Automated Blood Smearing Device

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Introduction

Blood Smears
- Single droplet of blood smeared across microscope slide
- Identify the number and shape of red and white blood cells and platelets
- Used for medical diagnostics

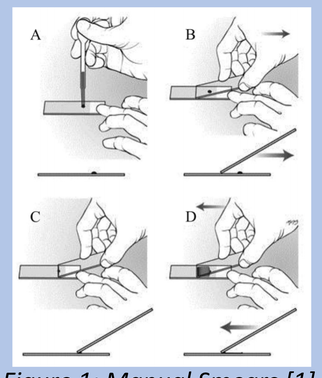

Figure 1: Manual Smears [1]

Basic Steps
- Place blood drop on clean slide
- Smear blood
- Stain the smear
- Image

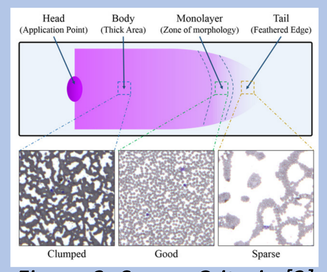

Figure 2: Smear Criteria [2]

Design Requirements

The aim of this project is to design a device that creates consistent smears for low throughput laboratories. This includes:
- Low cost device
- No contamination between smears
- User friendly
- Create consistent high-quality smears

Unique Device Components

- Graphical User Interface (GUI)
- Smears made with plastic PerfectSmear blades for one-time-use smearing
- Custom Built PCB


Figure 3: PerfectSmear

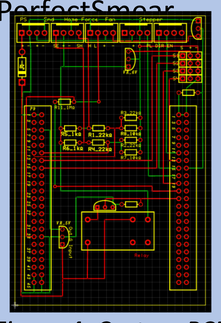
Figure 4: Custom PCB

Final Device

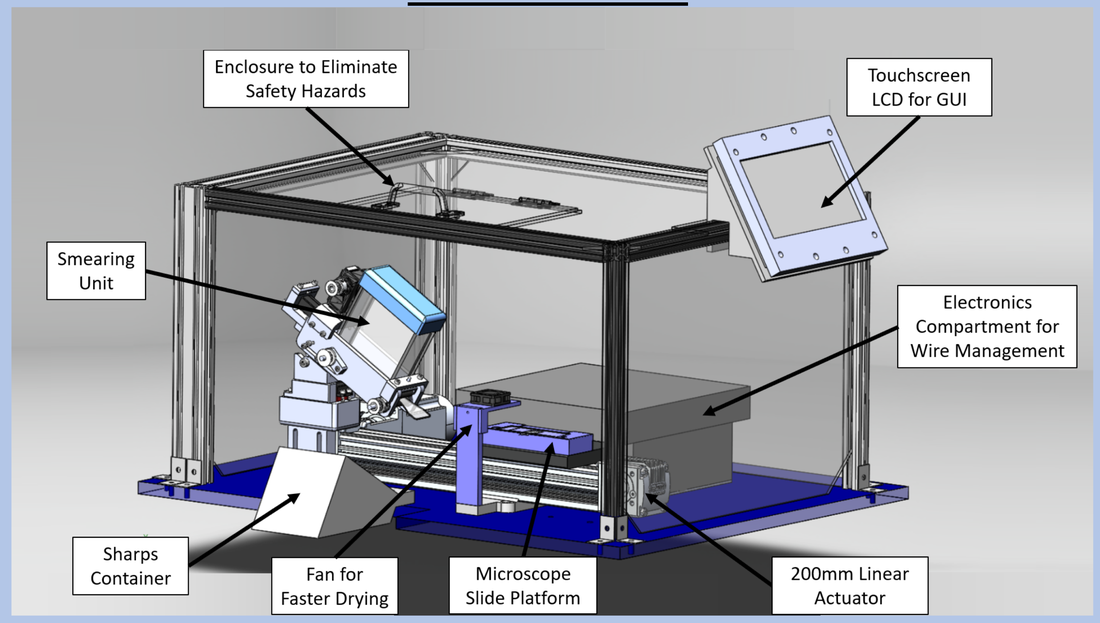

Figure 5: Annotated CAD of Final Device

Results

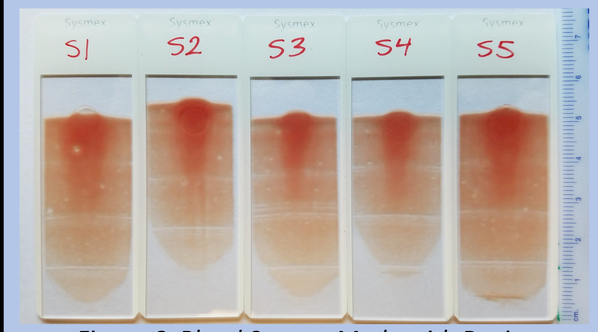

Figure 6: Blood Smears Made with Device

Figure 6 compares five consecutive blood smears made using this device and less than two days old pig blood. Our target smear length was 35 ~ 45 mm. Consistency in thickness and minimal chattering and streaking were evaluated.

The smears were stained in Figure 7 to evaluate the cell distribution and morphology.

Figure 7: Staining and Imaging Results for Each Sample

Smear Speed	150 mm/s					
Sample	Length (mm)	Thickness	Chattering	Streaking	Cell Distribution	Crushed Cells?
S1	46.4	✓	X	✓	✓	No
S2	41.2	✓	X	✓	✓	No
S3	44.8	✓	X	✓	✓	No
S4	40.9	✓	X	✓	X	No
S5	47.1	✓	X	✓	✓	No

Conclusion

In the end, the final device successfully:
- semi-automated the blood smearing process
- minimized human error by reducing the required user inputs
- performed consistent smears

The blood smears:
- were consistent in length and thickness
- were streak-free
- provided good cell distribution
- showed no crushed cells

One defect in the smears was consistent chattering marks seen as horizontal lines in the smears. These artifacts were due to issues in the stepper motor code and hardware that caused jerky motion and will be corrected in the future.

Future Design Recommendations

- Improved codes and sensors to better track automated process such as linear speed
- Addition of other automations
  - Blood Dispensing System
  - Slide Loading System
- Improvements to electrical components

References

[1] "STAINING OF PBF AND INTERPRETATION OF NORMAL AND ABNORMAL RED CELL MORPHOLOGY." *National Institute of Open Schooling*,

[2] Jahanifar, Mostafa. *Automatic Zone Identification in Blood Smear Images Using Optimal Set of Features - IEEE Conference Publication*, IEEE Xplore

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