Inexpensive Multi-Parameter Tester

Hailey Marsh, Roxanne Neufeld, Allison Saxby, Esteban Valencia, Robert Jameson, Trigun Soni, Taylor Hickson, Nathan Watson, David Miller, Abel Jacobs, Kevin Ortiz, Travis Carrel

Faculty Sponsor: Dr. Kristen Maitland (BMEN). Aggie Challenge and Engineering World Health

**Purpose**

Rwanda is a developing country in the heart of Africa. The lack of technology and useful resources present some unique challenges for the hospital workers in Rwanda’s District Hospitals. One such challenge that they encounter in the Rubavu District Hospital is a way to calibrate equipment that they already have. The departments have sufficient equipment, whether they are broken or working, much of it needs to be calibrated. Without proper calibration, one does not know if the devices are working properly, yet they continue to be used. More importantly, failure in calibration of medical devices or hospital equipment can lead to potential harm to patients and hospital workers.

**Objective**

Our goal is to design and manufacture a device for developing countries to test multiple parameters of different hospital equipment in a manner that is cost effective, with an emphasis on durability and simplicity. The following are the design specifications we want to achieve:
- Robust
- Able to measure:
  - RPM: 200-100,000 RPM
  - Temperature: 0-100°C with a 0.3°C resolution
  - Water Conductivity: 0-1500 μS
  - Air Pressure: 0-300 mmHg
  - Simple and portable
  - Battery-powered
  - Include a pictorial manual
  - Waterproof
  - Easily repairable

**Budget**

<table>
<thead>
<tr>
<th>Total Dissolved Solutes</th>
<th>Tachometer</th>
<th>Air Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Total Dissolved Solutes**

Water conductivity must be tested because hospitals must distill their own water in Rwanda.
- Water conductivity is a measurement that represents a solution’s ability to conduct electricity
- Conductivity is directly linked to the total dissolved solids
- Our device contains an extendable conductivity probe that will measure the conductivity of a solution
- Direct current is converted to alternating current through an oscillator. The signal is then amplified based on the conductance across the probes and then gets rectified to DC. This output is then processed by the microcontroller
- As conductivity increases, the voltage increases linearly

**Air Pressure Sensor**

The pressure sensor is included to calibrate sphygmomanometers (Blood Pressure Cuffs).
- Couples with blood pressure cuffs
- Uses an Omron 28MP-03 pressure sensor
- Provides a linear relationship between air pressure and output voltage
- Ranges from 0-2.7V for a pressure of 0-340 mmHg

**Tachometer**

The tachometer is included to calibrate the RPM of lab centrifuges.
- The tachometer works by a photo-transistor that acts as a switch across the circuit, using both an emitter and receiver
- When powered, it continuously emits an infrared light, which can be reflected off of a nearby surface
- This reflection switches open the circuit to output a voltage
- The total number of these voltages that occur over time corresponds to the number of rotations per minute

**Results**

Below are results taken from our pressure, total dissolved solutes, and temperature sensors, and tachometer respectively:

**Conclusion**

We met our specifications for temperature, water purity, and air pressure. The temperature sensor yields a linear voltage to temperature reading, allowing our device to display an accurate value. The particulates sensor returns a level of pollutants within the water in ppm. Finally, the air pressure sensor outputs a pressure of 0-340 mmHg.

**Next Steps**

The Multi-Parameter tester will be taken to Rwanda by a team of Engineering World Health students. The device will be used to aid in the calibration of medical equipment in hospitals.

**Acknowledgements**

- Hospital Workers in Rubavu District Hospital
- Faculty Sponsor: Dr. Kristen Maitland (BMEN)
- Email: kmaitland@tamu.edu
- Mentor: Mason Cote
- Engineering World Health
- Hospitals in Rwanda
- Patients

**References**

- http://www.newark.com/omron
- The Multi-Parameter Tester
- “Stellaris® LM4F120H5QR Microcontroller” DS41514F120H5QR
- “Multifunction Data Acquisition System”