All-In-One Sensory Diagnostic Tool
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Background
A neurological disorder is defined as a disorder of the body's nervous system. Biochemical, electrical, or structural abnormalities within the brain or spinal cord, or within the nerves leading to or from the central nervous system, can result in loss of sensation, muscle weakness, and paralysis.

Neurological disorders stem from problems in the transmission or reception of signals between neurons within the nervous system.

Light Touch/Pressure Sensation
AIO Medical implemented a retractable monofilament to test for light touch sensation and pressure sensation. In order to touch for light touch sensation, the neurologist utilizes the monofilament in a horizontal manner to lightly move individual hairs upon the patient's limbs. For pressure sensation, the neurologist presses the monofilament against the patient's skin with increasing force.

Offaction Sensation
Three essential oils (lemon, peppermint, and pine) were implemented to test for offaction sensation. Three small sponges were soaked in the essential oils and then placed within three separate appendage tubes.

Pain Sensation
A retractable pin was implemented to test for pinprick pain sensation. The pin has a built-in safety mechanism that causes the pin to move in an opposite manner when being pressed against the patient's skin. The pin component also includes a removable cap for additional prevention of accidental injury.

Temperature Sensation
A Peltier device coupled to a circuit for temperature regulation is used for temperature sensation testing. The circuit amplifies the current to achieve effective changes in temperature, and through an external switch, allows current to run in both directions. Reversing the polarity of the circuit allows the exposed side of the Peltier device to switch between hot and cold temperatures. The following figures chronicle the process of transforming a circuit schematic to a printed circuit board.

Method

Requirements Verified/Not Addressed

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Test(s)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Touch/Pressure Sensation</td>
<td>Test on 5 volunteers</td>
<td>Light touch and pressure sensations induced without causing pain</td>
</tr>
<tr>
<td>Offaction Sensation (Essential oils)</td>
<td>Test on 5 volunteers – blind scent detection</td>
<td>Scents easy to distinguish and do not linger in air</td>
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<tr>
<td>Pain Sensation</td>
<td>Test on 5 volunteers – blind pain induction and safety mechanism</td>
<td>Pinprick pain induction without causing harm to safety mechanism</td>
</tr>
<tr>
<td>Temperature Sensation (Peltier device + circuit)</td>
<td>Test on 5 volunteers – effective and safe temperature changes</td>
<td>Hot/cold sensations induced, temp. remains in safety range</td>
</tr>
<tr>
<td>Vibration Sensation (Solenoide + circuit)</td>
<td>Test on 5 volunteers – side-by-side comparison with tuning fork</td>
<td>Very representative of tuning fork, stimulates vibration sensation</td>
</tr>
<tr>
<td>Reproducible Tests</td>
<td>Quantity circuit reproducibility</td>
<td>Solenoide: 128 Hz, constant amplitude; Peltier: 40 – 70 Hz</td>
</tr>
<tr>
<td>Professional Appearance</td>
<td>Demonstrate to potential users – comparison with current instruments</td>
<td>N/A due to time constraints</td>
</tr>
<tr>
<td>Lightweight &amp; Durable</td>
<td>Manufacture device out of lightweight material</td>
<td>N/A due to monetary and time constraints</td>
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</table>

Conclusions

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The components of this device, especially those that allow for the conduction of reproducible tests, will assist neurologists in revealing potential problems with the transmission and/or reception of signals within the neurons of the nervous system. Unearthing such problems will allow neurologists to diagnose and subsequently treat neurological disorders in order to restore partial or full sensory perception.

Future Directions for Device
The next generation of the device will include a laser diode, smaller and more efficient circuits, and an LCD display screen. A laser diode would provide a non-invasive, non-contact method of inducing pinprick pain and thus testing for pain sensation. Working closely with electrical engineers and outsourcing the circuits to fulfill modifications would allow for a more handheld and lightweight device. Incorporating a 7-segment LCD display screen in conjunction with modifications to the circuits would allow for temperature and vibration output.

Acknowledgements
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References
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Purpose
Our mission is to develop a compact, all-in-one alternative to the current array of neurological examination tools used today. Current instruments used during neurological examinations are highly dependent upon the user and thus yield subjective results. Our device will provide methods for conducting reproducible tests and thus eliminate this subjectivity.

Market Analysis
A variety of instruments are currently used during a neurological examination. The AIO diagnostic tool is an innovative device that is marketed primarily toward resident neurologists and practicing neurologists. Currently there are approximately 13,300 practicing neurologists in the United States alone. However, AIO Medical designed the device so that it is simple and easy to use, allowing physicians the possibility to conduct preliminary sensory examinations effectively in a minimal amount of time. Therefore, the secondary customers include physiatrists, internists, and family practice physicians and residents.

Due to its potential to enter wide-range of customer segments, the AIO diagnostic tool is expected to flourish in the current market. With the predicted growth and its potential to standardize neurological examinations and thus revolutionize the clinical industry, the device will become more prevalent in hospitals and private practices.

Device Classification
The All-In-One (AIO) Sensory Diagnostic Tool is classified as a medical device since it is intended for use in the diagnosis of potential neurological pathologies in human patients. Specifically, it is a Class I medical device since it is simple in design and manufacture, presents minimal potential harm to the user and patient, and it contacts only intact skin of the patient.

Device Schematic

Printed Circuit Board

PRO/E Prototype

The external casing provides an ergonomic shape, professional appearance, and allows for efficient housing of all internal and external components.

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