Robotic Lamp

Mock Design Review

Team 82

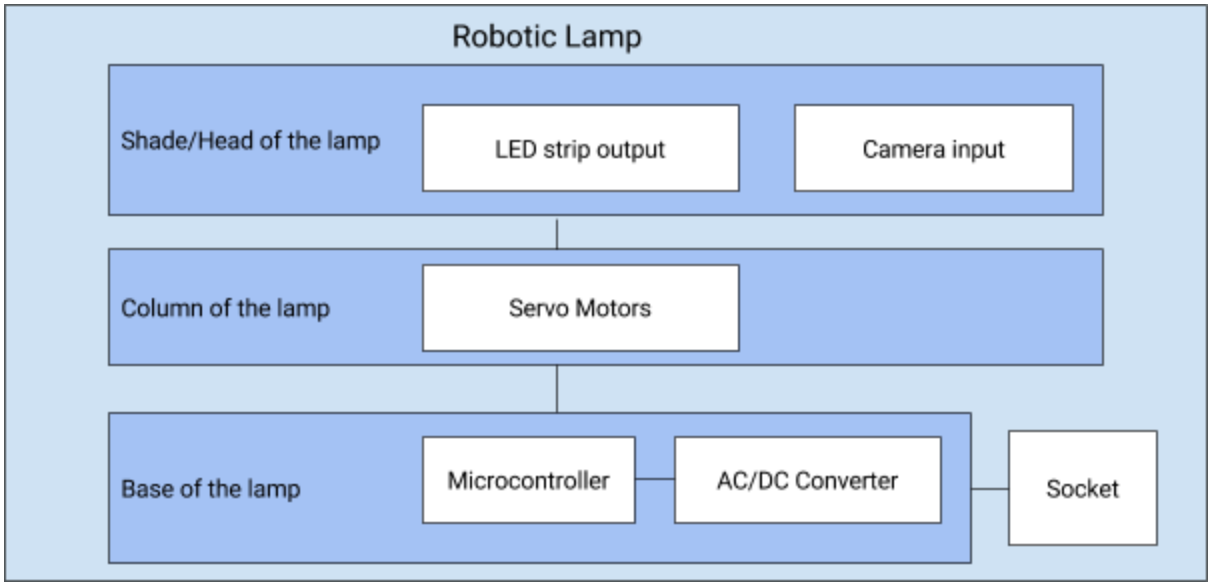
Dhruv Diddi (diddi2)

James Jia (jjia3)

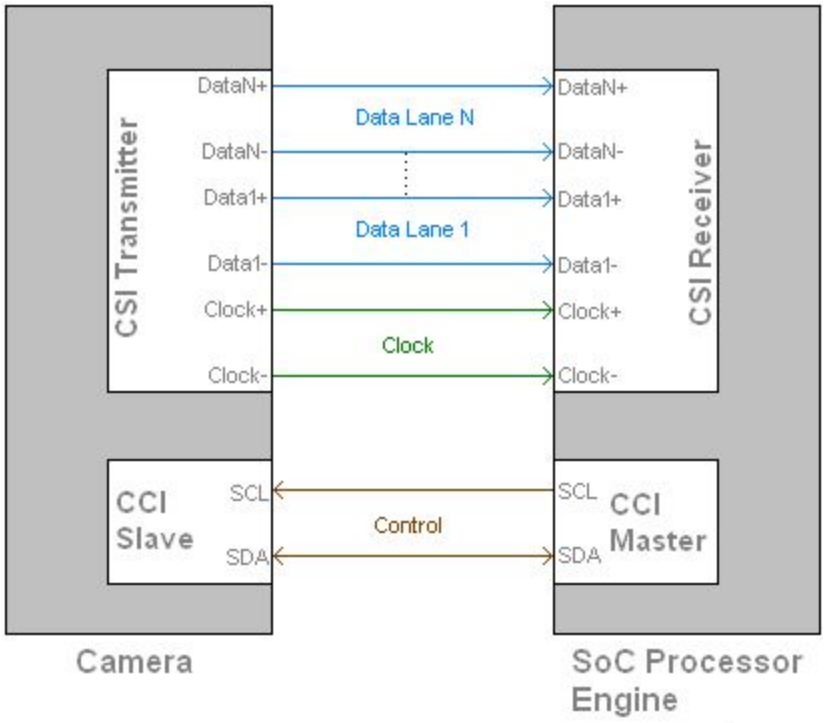
Saksham Saini (ssaini4)

TA- Eric Clark

1. Block Diagram



2. Circuit Schematic



3. Calculation

A calculation that is important in making sure all of our camera data 1.is processed is calculating the bitrate (bits per second) that will need to be processed by the the SoC. The camera will most likely be needing the most throughput of any component in our project, so it is important that we account for it, especially when we make calculations of what bitrate the processor can handle while processing it through OpenCV. The calculation is as follows:
Bitrate (bits per second) = (# Bit Color Depth) * (Frames Per Second) * (Vertical Resolution) * (Horizontal Resolution)

Color Depth Versus Resolution and Framerate (30fps Framerate)

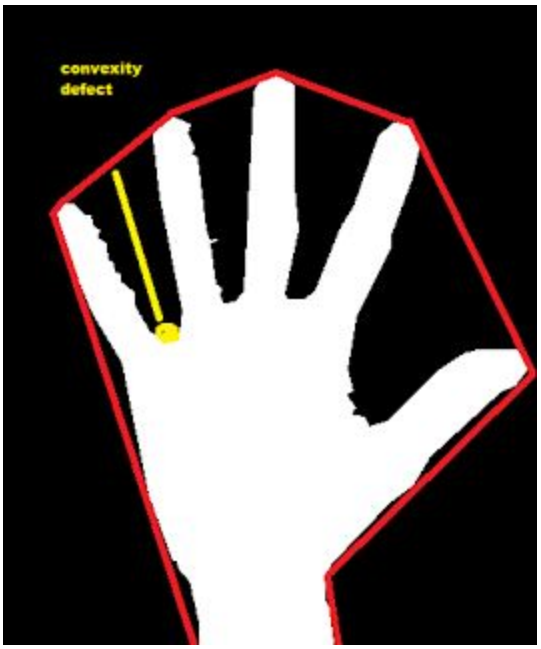
	240p (320x240), 30fps	**360p (480x360), 30fps**	**480p (640x480), 30fps**	**720p (1280x720), 30fps**	**1080p (1920x1080), 30fps**
1-Bit Color Depth (Black and White)	2304000 = 2.304 megabits	5184000 = 5.184 megabits	9216000 = 9.216 megabits	27648000 = 27.648 megabits	62208000 = 62.208 megabits
2-Bit Color Depth (Greyscale)	4608000 = 4.608 megabits	10368000 = 10.368 megabits	18432000 = 18.432 megabits	55296000 = 55.296 megabits	124416000 = 124.416 megabits
4-Bit Color Depth (Low Color)	9216000 = 9.216 megabits	20736000 = 20.736 megabits	36864000 = 36.864 megabits	110592000 = 110.592 megabits	248832000 = 248.832 megabits
8-Bit Color Depth (High Color)	18432000 = 18.432 megabits	41472000 = 41.472 megabits	73728000 = 73.728 megabits	221184000 = 221.184 megabits	497664000 = 497.664 megabits

Black and White: 1-bit color depth
Greyscale: 2-bit color depth
Low Color: 4-bit color depth
High Color: 8-bit color depth

Number of Channels in CSI Interface: 4
Maximum data-rate per channel: 1Gbps
Total maximum data-rate: 4Gbps [5]

4. Simulation

These are some simulations for hand detection using OpenCV:



5.Block Description

The camera module is the part which takes input from the user in terms of hand-gestures and object detection. The camera module sends the visual data over to the microcontroller, Raspberry Pi Zero for processing and deciding the response. The camera module that we are working with, OV5647[1] is capable of 1080p video recording at 30fps, but we will downgrade it to 480p at 30fps or 720p at 30fps to make the motion detection and object recognition faster on the processor side.[2]

The OV5647 interfaces with the Raspberry Pi Zero using the CSI Interface (MIPI Serial Camera)[3].

6. Requirements and Verification

- The camera module should be able to record video and have a frame rate of greater than or equal to 30 frames per second (fps).
- The camera module should be compatible with the Raspberry Pi Zero, the System on Chip (SoC) we have decided to use for the project. Additionally, all data from the camera module must be processed without stutter. An appropriate resolution must be decided at a later time to make sure this requirement is met.
- The camera module will be under 25 dollars.

7. Supporting Material:

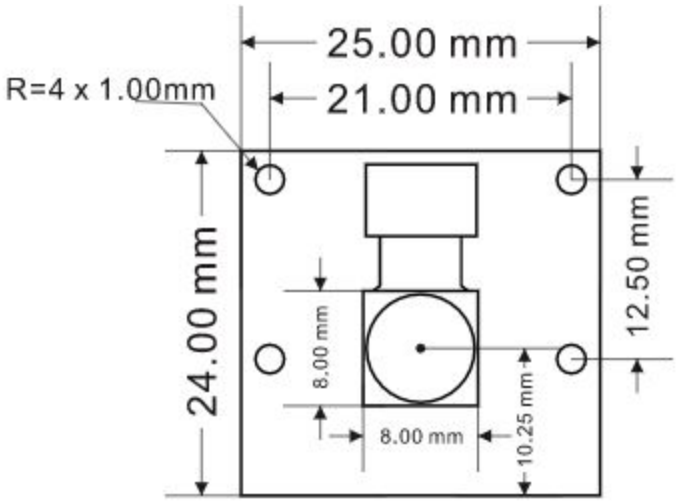
Camera module: Arducam 5 Megapixels 1080p Sensor OV5647 ($15)

In order to meet the increasing need of Raspberry Pi compatible camera modules. The Arducam team now released another add-on mini camera module for Raspberry Pi series boards which is fully compatible with official one. The board is 25mm x 24mm, which makes it perfect for mobile or other applications where size and image quality are important. It connects to Raspberry Pi by way of a short ribbon cable. The camera is connected to the BCM2835/BCM2836 processor on the Pi via the CSI bus, a higher bandwidth link which carries pixel data from the camera back to the processor. This bus travels along the ribbon cable that attaches the camera board to the Pi. The sensor itself has a native resolution of 5 megapixel, and has a fixed focus lens onboard. In terms of still images, the camera is capable of 2592 x 1944 pixel static images, and also supports 1080p30, 720p60 and 640x480p60/90 video. It attaches to Raspberry Pi by way of one of the two small sockets on the board upper surface. This interface uses the dedicated CSI interface, which was designed especially for interfacing to cameras.

Features:
Angle of View: 54 x 41 degrees
Field of View: 2.0 x 1.33 m at 2 m
Full-frame SLR lens equivalent: 35 mm
Fixed Focus: 1 m to infinity
Max frame rate: 30fps
15 cm flat ribbon cable to 15-pin MIPI Camera Serial Interface (CSI) connector

Application:
Cellular phones,PDAs,Toys
Other battery-powered products
Can be used in all Raspberry Pi platforms

Package including:
1pcs 5MP Mini Camera OV5647 Sensor 1080p 720p video for Raspberry Pi official Board
1pcs 15cm 15pin FPC cable



8. Safety statement

Regarding the camera module and safety, we wanted to emphasize the importance of privacy and to protect against discrimination as stated in IEEE Ethic #8: “to treat fairly all persons and to not engage in acts of discrimination…” [4]. In our initial proposal, we considered a mechanical cover to be put on the lamp’s camera when it is not in use. However, this complicates our design and requires many additional components to be added to even thread an electrical signal to the camera module from our circuitry. As we have considered the complete design of our robotic lamp, we found the Raspberry Pi Zero a formidable SoC to use, because it is fully functional for all our needs, but in respect to safety, does not contain any network connectivity on the chip itself. Thus, we can be confident that a consumer would be protected from spying, or from anyone using the camera for their own needs.

9. Citations

[1] ovt.org. “OV5647 Product Brief”. Available: http://www.ovt.com/uploads/parts/OV5647.pdf

[2] Vis, Peter. “Raspberry Pi CSI-2 Connector Specifications”. Available: http://www.petervis.com/Raspberry_PI/Raspberry_Pi_CSI/Raspberry_Pi_CSI-2_Connector_Specifications.html

[3] raspberrypi.org. “RPI Camera Module Datasheet”. Available: https://www.raspberrypi.org/documentation/hardware/computemodule/RPI-CM-DATASHEET-V1_0.pdf

[4] Ieee.org. "IEEE IEEE Code of Ethics". Available: http://www.ieee.org/about/corporate/governance/p7-8.html.

[5]CSI Interface Specs Available: https://www.petervis.com/Raspberry_PI/Raspberry_Pi_CSI/Raspberry_Pi_CSI_Camera_Interface.html