Heads-Up Display for Microscopes
EE491: MAY1607

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1 Project Statement

The purpose for this project all stems from the challenges faced by Honeywell technicians during their assembly process. During the assembly of miniature mechanisms, work is primarily performed by operators under a microscope. Constant motion and movement is required to look up from the microscope to check the assembly instruction, graphics and drawings on a computer monitor. By optically putting a heads-up display in the eye pieces of the microscope, the operator could view the work directions and then switch back to assembly work as needed. This would make the assembly instructions easier to view and would reduce repetitive motion and eye strain.

2 Background

Honeywell is interested in designing a heads-up-display for a microscope. A previous research group from Kansas State identified several alternative setups for Honeywells microscope assembly setup. Computer monitors and tablets are the only options at this time. Several textbooks including Bioimaging: Current Concepts in Light and Electron Microscopy by D. Chandler and R. Roberson are great resources on the application and design of microscopes.

3 System Design

3.1 System Requirements

There are several key requirements that must be met for the system to be successful. First off, we could choose just one specific microscope model for our design to work for, the microscope we chose was the Meiji EMZ-8U Zoom Stereo Head. It was also vital that a beam-splitter was used as well as eyepiece lenses to magnify the instructions. Finally, although it may seem slightly trivial it was important to note this system can only work if the user has both a spacious workspace in order that the head up display device doesn't interfere with the microscope. A desktop computer is the only kind of computer that will be used in this system (laptops and tablets are forbidden).

3.2 Functional Overview

The objective of this system is to build a heads-up display(HUD) and a mechanism for magnifying the signal that appears out of the heads up display. This was broken down into two basic components both of which had multiple sub-functions.

1. DLP Mini Projector Unit-A mini-projector we designed that emits the instructions from the computer as a condensed stream of light.

   - MSP432-The main circuit microcontroller.
   - HDMI / VGA inputs -Video inputs from computer.
   - DLPA2005 -LED driver for projection LEDS

- DLPC3435 - DMD display driver.

2. Modified Microscope- A mechanism we designed to magnify the image from the projector in the microscope's lenses.

   - Beam Splitter - Mirror Used to redirect light into the Microscope's eyepiece.
   - Meijer Paired eyepiece- Used to magnify the image.

4 Detailed Design

The system being designed incorporates a variety of signals and user interface aspects.

4.1 Input and Output Specification

- HDMI Input
  - HDMI cable from computer to projector.
  - The signals connect to the ADV7611 HDMI receiver integrated circuit which transforms the data into YCBCr / RGB data. This is then sent to the Digital Micro-Mirror Device Controller.
- User Input
  - Several buttons located on the board allows the user to adjust settings and interact with the system.
  - Future iterations will be able to interact with the computer to interact with applications shown on the screen.
- Power Inputs
  - Power will be supplied via USB cable or separate 12V wall plug.
- Light Outputs
  - The DMD controller will talk directly to the DLP Display Driver, DLPA2005.
  - The display driver controls the red, green, and blue LEDs.
  - Light from the LEDs is collimated and focused towards the DMD.
- Optical Output
  - The DMD, DLP2010, contains an array of 854 x 480 micro-mirrors. These mirror toggle between two states, reflecting towards or away from the output lenses.
  - Light reflected towards the output is sent through a variety of focusing and magnifying lenses before being projected.
- Debugging and Other Interfaces

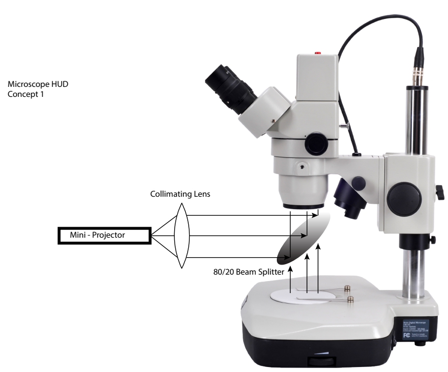
- An on-board MSP432G2553 coordinates all events happening on the board.
- An FTDI will communicate with the computer.
- Extra serial ports will be used for debugging.

4.2 User Interface

- Setup of the display will depend on final design (Window mounted below microscope or integrated into the eyepiece).
- The device is intended to be used in addition to a PC with an HDMI cable.
- The user will interact with focusing, screen size, and brightness via menu buttons located on the circuit board.

5 Design Concepts

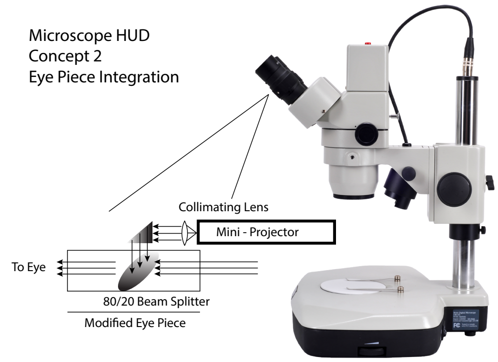
5.1 Window Concept



Our primary design will consist of a microscope similar to what the client uses and integrating a projector, collimating lens, and beam splitter in order to project the necessary instructions directly to the user within the microscope. The projector will output the directions which will then be collimated for optimal optical signal transfer. The beam splitter placed below the objective lens at a 45° angle will allow the image below the objective lens to still be transmitted to the eye, while also allowing the projected image to be reflected into the microscope and seen as well. The collimated signal will be reflected into the microscope for the user to see by the beam splitter. This concept offers a solution independent of the microscope itself.

5.2 Eye Piece Integration

An alternative design further integrated the above implementation into the microscopes' eyepiece. This concept would also use a projector to output the desired instructions. The image would again be collimated so it may be transferred optimally. A prism will be utilized in order to reflect the optical signal to the beam splitter where it will again reflect the projected image to the user. This design would allow for more working space for the user. However this approach will require alterations of the microscopes eyepieces.



5.3 Testing

Below are the prototyping and design tests that will be used to verify the operation of our product.

1. Hand-Held Projector Experiment: Using a small projector, convex lens, and 70/30 R/T Beam Splitter oriented in the Window configuration described above. We are using this test as a proof of concept for our project. This will show us what kind of control, focus, and other benchmarks to compare to the final design.

2. Nano-Block Assembly: Display instructions for assembling nano-blocks. Compare user experiences between using our product and viewing the instructions externally.