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Introduction

It is a usual sight for us to see the lights/fans running in an empty classroom. The amount of electricity wastage is considerably high in such cases. More electricity wastage implies to a heavy electricity bill, something that disappoints people. As a solution to this common problem, we came up with an idea to develop a system with the concept of Image Processing and Raspberry pi that controls the power usage of the room based upon the presence of humans in the room.

Using this system, we monitor the changes in the room through sequence of images and according to that, the power supply is controlled. Image processing is a form of signal processing for which the input is an image, and the output may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. The implementation of power supply control using image processing is relatively very simple. The image of the empty class room is taken as a reference image, using a digital camera in an elevated view. The image is converted to gray and edge detection is done. Similarly, the captured real time image is enhanced and edge detected. These two images are compared and using the comparison results, respective control signals are generated using a hardware prototype. The reference and real time images undergo the following processes starting from their acquisition, Gray conversion, Partitioning, Edge detection, Comparison and finally generating the control signals.

Live camera feed is used as an input. Using Face Detection in MATLAB, the GPIO signals are generated for Raspberry Pi. A LED is connected through a circuit board to the Raspberry Pi GPIO pin. If a human face is detected, the LED turns on and if not, LED turns off

Requirement Gathering

➢ Functional Requirement:

- Image of empty room is taken as a reference image. Image Acquisition(RGB-Gray), Edge Detection and Image Comparison is then done on real-time images and the results are compared to ref. image
- If the room is detected to be empty, the power supply of the room is cut-off by the circuit

➢ Non Functional Requirement:

- 10 sec. of response time(Raspberry pi waits for 10 continuous frames to be constant before assuming that there is no person in the room)
- Backup-The video backup is regularly stored in the HDD

➢ Hardware Requirements:

- Raspberry Pi
- CCTV Camera
- Display Screen
- Wires
- Circuit board
- HDD

➢ Software Requirements:

- Open Cv
- MATLAB
- IoT
- Linux
- Python

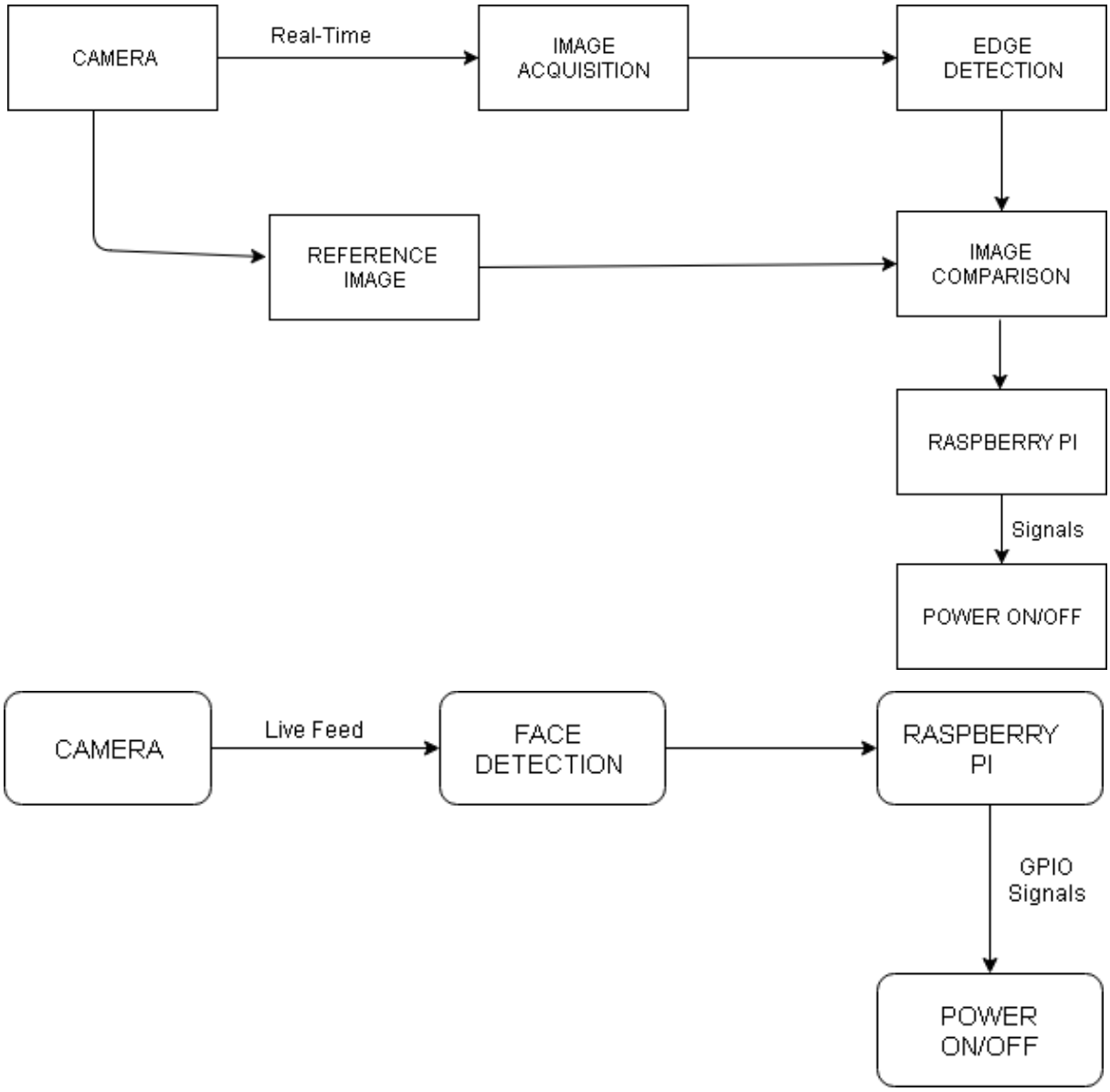
Feasibility Study

- Time Feasibility:
  - Time Feasibility is defined as the probability of a project to be completed within its scheduled time limits, by a planned due date. If a project has a high probability to be completed on-time, then its time feasibility is appraised as high. The project will take 8-10 months for the completion, documentation and modelling of the project

- Technical Feasibility:
  - Technical feasibility of proposed project refers to the software and hardware requirements. The system requires MATLAB and Open Cv for Image Processing and to control hardware and other equipments, we use Raspberry Pi

- Economic Feasibility:
  - It determines whether the model is cost effective. The hardware includes Raspberry Pi and a circuit. It is assumed that the user already has a CCTV Camera installed

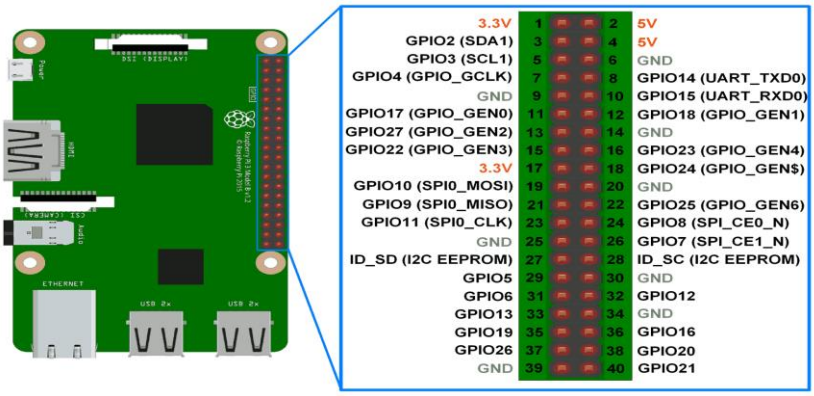
System Architecture

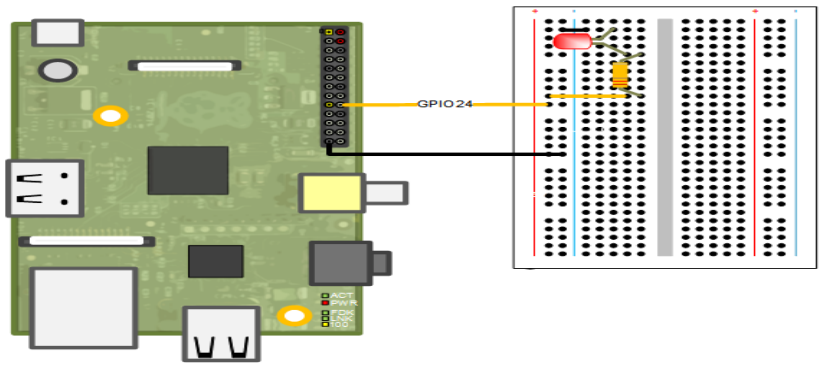


GPIO Access using Raspberry Pi

GPIO (General Purpose Input Output) pins can be used as input or output and allows raspberry pi to connect with general purpose I/O devices.

- Raspberry pi 3 model B took out 26 GPIO pins on board.
- Raspberry pi can control many external I/O devices using these GPIO's.
- These pins are a physical interface between the Pi and the outside world.
- We can program these pins according to our needs to interact with external devices. For example, if we want to read the state of a physical switch, we can configure any of the available GPIO pins as input and read the switch status to make decisions. We can also configure any GPIO pin as an output to control LED ON/OFF.
- Raspberry Pi can connect to the Internet using on-board Wi-Fi or Wi-Fi USB adapter. Once the Raspberry Pi is connected to the Internet then we can control devices, which are connected to the Raspberry Pi, remotely.
- GPIO Pins of Raspberry Pi 3 are shown in below figure:





Hardware Components Description

Raspberry Pi

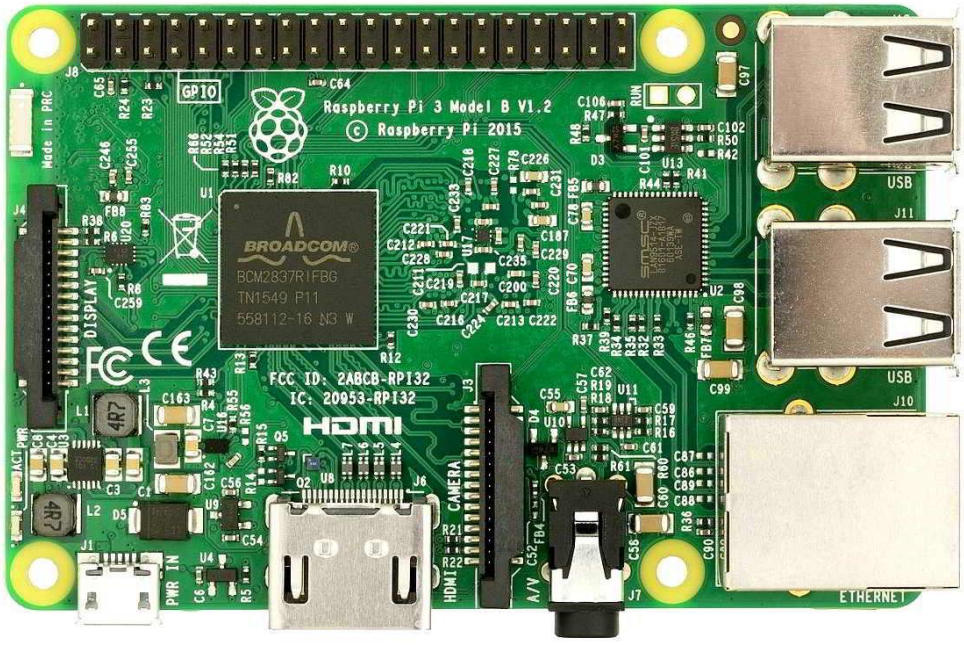
Raspberry Pi is a small single board computer. By connecting peripherals like Keyboard, mouse, display to the Raspberry Pi, it will act as a mini personal computer.

Raspberry Pi is popularly used for real time Image/Video Processing, IoT based applications and Robotics applications.

Raspberry Pi is slower than laptop or desktop but is still a computer which can provide all the expected features or abilities, at low power consumption.

Raspberry Pi is more than computer as it provides access to the on-chip hardware i.e. GPIOs for developing an application. By accessing GPIO, we can connect devices like LED, motors, sensors, etc and can control them too.

The CPU speed of Raspberry Pi varies from 700 MHz to 1.2 GHz. Also, it has on-board SDRAM that ranges from 256 MB to 1 GB.



CCTV Camera

Night vision CCTV Camera is used so that the system is capable to work in low-light conditions too.

CCTV Camera captures the reference image and real-time images for comparison.

Software Components Description

Open CV

OpenCV (*Open Source Computer Vision*) is a library of programming functions mainly aimed at real-time computer vision. Originally developed by Intel, it was later supported by Willow Garage and is now maintained by Itseez. The library is cross-platform and free for use under the open-source BSD license.

OpenCV runs on a variety of platforms.
Desktop: Windows, Linux, macOS, FreeBSD, NetBSD, OpenBSD;
Mobile: Android, iOS, Maemo, BlackBerry 10.

MATLAB

MATLAB (**mat**rix **lab**oratory) is a multi-paradigm numerical computing environment. A proprietary programming language developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, Fortran and Python.
All Image Processing programs are done in MATLAB.

IoT

The Internet of things (IoT) is the network of physical devices, vehicles, and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data.
The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention.

Python

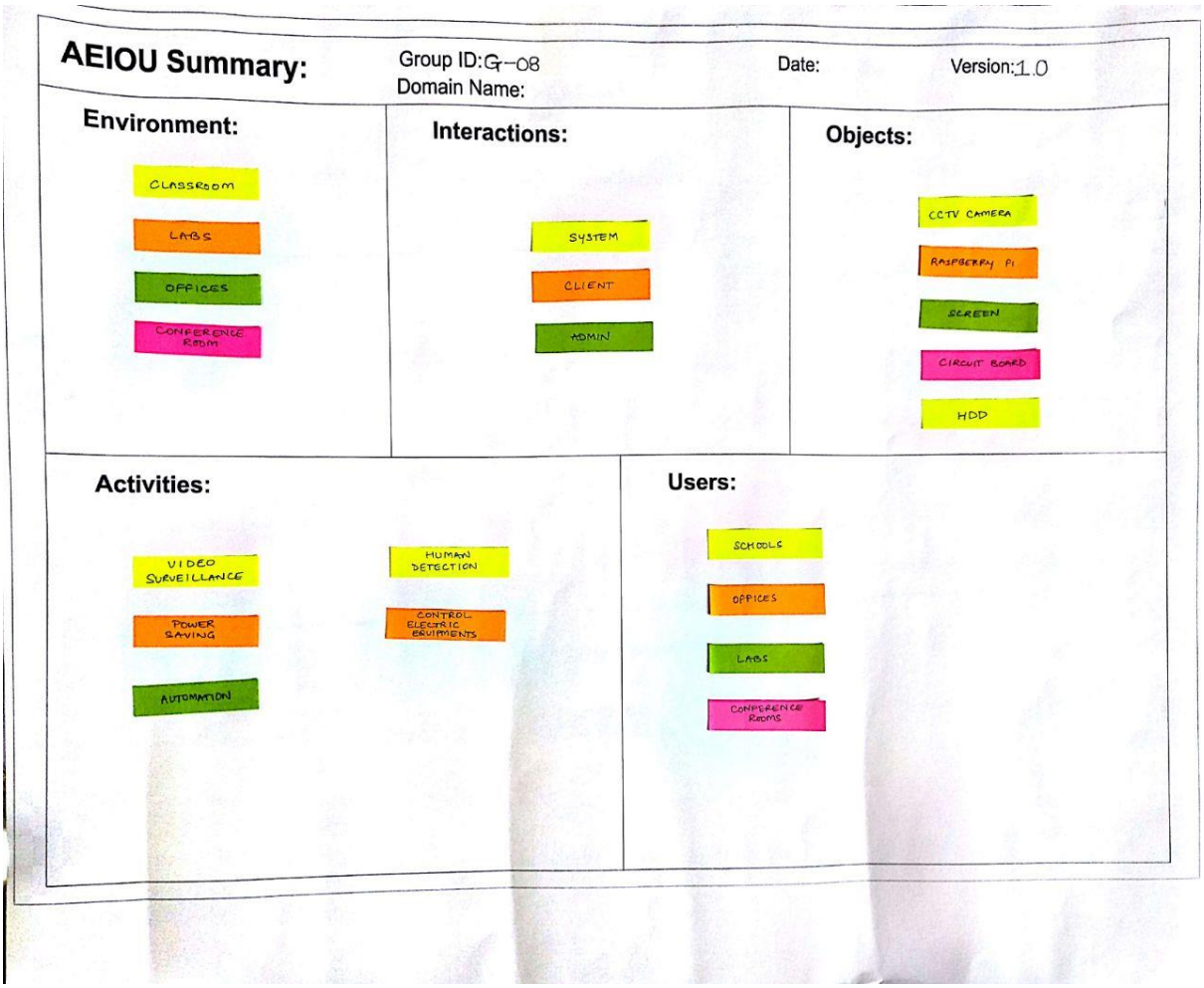
Python is a widely used high-level programming language for general-purpose programming, created by Guido van Rossum and first released in 1991.

Python is one of the most popular languages in the world and has been around for more than two decades. It is heavily used in academic environments and is a widely supported platform in modern applications, especially utilities, and desktop and Web applications. With its easy-to-read syntax, the introduction is gentle and the overall experience much better.

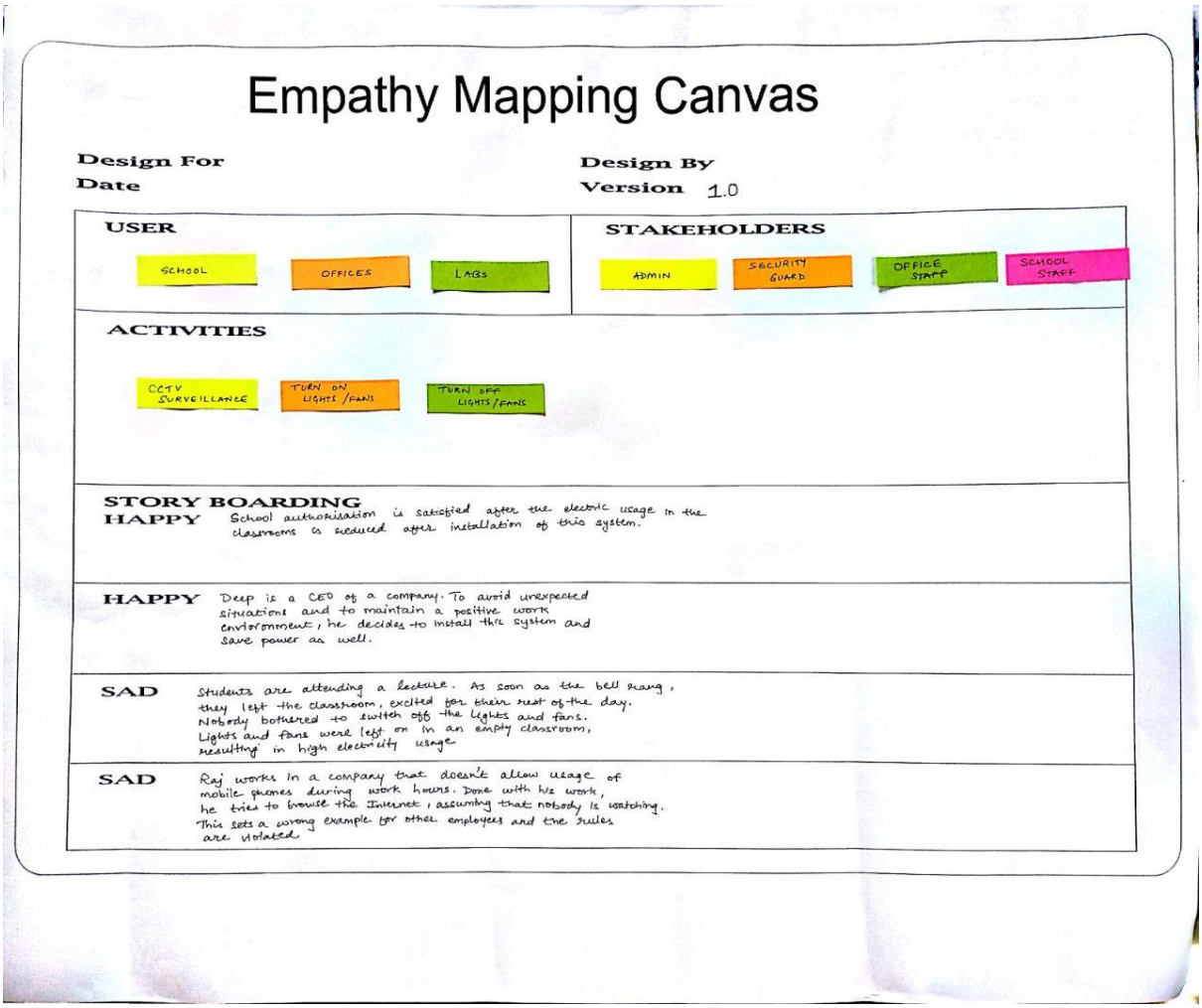
The latest version of the Raspbian OS comes bundled with both Python 3.3 and Python 2.x tools. Python 3.x is the latest version of the Python language and is recommended by the Raspberry Pi Foundation too.

Design Engineering Canvas

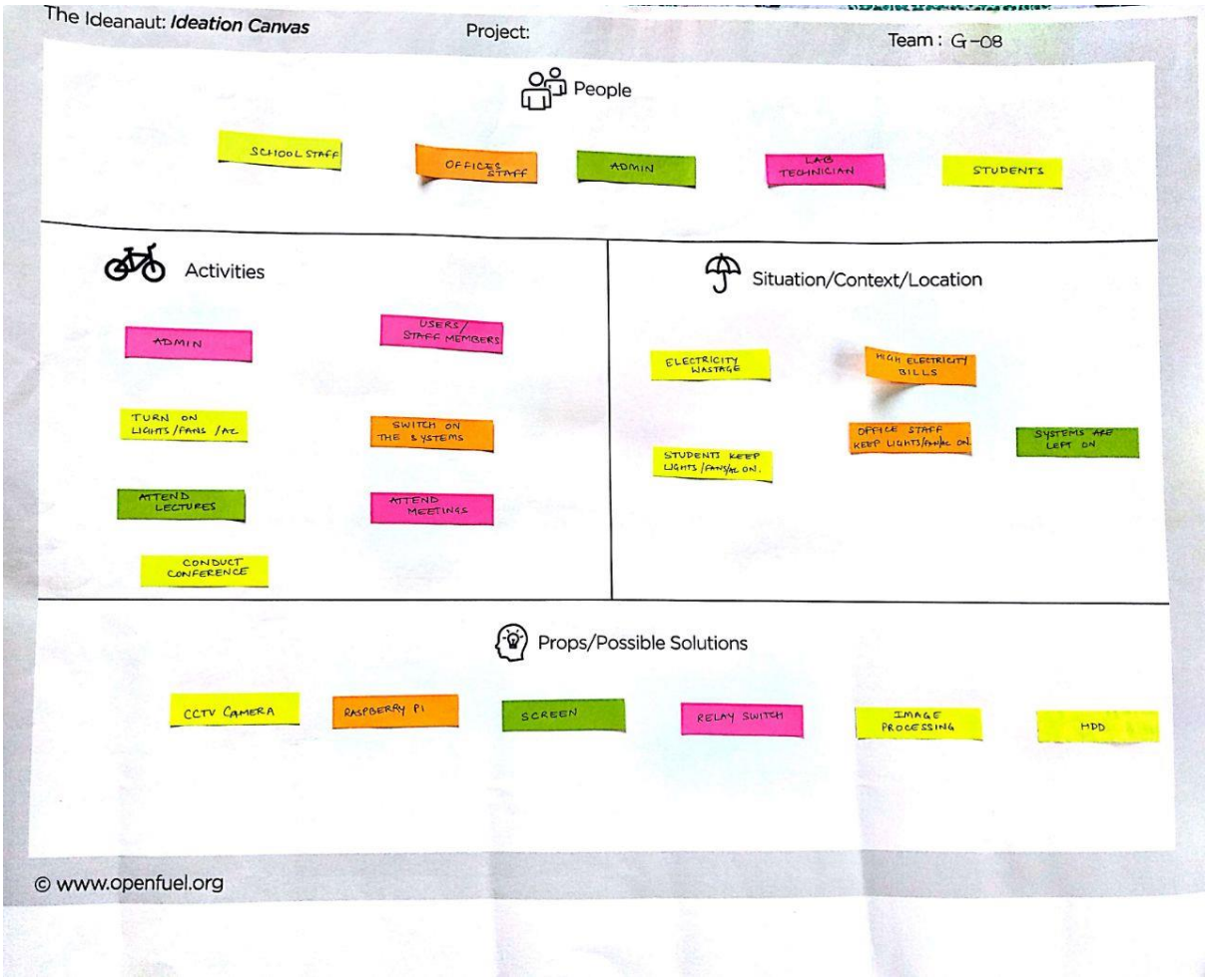
AEIOU Summary Canvas



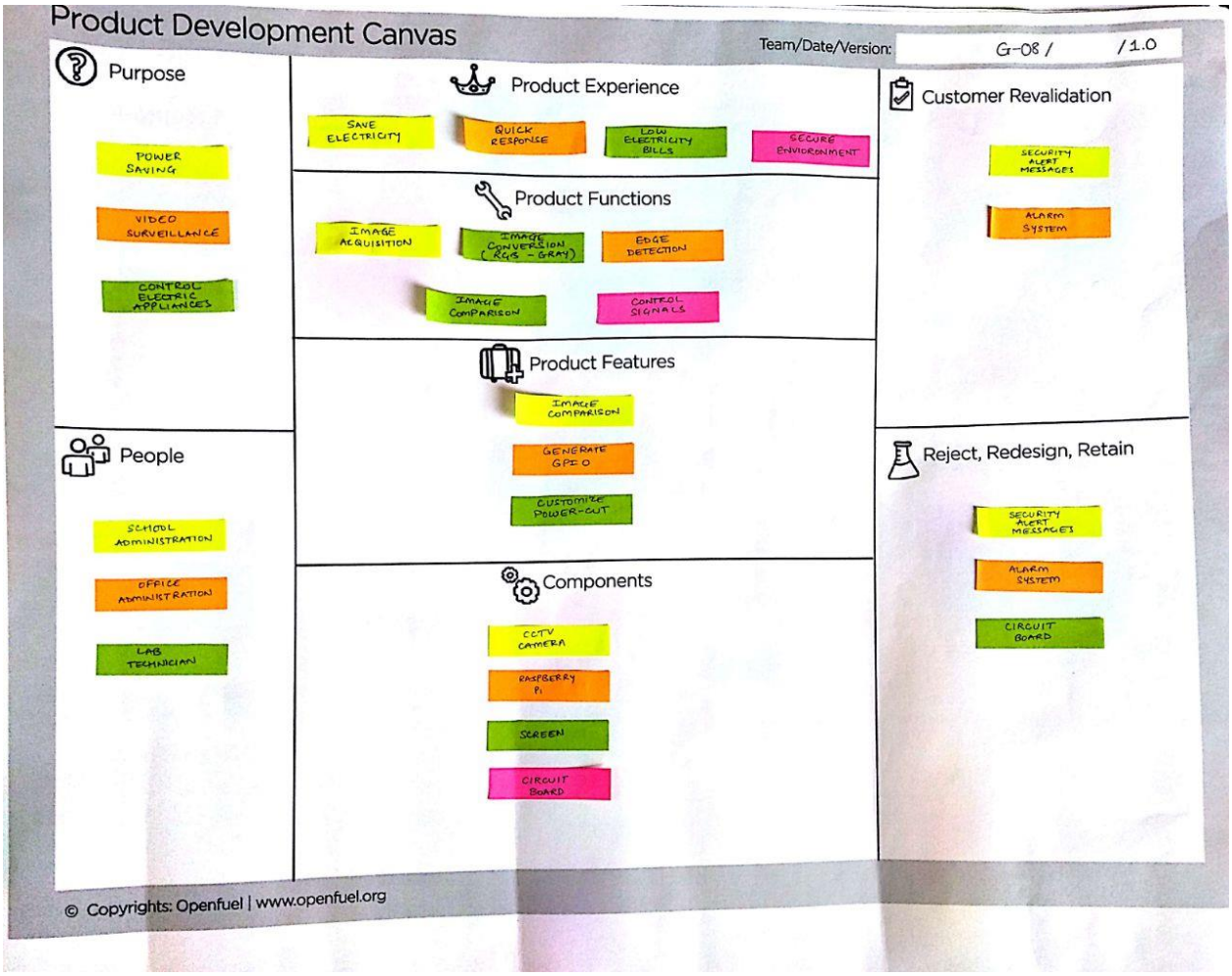
Empathy Mapping Canvas



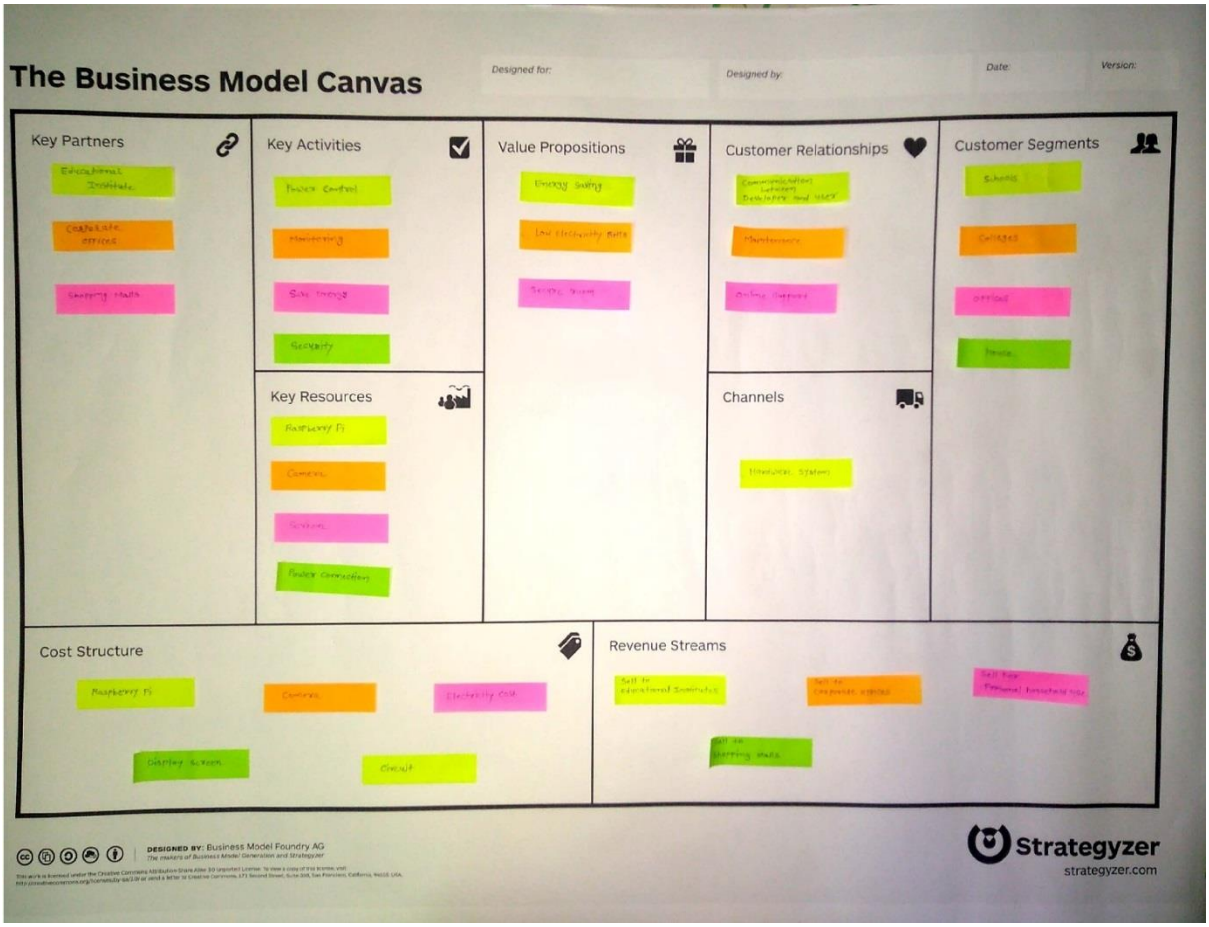
Ideation Canvas



Product Development Canvas

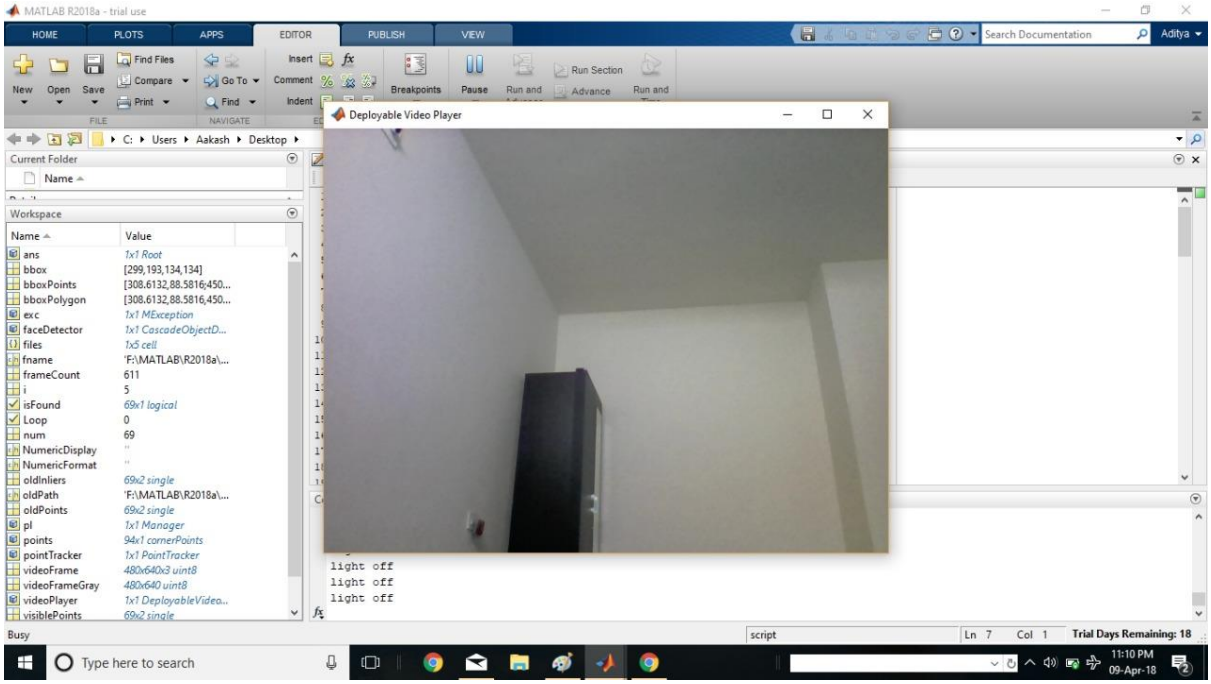


Business Model Canvas

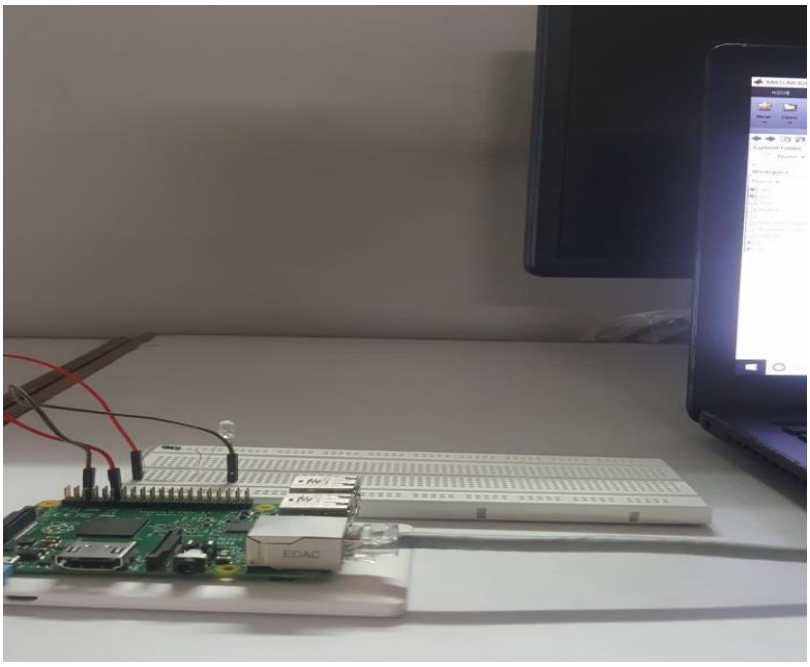


Testing

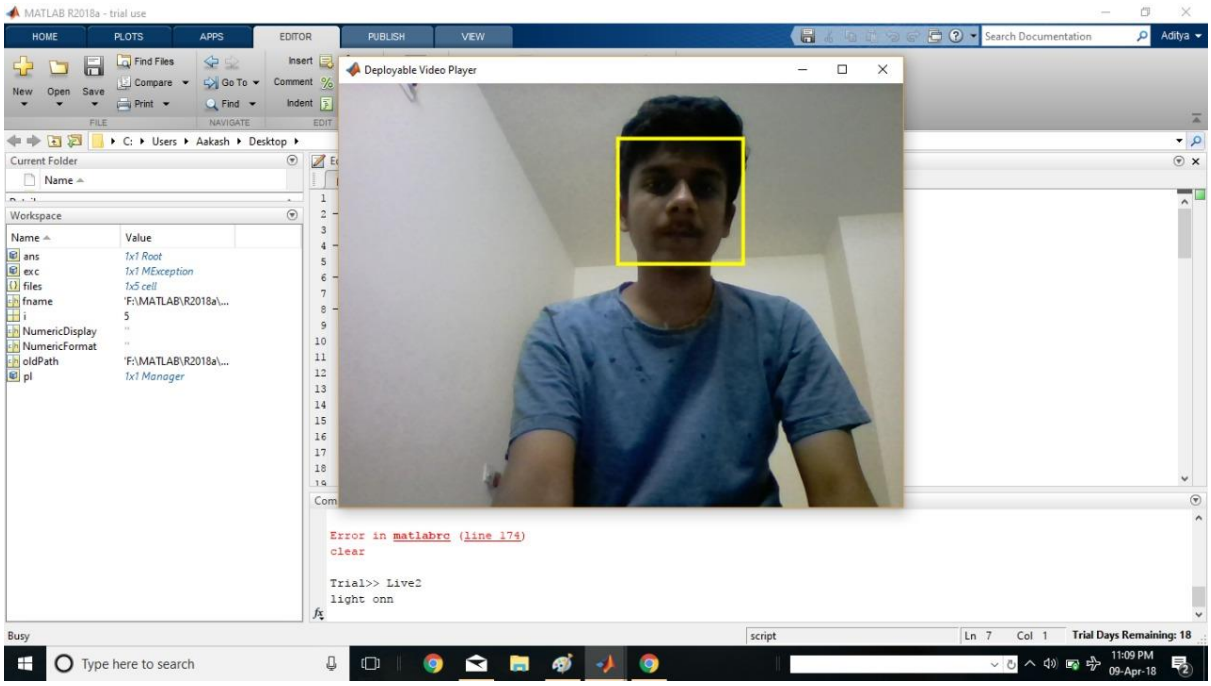
CASE 1: Empty Room



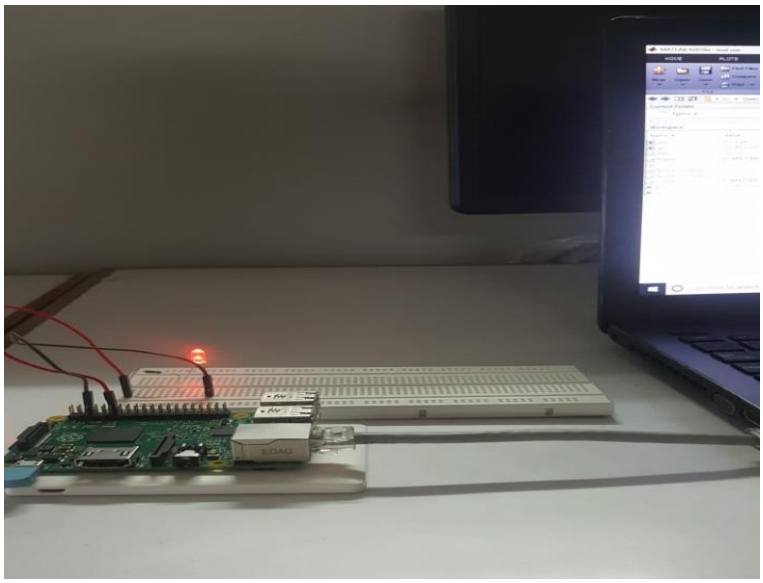
Action: Lights off



CASE 2: Human Face Detected



Action: Lights on



Periodic Progress Report : First PPR

Project : Power Saving Using Image Processing

Status : Reviewed

1. What Progress you have made in the Project ?

We started the hardware part of the project in this semester. This includes working with Raspberry Pi and other hardware components.

2. What challenge you have faced ?

Establishing a connection between MATLAB and Raspberry Pi was a challenging task. We learnt that from several websites.

3. What support you need ?

The process of accurate communication between MATLAB and hardware components will need some expert guidance.

4. Which literature you have referred ?

We referred the net about Raspberry Pi functions and www.mathworks.com for MATLAB .

Periodic Progress Report : Second PPR

Project : Power Saving Using Image Processing

Status : Reviewed

1. What Progress you have made in the Project ?

2 successful connections were established: 1.between MATLAB and Raspberry Pi 2. between Raspberry Pi and Breadboard. We also explored the support package for Raspberry Pi provided by MATLAB and its several functions.

2. What challenge you have faced ?

Connection Raspberry Pi to Breadboard using GPIO was tough.

3. What support you need ?

Working with GPIO and Breadboard will be easy with some support.

4. Which literature you have referred ?

MATLAB tutorials on www.tutorialspoint.com and videos from www.youtube.com

Periodic Progress Report : Third PPR

Project : Power Saving Using Image Processing

Status : Reviewed

1. What Progress you have made in the Project ?

We completed the hardware part of our project.

2. What challenge you have faced ?

Face detection from available video is a difficult task and also to continue it from next video frame is hard.

3. What support you need ?

We need to install several support packages and modules in MATLAB.

4. Which literature you have referred ?

MATLAB tutorials on www.mathworks.com and video from YouTube.

Periodic Progress Report : Forth PPR

Project : Power Saving Using Image Processing

Status : Reviewed

1. What Progress you have made in the Project ?

We did image partitioning part of our project. So now our system turns on lights only where human face is detected.

2. What challenge you have faced ?

Image partitioning in real time video frame is hard

3. What support you need ?

We need to study different processing on real time video frames

4. Which literature you have referred ?

MATLAB tutorials on www.mathworks.com and videos from www.youtube.com

Conclusion

- Power Saving has always been a matter of concern. The electricity wastage leads to a large unit of power wastage. As a solution, we propose new system using image processing and raspberry pi operation to save power. Installation of this system would result into a considerable reduction in the power wastage and low electricity bills accordingly.

Reference

Venkatesh, Sarath Kumar "Automatic Real Time Auditorium Power Supply Control using Image Processing" (Research paper)

Jay Visariya, Gaurav Gandhi, Haifa Bagdadi "Third Eye-Office Automation using Image Processing" (Research paper)

We have referred to some of the websites like "**Tutorials point**" that include basic operations about image processing.

Books like Digital Image Processing (English) 3rd Edition by **Gonzalez, Rafael C|Author;Woods, Richard Author** (book)

www.youtube.com

www.mathworks.com