Research: Camera

Project Babymeter

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Theoretical Framework

In order for this project to succeed, a pair of camera's need to be found that are able to perform stereoscopy. The research that precedes this project and serves as a baseline does not specify the requirements for a camera to be used for stereoscopy.

The computer for this project has been determined to be a Raspberry Pi Model 3B+ (RPi). From the list of specifications, the following relevant points can be found for this research:

- Broadcom BCM2837B0, Cortex-A53 (ARMv8) 64-bit SoC @ 1.4GHz
  It's important to know how powerful the CPU is if one wants to perform image processing and wants to communicate to camera's over USB, CSI, or GPIO.
- 1GB LPDDR2 SDRAM
  The amount of RAM is important to know the limitations that the program to be ran on the computer will have.
- 2.4GHz and 5GHz IEEE 802.11.b/g/n/ac wireless LAN
  Should communication to the camera's not happen through a wire, or should another computer be involved in the project, then it is good to know the wireless/wired network capabilities of the computer.
- 40 GPIO pins
  The amount of GPIO pins is necessary to know should the project not make use of CSI or USB camera's.
- 4 USB 2.0 poorten
  Should USB camera's be chosen, then at least 2 USB ports are required.
- CSI camera poort
  The CSI port is obviously important as it is a camera port.

The rest of the specifications have been left out as they are not relevant to this paper specifically.

Regarding the cameras one can then define the following criteria:

1. The camera's need to be able to communicate over USB, CSI, or GPIO pins (ex. SPI);
2. The camera's should, in total, not cost more than two thirds of the project budget. The budget for this project amounts to 150 Euro, two thirds of that is 100 Euro. Each camera should therefore not cost more than 50 Euro. The reason for choosing two thirds is so that there is still a leftover amount of budget to spend on e.g. frame parts.
3. The camera's need to be able to take still images;
4. The camera's need to be able to focus on an object under a predetermined angle;
5. Because no resolution was specified, the cameras should be able to take still images with a minimum resolution of 320x240 and a maximum resolution of 1920x1080. Any higher resolution would unnecessarily strain the CPU.

Literature Research

Method

The methods used for this research revolve primarily around literature study. Finding specifications and other performance-metrics for each type of camera - all of which should be in the same ballpark (the specifications and tests should be similar enough for a fair comparison).

Sources exclusively come from the internet in the form of articles and product reviews. In these sources, specifications, test results, prices, and availability are the most important factors. This is because the cameras are an integral part of the project.

Results

CSI

CSI or Camera Serial Interface is a serial interface used for communication between a camera and a host processor. The advantage of using CSI over other protocols is that it is easy to implement because a CSI port exists on the RPi. Another upside is that CSI is conventionally faster than USB 2.0 which is the USB specification used on the RPi.
The only downside to CSI is that there is only one port available on the RPi whereas there are two cameras required, so an adapter board or splitter would be required which means additional hardware.

Name	Price	Criteria Met	Megapixel count	Pros	Cons
Raspberry Pi Camera V1.3	EUR 8.95 excl. shipping	1, 2, 3, 4, 5	5	Cheaper	Lower megapixel (MP) count
Raspberry Pi Camera V2	EUR 29.95 excl. shipping	1, 2, 3, 4, 5	8	Higher megapixel count	More expensive

Conclusion: Raspberry Pi Camera V1.3. The loss in image quality is negligible in comparison to the difference in price. Details are still readable in both images. The difference in area lighting shows the difference in megapixel count.

USB

USB possesses *mostly* the same strengths as CSI, with one drawback. USB 2.0 cameras cost a lot of CPU power to extract image data from over USB. Talking to 2 USB cameras will be slower than talking to a CSI split signal. The advantage is that there is an incredibly wide range of products to choose from for USB cameras. It is likely that even for this comparison the perfectly ideal camera for the situation wasn't found.

Name	Price in EUR	Criteria Met	Max. resolution	Megapixel count	Pros	Cons
Trust Spotlight	17,55 incl. shipping	1, 2, 3 (?), 4, 5	640x480	Unknown	Cheap	Unknown MP count, low resolution
Microsoft Lifecam HD-3000	30,- incl. shipping	1, 2, 3, 4, 5	1280x720	5	High MP count, high max. resolution	Most expensive
Logitech C270	27,50 incl. shipping	1, 2, 3, 4, 5	1280x720	3	High max. resolution	Low MP count, relatively expensive
Logitech C170	20,95 incl. shipping	1, 2, 3, 4, 5	1024x768	5	Cheap, high MP count	Image quality allegedly poor
Creative labs live!	27,50 incl. shipping	1, 2, 3, 4, 5	1280x720	Unknown	High max. resolution	Unknown MP count, relatively expensive

Conclusion: Microsoft Lifecam HD-3000. Although it is almost twice as expensive as the cheapest entry, it more than makes up for it by megapixel count and maximum resolution. Works on RP3b+ power out of the box.

GPIO

GPIO is generally not preferred. It possesses none of the advantages of USB or CSI and brings added development time because of its particular hardware. Most GPIO-only camera modules also require an external oscillator, hence GPIO is not preferred.

Conclusion

It's a toss-up between the Raspberry Pi Camera v1.3 and the Microsoft Lifecam HD-3000. The advantage of CSI is less CPU overhead but it requires an extension board to mount 2 cameras. The Lifecam does not need an extension board as there are two USB ports, but it is a lot more CPU intensive to use two USB cameras, though that CPU usage could be lower if only used for still photography. A definitive decision will be made once both are tested.