

Optical Attenuation Sensor for Process Control

Proposal for Senior Project

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Project Definition

A manufacturing company in the greater Cleveland area originated this project idea. The company uses robotic sprayers to combine two binary components to form an epoxy on an assembly line. Their problem is finding a way to test the composition of the glue and ensure that it is correct.

The idea that was presented to us was to design an optical circuit using an LED and a photodiode to measure the attenuation through the glue. While it is beyond the scope of a one semester project, an eventual design would include circuits to measure attenuation at several wavelengths as well as a processor to compare the known attenuation values with those given by the circuit. The system could then flag a problem with the composition and make adjustments as necessary.

Project Objective

For our project, we are going to design and build the basic circuit described above. We will research the required components, come up with a simple, inexpensive, and effective design, and then build it. After a series of tests, we will perfect our circuit and then be ready to present to our advisor and classmates.

Strategy for Achieving Goal

There has been at least one senior project that has investigated components for this type of circuit. We will investigate this prior work, as well as work that Dr. Merat has done himself, and then continue the research. We intend to split our group into two teams to get more research done. One team will research the optical components while the other team researches the electronics. The two teams will both work on basic ideas for the design. Armed with our research findings and design ideas we will come together and decide on a final design. Once we are happy with our circuit design we will acquire the parts and build the circuit. After that, we will test the circuit to make sure it works as required. We hope to get some samples of materials with different attenuation factors to test our circuit in a realistic application.

Currently, we have several technical approaches under consideration. We plan to use a square wave input, but we will investigate the use of an oscillating sinusoid instead. The input signal will be at a frequency of 1kHz while the receiver will measure the attenuation through a balanced mixer. We will also research the use of an RMS-to-DC converter, and AM radio chips to serve this purpose. The sinusoid may provide better (or perhaps equal) noise immunity, and may also allow for the use of the RMS-to-DC converter in place of the balanced mixer. For the light source, the design will utilize an LED, but we will also research the use of a laser diode. The output signal will pass through a 1 Hz low-pass filter to reject noise, and should provide an electrical sensitivity of at least 1 to 10 mV, though we hope to achieve sensitivity in the nV range.

Plan of Action

Our first steps toward completing this project will be research and investigation. We will investigate past research projects to see what they may contribute to our ideas, and we will research the components necessary to design the simplest and most effective circuit. We hope to have our final circuit design done by week 7, which is when the midterm report is due. Week 8 is spring break which will be a good time to order parts and wait for their arrival. Weeks 9 and 10 will be spent building our circuit, and then weeks 11 through 13 will be spent testing and fine-tuning our circuit. During week 14 we will complete our final report and presentation. The timeline for our project can be seen at the end of this proposal.

Reporting Schedule

We will meet weekly with our advisor, Dr. Merat, to make sure that we remain on schedule. At the weekly class meetings we will report our status to Dr. Newman and our classmates. We will do a more in depth status report at the midterm, and at the end of the semester we will do a final report and presentation to demonstrate our results. Barring any unforeseen problems, we will follow our timetable as it is laid out at the end of this proposal.

Budget

One of the goals of our circuit design is to keep the cost low. We do not anticipate spending more than \$100 for components. Dr. Merat has stated that he will take care of any expenses that we incur.

Verification

We intend to have a working circuit to demonstrate at our final presentation. If possible, we will get samples of materials with different attenuation factors to show that our circuit works as intended.