Methodology

Before using the FPGA board and a connected camera, camera equipped with sensor OV5640was to be used for the purpose of environmental profiling which wasn’t available, so after searching various resources, we found out that that the image sensor in Picamera i.e. OV5647 was similar in many aspects. So, for proof of concept, we started with available resources in order to fulfill our objective, using this camera sensor integrated with raspberry Pi board we tried to access, read and modify the internal registers states by varying the sensor parameters of the sensor, by exploring different possibilities using protocols like UART and I2C, but due to OS and library specific restrictions register level information of the image sensor could not be made accessible. After thorough analysis and research, we found out that camera sensor parameters can be modified using command line interface, and that the parameter values ranged between 0 to 100 where 0 represented minimum and 100 maximum value which gave us proof of concept that sensor state is modifiable and is not fixed like traditional and conventional cameras. By using this approach various environments were chosen. With one particular location, the camera was placed in afixed position and was made to generate live stream and capture the images at regular intervals. These imageswere then analysed in MATLAB and their certain parameters were calculated. These image parameters comprised of brightness, hue, saturation, sharpness, and luminance.Studying these parameters and their change that result in images of varying degree ofquality helped determine the most relevant ones which can be later manipulated in pre-processing of the video stream captured by the image sensor used later.

**Executive summary**

Traditional cameras are not flexible and also unaware of their environment. They cannot provide constant and standard image quality in every environment because of their fixed (non-programmable) internal architecture. Along with image quality, image pre-processing is also crucial. The images need to be pre-processed before they can be used for useful results. For this purpose, FPGAs are used which are programmable semiconductor devices that are based around a matrix of Configurable Logic Blocks (CLBs) connected through programmable interconnects. As opposed to Application Specific Integrated Circuits (ASICs), where the device is custom built for the particular design, FPGAs can be programmed to the desired application or functionality requirements. Along with the FPGA, Omnivision OV5647 image sensor is used to 'preprocess' the camera input before the capture of images. After that, the images were examined in MATLAB, and specific parameters were determined. Brightness, color, saturation, sharpness, and luminance were among the criteria. The parameters were utilized to identify the most important ones, which could then be manipulated during pre-processing. The camera was put in a fixed position at one particular location and was programmed to generate a live feed and take photographs at regular intervals. Before using the FPGA board and a connected camera, camera equipped with sensor OV5640 was to be used for the purpose of environmental profiling which wasn't available, so after searching various resources, we found out that that the image sensor in Pi camera i.e. OV5647 was similar in many aspects. Sensor parameters can be modified using command line interface. Parameter values range between 0 to 100 where 0 represented minimum and 100 maximum value. This is proof of concept that sensor state is modifiable and not fixed like traditional and conventional cameras. The implemented solution provides a way to realize a design on the FPGA board to pre-process the live video stream being captured in real-time. The proposed design for this can be extended with further image processing blocks and environment adaptable capturing features for further applications as well.

**Summary**

Image processing applications are widely employed nowadays in situations where a high number of images and video streams must be analysed and processed in real time. This real-time constraint can be overcome by preprocessing the live camera feed right at the edge device, such as an FPGA. The FPGA is used in combination with an image sensor to create an adaptive camera that can use high-level synthesis to preprocess the incoming live video feed.