This is reflected in the language's name—a tribute to the British comedy group Monty Python—and in occasionally playful approaches to tutorials and reference materials, such as examples that refer to spam and eggs (from a famous Monty Python sketch) instead of the standard foo and bar.

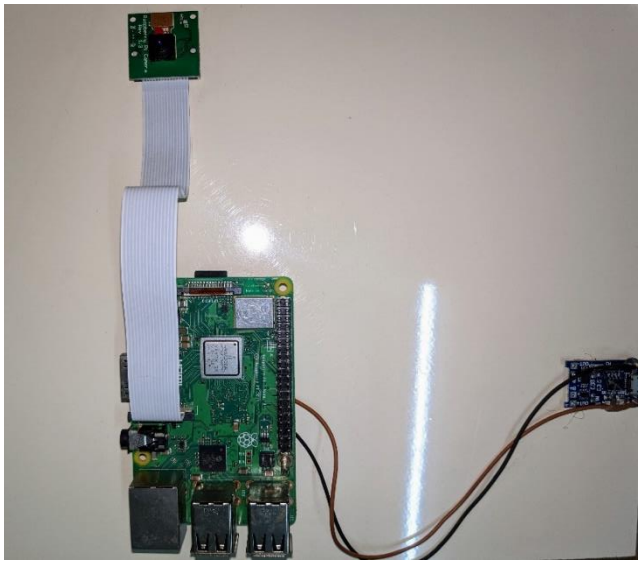
A common neologism in the Python community is *pythonic*, which can have a wide range of meanings related to program style. To say that code is pythonic is to say that it uses Python idioms well, that it is natural or shows fluency in the language, that it conforms with Python's minimalist philosophy and emphasis on readability. In contrast, code that is difficult to understand or reads like a rough transcription from another programming language is called *unpythonic*.

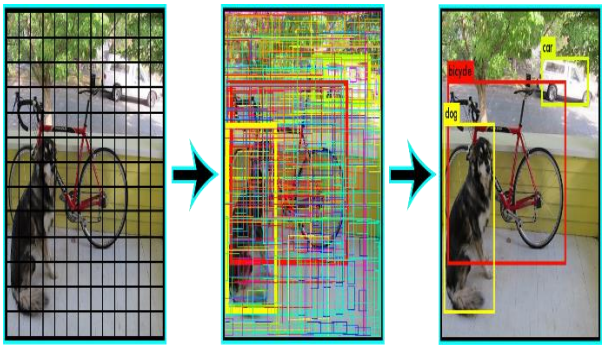
LINUX

Linux was originally developed for personal computers based on the Intel x86 architecture, but has since been ported to more platformsthan any other operating system. Because of the dominance of the Linux kernel-based Android OS on smartphones, Linux has the largest installed base of all general-purpose operating systems. Linux is also the leading operating system on servers and other big iron systems such as mainframe computers, and the only OS used on TOP500 supercomputers (since November 2017, having before gradually eliminated all competitors). It is used by around 2.3% of desktop computers.[19][20] The Chromebook, which runs the Linux kernel-based Chrome OS, dominates the US K–12 education market and represents nearly 20% of the sub-$300 notebook sales in the US.[21] Linux also runs on embedded systems—devices whose operating system is typically built into the firmware and is highly tailored to the system. This includes TiVo and similar DVR devices, network routers, facility automation controls, televisions,video game consoles and smartwatches. Many smartphones and tablet computers run Android and other Linux derivatives. The development of Linux is one of the most prominent examples of free and open-source software collaboration. The underlying source code may be used, modified and distributed—commercially or non-commercially—by anyone under the terms of its respective licenses, such as the GNU General Public License.

Some of the most popular and mainstream Linux distributions are Arch Linux, CentOS, Debian, Fedora, Gentoo Linux, Linux Mint, Mageia, openSUSE and Ubuntu, together with commercial distributions such as Red Hat Enterprise Linux and SUSE Linux Enterprise Server. Distributions include the Linux kernel, supporting utilities and libraries, many of which are provided by the GNU Project, and usually a large amount of application software to fulfil the distribution's intended use. Desktop Linux distributions include a windowing system, such as X11, Mir or a Wayland implementation, and an accompanying desktop environment such as GNOME or KDE Plasma; some distributions may also include a less resource-intensive desktop, such as LXDE or Xfce. Distributions intended to run on servers may omit all graphical environments from the standard install, and instead include other software to set up and operate a solution stack such as LAMP. Because Linux is freely redistributable, anyone may create a distribution for any intended use. Many Linux distributions use the word "Linux" in their name. The Free Software Foundation uses the name "GNU/Linux" to refer to the operating system family, as well as specific distributions, to emphasize that most Linux distributions are not just the Linux kernel, and that they have in common not only the kernel, but also numerous utilities and libraries, a large proportion of which are from the GNU project. This has led to some controversy

III. RESULT AND DISCUSSION





The camera tracks the image of the eye and stores it in the memory location mentioned in the main program. As a primary section, Acquisition is very important. Obtaining a transparent image of the pupil within the eye is crucial to the eye-tracking method. A changed low price USB digital camera is employed for capturing a close-up image of 1 eye pupil. An integral a part of the planning method, therefore, is to determine the optimum camera settings and light source positions to produce a clear image. Python program is employed to decision the digital camera for deed the important time video input file. The tracked image of the eye is converted into grey scale and the centroid of the eye is calculated. Thus when the centroid is calculated the continuous eye ball tracking is done.Thus by this way the image tracking is displayed as the result.

IV. DRAWBACKS

- The main drawback for a portable device like the raspberry pi is that it lacks eMMC Internal Storage and requires external storage support
- As a mini computer it we expect the graphical performance but it also does not have a graphics Processor
- As the board doesn't come with any heat-sinks pre-applied or any cooling fan. As the raspberry pi 4 comes with a powerful processor and multiple features, it starts to heat up after sometime due to the same board size, the heat dissipation is not proper as expected.
- Of course it is considered as a powerful portable device but it could never be a computer as it could not handle higher resolutions like 4K or higher frame rates even the 4GB ram board have memory issues
- Last drawback is that it runs only in the lnux operating system and not the other big OS like Windows OS or the MAC OSs

V. CONCLUSION

The proposed system has been developed and its main goal is to increase the capability of blind individuals. The technique used here is a well know name in imaging industries, where they reduce the errors by using more advance cameras and algorithms. With the person would be able to detect each and every obstacle and using camera the person would be able to find out what is exactly there in front of him. Although the current system can detect objects in the nearby location, it can't detect blind spots and other hard corners yet. This is limited with the sensor used in the system and also limited with the principle of ultrasound's reflection. The results obtain during testing are satisfactory to provide conclusive evidence that Haar – Like classifier with a good Ad boost algorithm, can detect faces more quick than conventional methods

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