"White Powder" – Is it Harmful or Not?

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Research Question

The main question of this research project was 1) Whether or not it was possible to identify white powder substances that looked similar with fairly inexpensive and lightweight technology. 2) Can a small camera give enough accuracy when paired with a Raspberry Pi? If so, within how much accuracy can we say the results are correct?

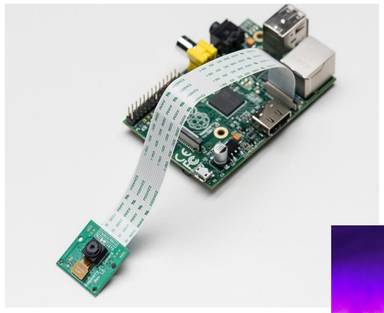
Technology

The technology is a Raspberry Pi with a camera module specially designed for the Pi. The board consists of an ARMv6 SoC with 512Mb of RAM and a Broadcom VideoCore GPU. The CPU is on par with a Pentium II from the mid-nineties, while the GPU is closer to the Xbox from 2001. The camera module is five megapixels and fixed focus. When ran without a graphical environment it performs adequately when paired with a lower level language like C.

Results

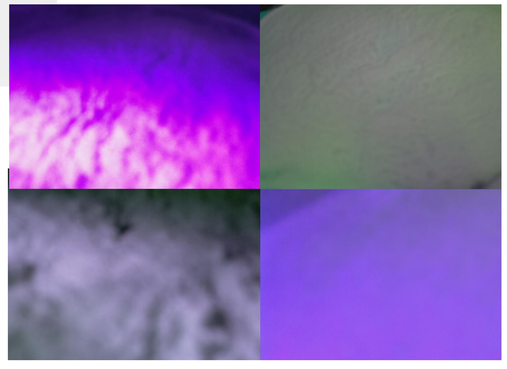
The key to differentiating between the four substances (Baking Soda, Baking Powder, Flour, and Salt) is how much light absorbance happens at different wavelengths. As can be seen on the right, the substances all absorbed different amounts of the UV light, giving them all unique attributes. When comparing the results of a professional spectrometer (Figure 1) to the results of what the Pi Camera produces (Figure 2) one can that while the Pi produces a lot less detailed results it follows the same basic path that the professional spectrometer does.

In the end, it is estimated that the program works to a degree of about 75% accuracy. When the substance is pure, it averages 90% accuracy, when the powders are mixed it only averages around 60%. While not perfect, it is definitely a solid proof of concept that differentiation can be seen between white powders that look really similar, with equipment that cost less than $100.



Raspberry Pi Model B

Baking Soda | Baking Powder
Flour | Salt



Learning Experience

During the duration of the project many things were learned including effectively implementing a third party API and proper memory management. The hours of testing that went into finding the proper values so the camera could differentiate between the four white powders was a great experience. Building a program the ground up was a valuable lesson, especially when having to compute within specific performance boundaries.

Program Algorithm

- Snap Picture
- Load into Mat Object (openCV)
- Loop through four "threshold" tests on the image
- Count each pixel in the image to see which parts of the image were in the threshold
- Compare the percentage of positive to negative pixels
- Output result based on which threshold had the highest percentage in a certain test

Flour Spectrum (Professional)

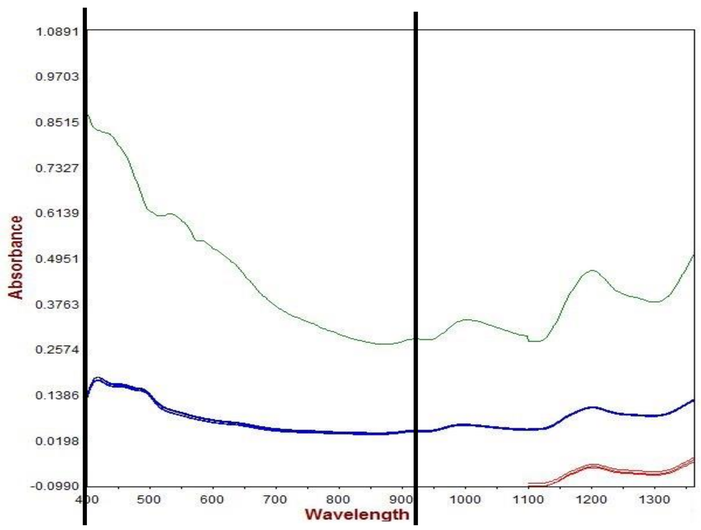


Figure 1

Flour Results (Pi)

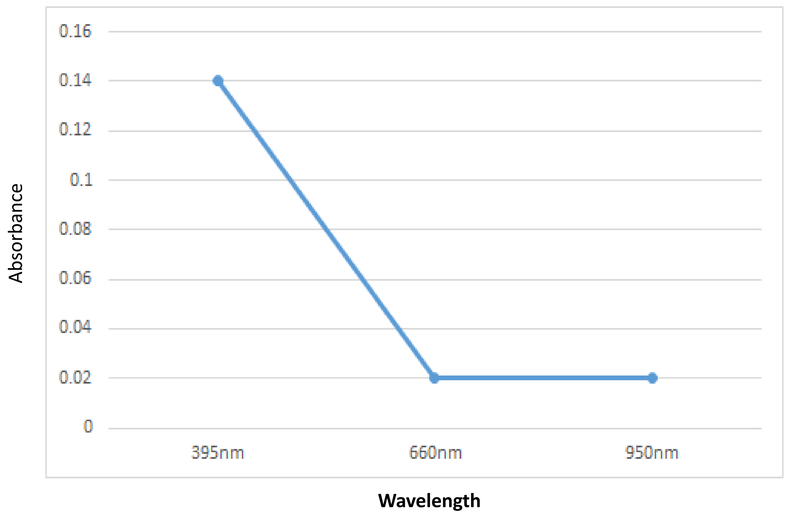


Figure 2

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