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Bodkin Design Featured in Medical Design Technology

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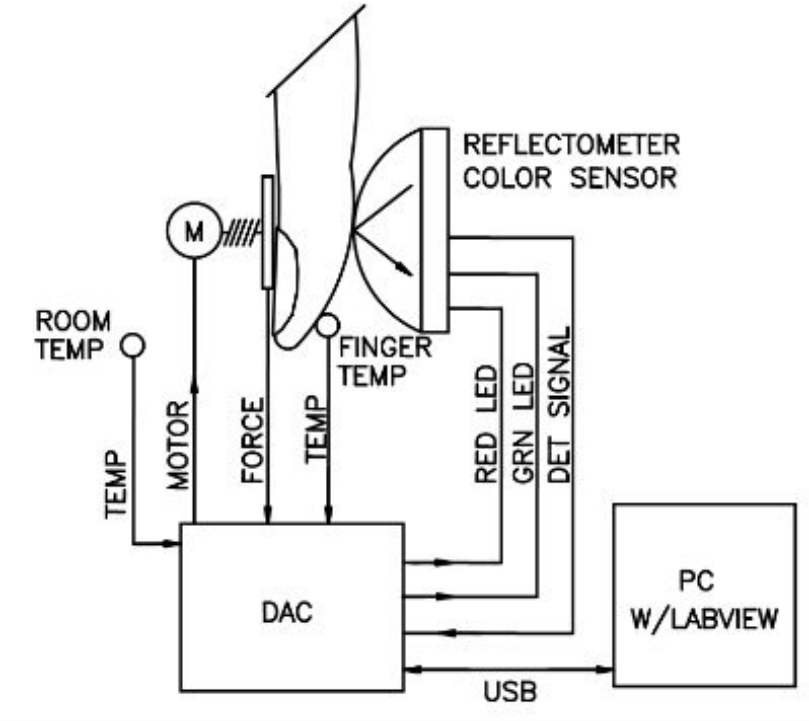
A New Optical Technique to Improve Diagnostic Accuracy of Dehydration in Young Children

By Brian Imhausen, Electro-Optics Design Engineer and Project Manager, Bodkin Design and Engineering LLC

Bodkin Design is featured in Medical Design Technology (MDT) for designing the non-invasive optical device for measuring Capillary Refill Time (CRT). One clinical measure of dehydration in young children relies on Capillary Refill Time (CRT). The doctor visually evaluates the time it takes for the patient's finger to refill

with blood after a squeeze is released. This subjective assessment of CRT is an inexact measurement of dehydration. The Center for Integration of Medicine and Innovative Technology (CIMIT), in collaboration with Phil Levin of Advanced Devices, hired Bodkin Design and Engineering (BD&E), an electro-optic research and design firm, to develop a handheld device for dehydration measurement. BD&E provided R&D support to evaluate the prototype and update the instrument to collect dehydration data in the field. BD&E worked in partnership with Vassillios Bezzerides MD, the clinical fellow in the Cardiovascular Program at Children's Hospital Boston who invented the device.

During his daily routine Dr. Bezzerides noticed that it is often difficult to determine whether a patient is properly hydrated. Measuring electrolytes or other markers in blood or urine can provide a good gauge, but they involve cumbersome sample collection and can produce false positive results. A quick, noninvasive test involves the application of gentle pressure on a fingernail until it turns white. The length of time it takes for the finger to regain color indicates the capillary refill time. However, this test is crude and its interpretation is highly subjective.



Schematic diagram of CRT fingertip sensor

The developed non-invasive optical system measures the light reflected by a fingertip from signal and reference light sources. By monitoring the reflected light when a localized uniform pressure is released, the system can sense changes in the patient's blood flow. The instrument then calculates the Capillary Refill Time after correcting for finger temperature, room temperature, force applied to the finger, and the reference signal intensity. Regarding the prototype device, Andrew Bodkin, President of BD&E said, "To optimize the performance value of the device, we created robust laboratory tests which involved recording and replaying the test procedure in a controlled environment. After a deeper analysis of the prototype, it was discovered that the contact surface area was difficult to control. We were able to resolve the issue by affixing a glass riser on the slide, to keep the contact area constant while force is applied. In order to improve the overall measurement accuracy, the initial design evolved through a series of design concepts. Rapid design iterations yielded an improved device that incorporated all aspects of a clinically useful, portable and patient-friendly CRT device."

The device may also have applications outside the hospital, at the bedsides of assisted living patients and among athletes, who need to measure their hydration during rigorous activity. Most importantly, this device could be used in developing countries with a high incidence of dehydration caused by gastrointestinal

infections, especially among children. A CRT measurement system could have an impact on patient triage, allowing limited staff to focus on patients who need immediate attention.

Back to top

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