Multi-Microscope Malaria Diagnosis Device

B.Sc. (Honours) in Industrial Physics

Department of Physical Sciences

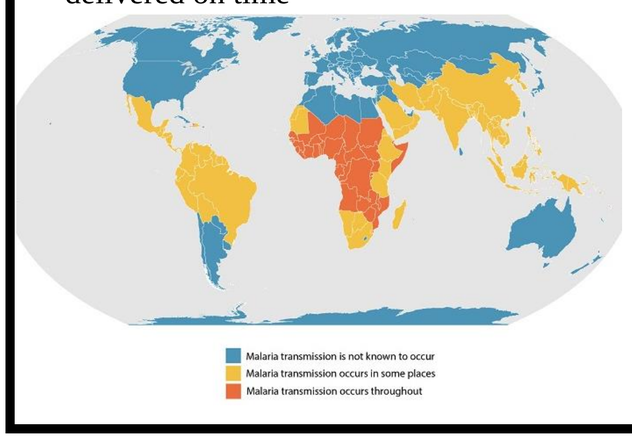
Student Name : Darragh White

Supervisor Names: Dr William Whelan-Curtin, Dr. Chinna Devarapu

Project Background and Motivation

Malaria Disease Burden

- According to the WHO there was 229 million cases of malaria in 2019 causing 409,000 deaths
- Areas worst affected are typically resource poor regions
- Despite the death toll, Malaria is a treatable disease if proper diagnosis is delivered on time



Current Diagnosis Methods

- Traditional optical microscopy is still considered the gold standard of malaria diagnosis
- A trained microscopist examines a stained blood smear visually identifying parasites
- Method is effective but labour intensive
- Since regions endemic to malaria are typically resource poor and isolated, there is a shortage of skilled microscopists and adequate equipment for diagnosis
- Great care must also be taken to not over diagnose the disease due to growing immunity of malaria parasites

Solution Proposed

- This project proposes a low-cost image platform capable of scanning blood samples and making diagnosis automatically
- This will reduce the strain on an already short supply of skilled microscopists
- By building the platform from open-source and consumer parts this reduces the difficulty of obtained expensive microscope equipment
- Compared to similar devices available, this device will utilise multiple microscopes and a voice coil to realise stage movements, reducing cost size and cost of device

Equipment Needed

- Raspberry Pi Single Board Computer

- Arduino Uno Microcontroller

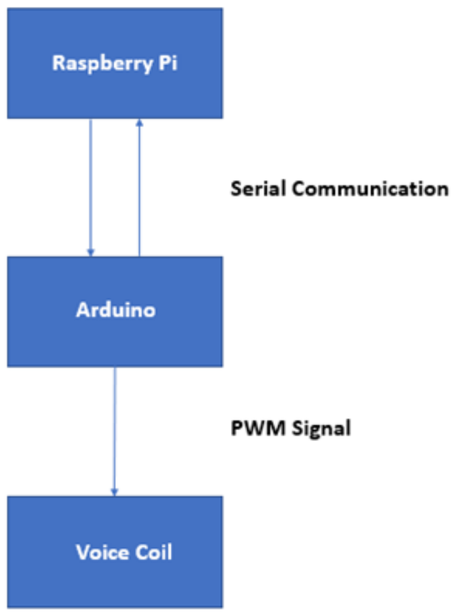
- Voice Coil

Raspberry Pi Camera Module

Project Plan

Control Strategy

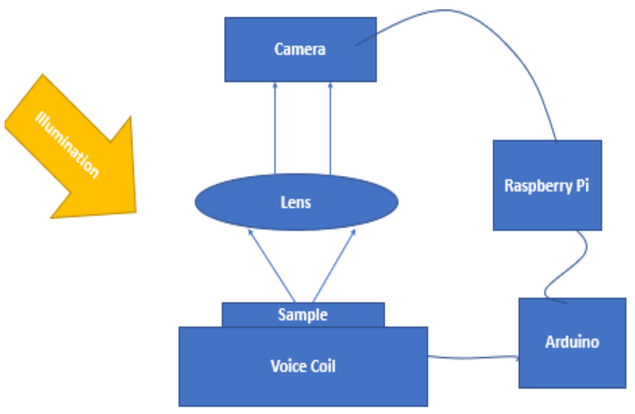
- The Raspberry Pi is set up in master-slave configuration with the Arduino
- The Raspberry Pi (master) always initiates communication with the Arduino (slave). The Arduino is able to communicate back to the Raspberry Pi sending confirmation that commands have been carried out
- The Raspberry Pi controls both the Arduino and camera module, the Arduino controls the voice coil
- The Arduino and Raspberry Pi communicate serially, while the Arduino uses a PWM signal to control the voice coil.



Scanning Routine

- The microscope device will implement a scanning routine capable of automatically analysing a sample
- The scanning routine will be implemented using python on the Raspberry Pi and the Arduino native programming language.
- The Raspberry Pi will instruct the Arduino to cycle the voice coil through x-coordinates with the sample attached
- At each x-coordinate the coil will cycle through several z-coordinates
- The Raspberry Pi will analyse these images using OpenCV, picking best quality image for recording

Device Diagram

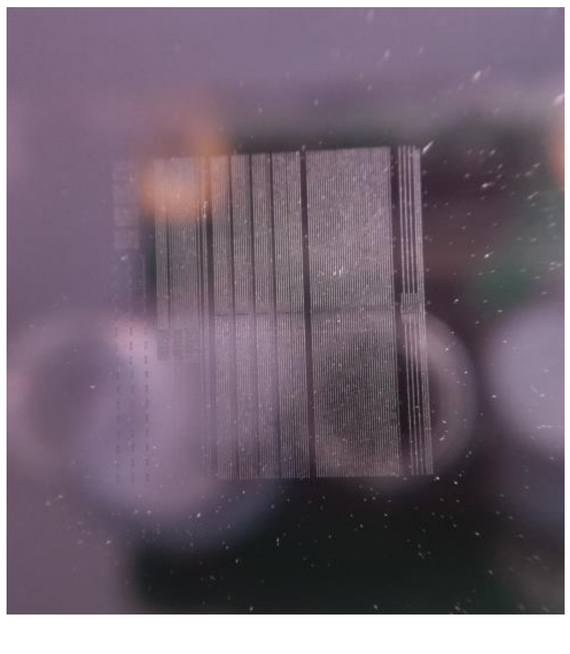


Results and Conclusions

Spatial Resolution

- A silicon chip with gratings of a known distance was used to evaluate the resolution of the microscope
- The Rayleigh criterion was used to resolve the spatial resolution
- The microscope spatial resolution was determined to be 40 microns

Silicon Chip with Gratings



Onion Sample Imaged

Conclusions

- A low-cost device capable of automatically scanning and evaluating focus in samples, and resolving as low as 40 microns
- With more time, this device can be expanded to have multiple cameras as originally planned
- This device can also have a machine vision system implemented during the scanning routine to automatically detect malaria parasites
- With more time and under laboratory conditions the spatial resolution can be improved, better light etc.

References

Raspberry Pi,

www.Raspberrypi.org

Arduino

www,Arduino.cc

Kasukurti, A. et al, 2011

Single-cell isolation using a DVD optical pickup