

Abstract

Hydrocephalus is a condition where excess cerebral spinal fluid (CSF) accumulates in the brain, causing death when left untreated. Medtronic Neurosurgery produces shunt valves that appropriately drain the CSF with an adjustable mechanism that varies flow rates. The automated system tests valves by automatically completing the current Medtronic testing procedure. A LabVIEW program is initialized with one click, which then runs all pressure/flow tests, adjusts performance settings, and outputs data to a spreadsheet.

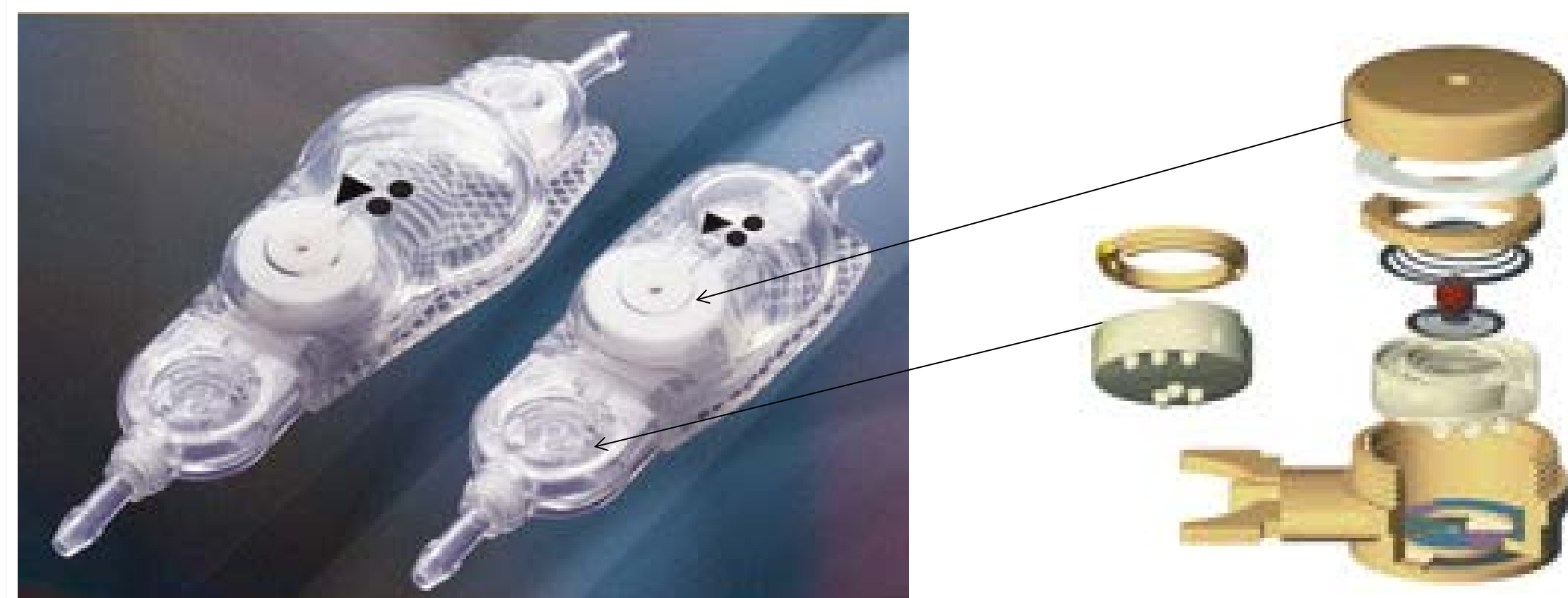


Figure 1. Strata Valves with CAD of Internal Setting Mechanism.

Performance Requirements

Our system must meet Medtronic's testing procedure requirements, FDA guidelines for medical device testing as well as team performance goals. These include:

- Flow Rate: $5\text{ ml/hr} < Q < 50\text{ ml/hr}$
- Pressure Range: $0\text{ Pa} < P < 2000\text{ Pa}$
- Test time per valve: 15 min
- Operation Time: > 8 hrs
- Device Dimensions: 3' x 2' x 1'
- Pressure Accuracy: $\pm 1\%$

Acknowledgments

UCSB: Stephen Laguette, Mary Dinh, Casey Hare, Verne Parmenter & Andy Weinberg

Medtronic: Jeff Bertrand, Bill Busby

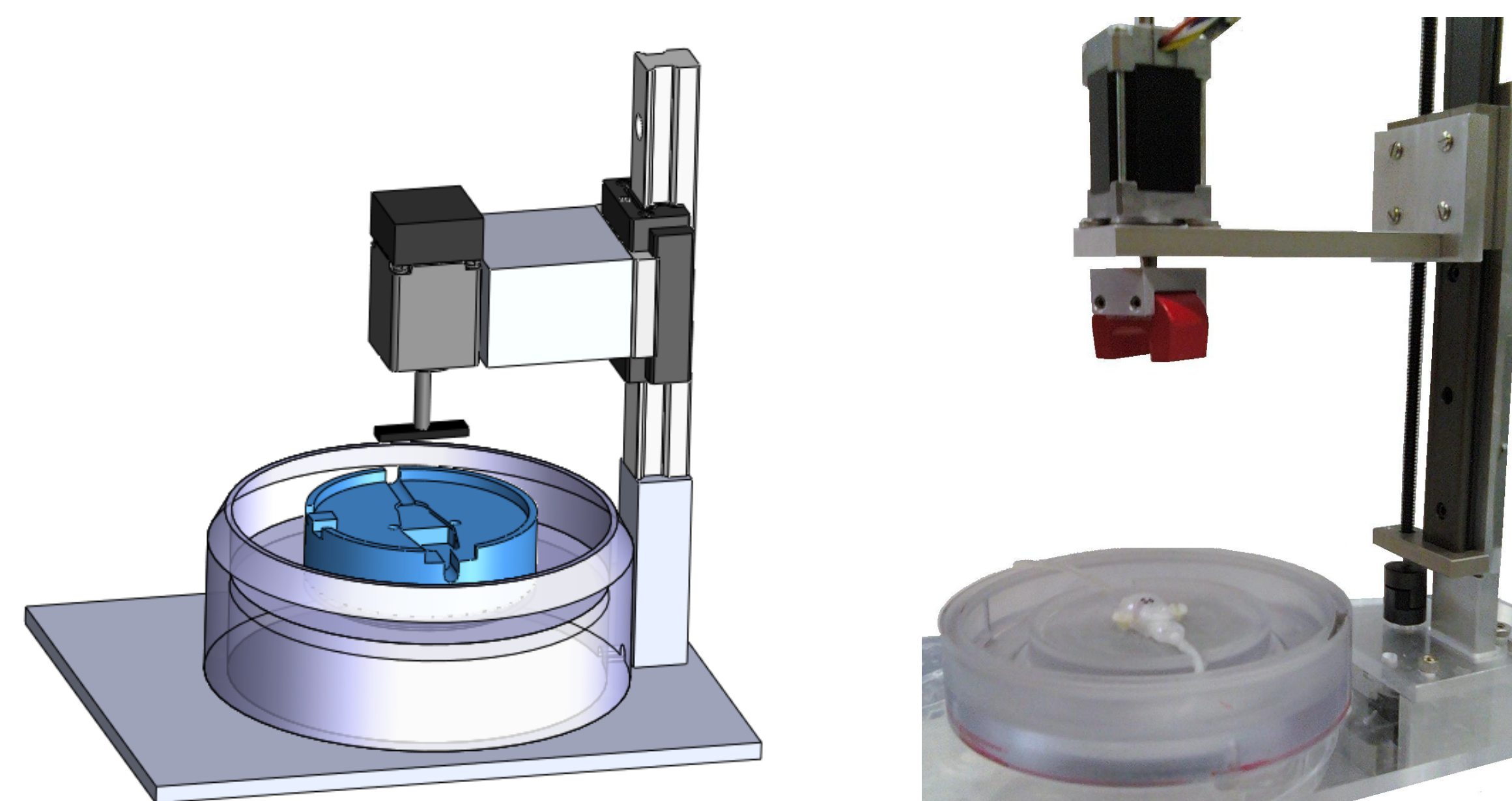


Figure 2. CAD Model of Magnetic Adjuster

Figure 3. Magnetic Adjuster Prototype

Technical Challenges

- Select syringe pump, pressure transducer, and motors that meet performance requirements
- Calibrate pump and pressure transducer
- Fabricate performance setting adjuster
- Create LabVIEW program to control syringe pump, pressure transducer, and stepper motors
- Capture pressure data when valve has reached steady state
- Move magnetic adjuster vertically and rotate magnet to a specific position
- Record and output data to spreadsheet

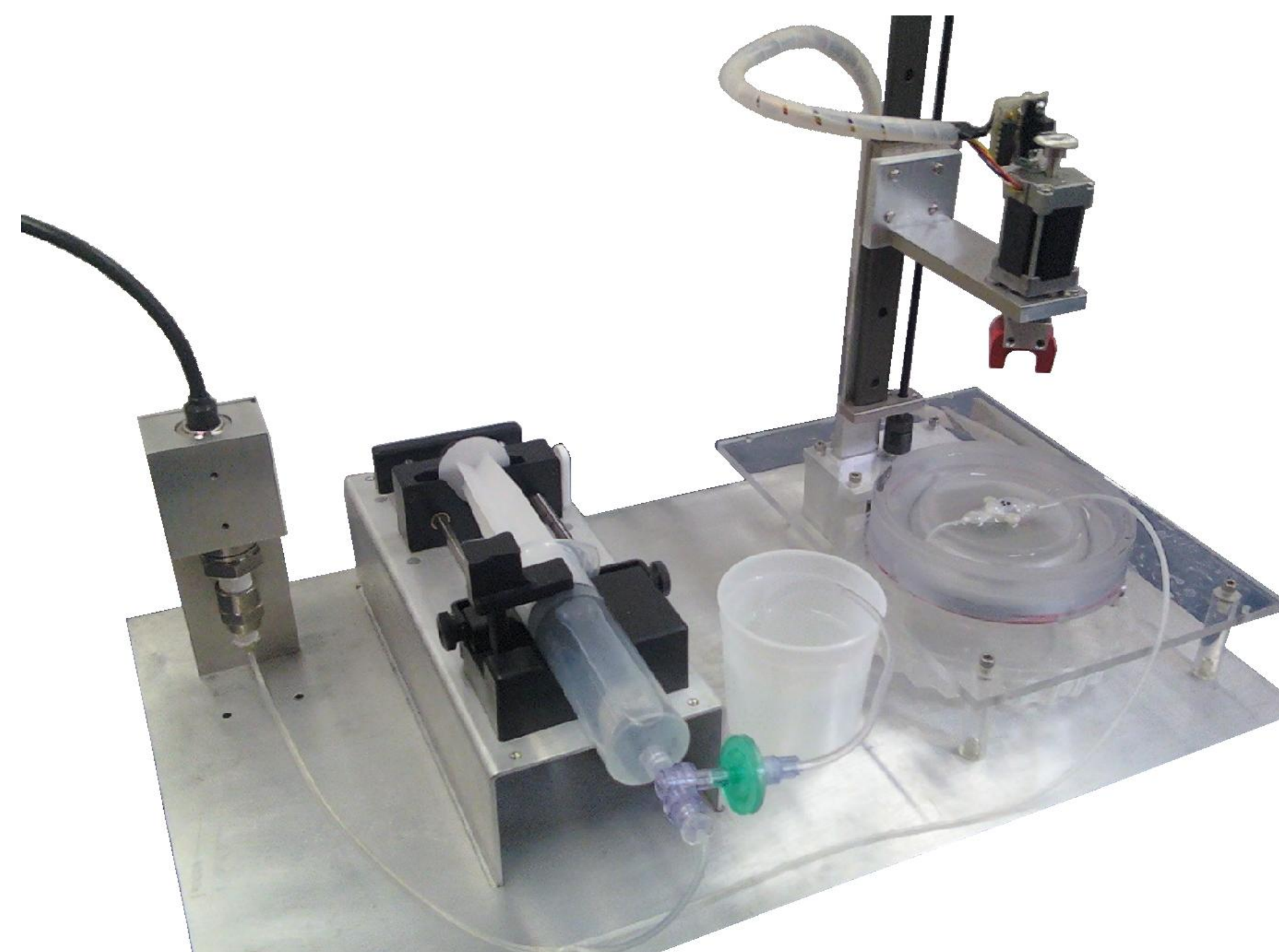


Figure 4. Automated Testing System Prototype.

Testing

To ensure system functionality:

- Tested the accuracy of the valve adjuster
- Ran pressure/flow tests
- Completed a Repeatability & Reliability study

The adjuster changed settings with 100% accuracy and the pressure/flow tests recognized more bad valves than Medtronic's testing method. The R&R study produced results comparable to Medtronic's with Repeatability and Reproducibility Standard Deviations of 0.24 and 0.35 respectively.

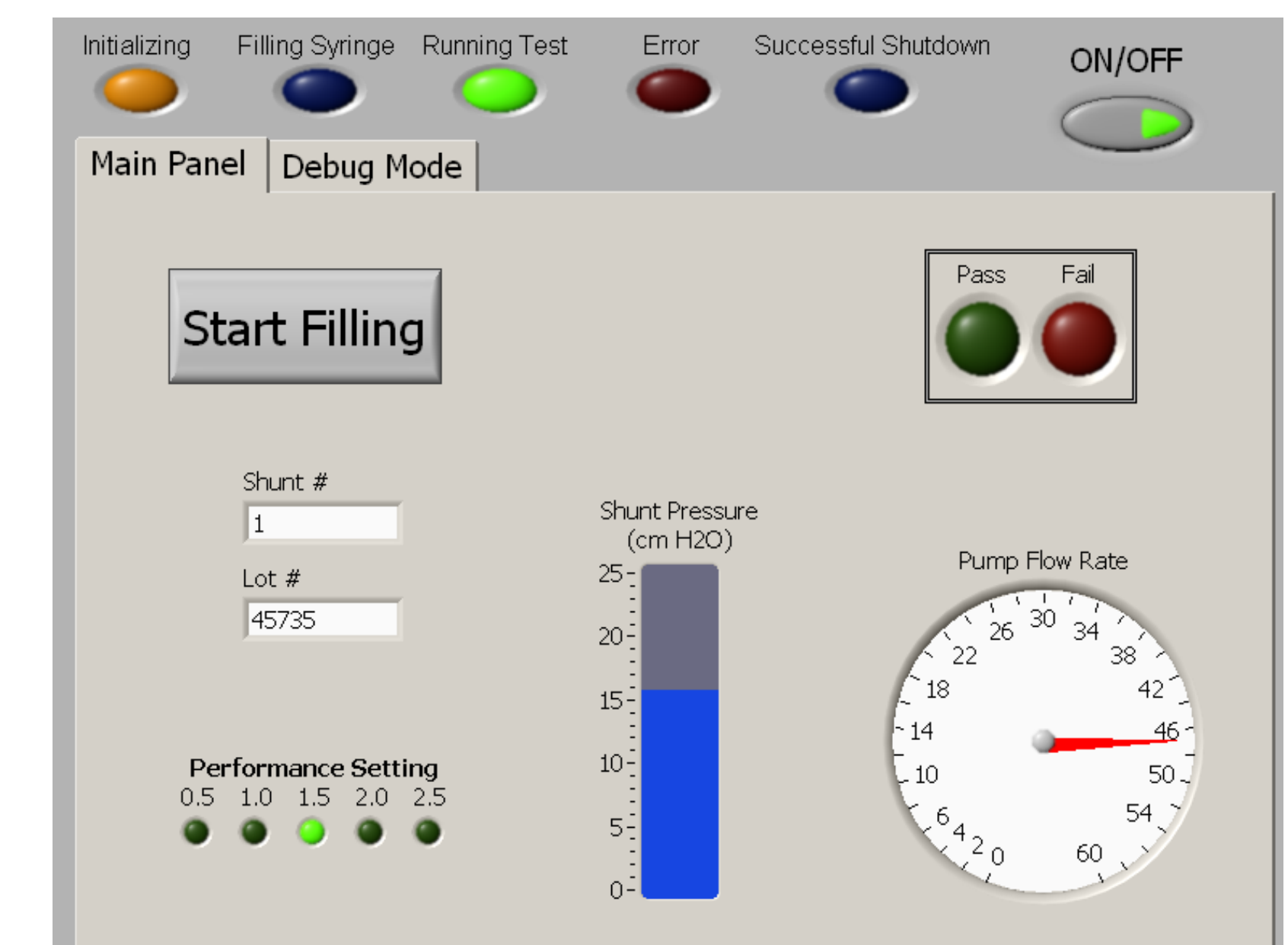


Figure 5. LabVIEW Graphical User Interface (GUI)

Results and Conclusions

All performance requirements were either obtained or improved upon. The system consistently completed over 100 successful tests demonstrating overall reliability. The controlling LabVIEW program is user-friendly and completes the testing procedure without operator interaction. The system has the potential to be integrated into the Medtronic testing facility.

References

<http://www.medtronic.com/your-health/hydrocephalus/index.htm>

Medtronic Technical Document number TD-04275

Medtronic Testing Procedure