A Design Proposal for a Bacteria "Colonalyzer"

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Final Project

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1.0 Introduction

The Bacteria "Colonalyzer" project originates from an observation of the process of analyzing bacteria colonies in a culture sample. Specifically, individuals conducting water testing in remote areas around the world collect several samples of water from the water body and create Petri dish samples using membrane filtration. The filter membrane samples are incubated for about 24 hours and then checked for the number of bacteria colonies – specifically, counts of *E. coli* and total coliform bacteria. The process of checking the water samples are involves manually counting the blobs of colonies of bacteria on the filter membrane in a petri dish like the one in Figure 1. This process is not only tedious, but also highly prone to counting errors.

1.1 Objective

The goal of this project is to increase the accuracy and throughput of analyzing the results of this test. Making the testing process more efficient will allow for more tests to be conducted in more locations. Water treatment solutions can then be applied sooner to curb the deaths and disease caused by drinking contaminated water.

1.2 Technical Issues

To analyze the culture sample, a high resolution image of the culture sample is needed. Once this image is obtained, decisions have to be made about what blob size will constitute a threshold to be counted as a colony. Also, a distinction needs to be made between the different colored blob types representing different bacteria strains (E.coli versus coliform). The different shapes of blobs (Figure 2) also need to be taken into account.

Figure 1: Bacteria filter membrane on petri dish showing red and blue colored blobs.

2.0 Technical approach

The task posed by this project involves a correct theoretical representation of the problem as well as an efficient implementation method.

2.1 Theory

The core of the project requires an algorithm to identify the different shapes and sizes of blobs that could possible be found on the filter membrane. As shown in Figure 2, the shapes of the blobs could range from circular, rectangular, L-shaped and elliptical. Using the high resolution image, we propose an

algorithm involving a top-to-bottom scan of each row of pixels in the image, while keeping a state count of number of partial and complete blobs at each row of pixels. When progressing from one row to the next. The algorithm would compare vertically adjacent pixels (or blocks of pixels) to determine whether a blob in the previous row terminates or remains continuous.

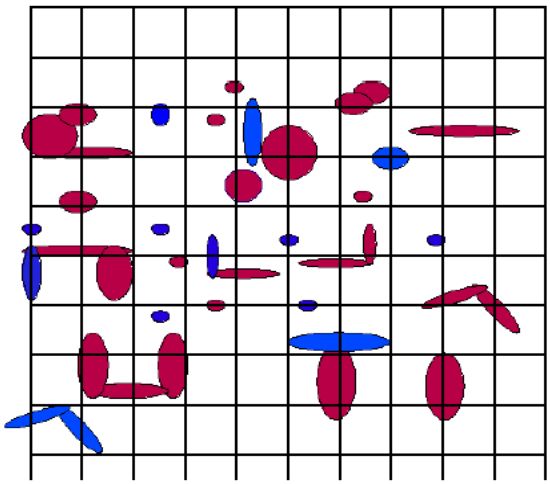

Figure 2: Analyzing Bacteria Colonies

2.2 Method

Figure 3 is a high-level illustration of various modules that will make up the system. The RGB image generator is required to interface with the device for obtaining the digital image of the culture, and to generate a specified image resolution for the VGA display. Once the image is obtained, the blob type detector will be used to detect the different colored blob types in the image. The processor FSM will be needed to keep track of counts and types of blobs as the counting algorithm progresses from row to row down the image. The image analyzer does the final computation of population density of specific bacteria types using the image information. The overlay module generates an output of the results of the image analyzer to the VGA display.

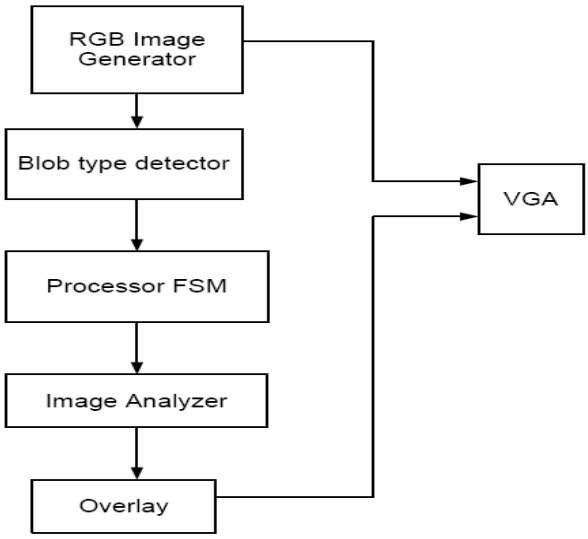

Figure 3: High-level block diagram of system modules

3.0 Management plan and requirements

This section presents the schedule as well as the resources that are needed for the successful completion of the project. Throughout the whole period, I will be meeting regularly with my project advisor to review the status of the project, and the challenges that may come. The projected schedule is shown in Figure 4. I will produce a formal report on the project by December 11.

3.1 Projected time schedule

The execution period for the project will be November 3 to December 11. The first two weeks of November will be used to implement the simpler output modules, planning and revising the design as needed. The last two weeks of November will be spent implementing all modules of the system. Module Testing will begin as early as the second week of November and continue till the last module is complete. System testing is scheduled to begin by the last week of November. The first week of December will be spent on more testing and refinement of the implementation. Figure 4 shows the projected schedule in more detail.

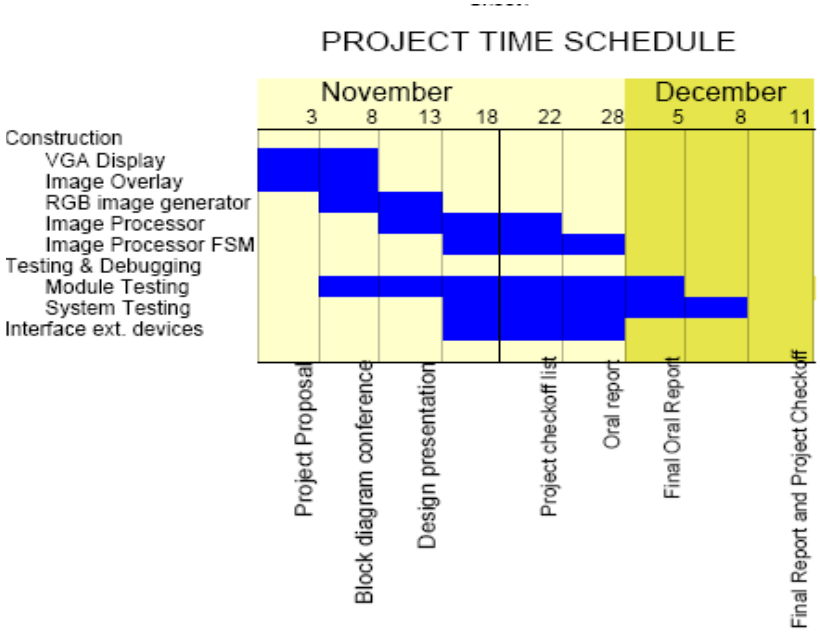

Figure 4: Timetable for projected completion.

3.2 Required facilities and resources

Most of the project will be implemented using the 6.111 lab kit and FPGA. All the modules will be implemented using the Verilog Hardware Description language. A digital raster scanner would possibly be used to obtain the image of the filter membrane. A monitor or computer screen will be used to display the high resolution image of the filter membrane as well as the test results (count of bacteria types). A logic Analyzer will be used for outputting waveforms when conducting module and system tests. With the exception of the digital raster scanner, all the necessary equipment will likely be available from the 6.111 laboratory.

Given the knowledge and skills in building digital systems that I have acquired over the past two weeks, I feel adequately prepared to take this project to completion. The 6.111 staff will be available to provide the necessary guidance and feedback on the design and implementation throughout the project timeline.

4.0 Conclusion

The completion of this project will have a significant impact on the process of analyzing culture samples. Specifically students and professionals who conduct several water tests will be able work faster and more efficiently. As a result of the improved efficiency in water testing necessary actions for treating contaminated water will be taken more quickly and more diseases and deaths caused by drinking contaminated will be prevented. The culmination of the project will be a formal presentation on December 5, and a formal report on December 11.