'Smart cane' could one day help flag gait problems, falling risks more quickly

February 13 2018, by Liz Entman

Feeling a little unsteady and don't know why?

A pair of Vanderbilt University engineers have developed an instrumented cane that not only provides added support, but can also analyze your gait to determine your risk of falling. Nilanjan Sarkar, professor of mechanical and computer engineering, says the "IntelliCane" can quantitatively calculate falling risk as accurately as a physical therapist can with their own eyes.

If you are a senior citizen, dizziness and balance problems can be a big deal. In the United States, every year one out of three adults over 65 years of age falls and the statistic climbs to one out of two after age 80. Falls can be serious, leading to hip and other bone fractures, brain injury, loss of independence and even death. Falls are also expensive: The cost of treating injuries from falls is estimated at $34 billion annually.

The problem is not restricted to the elderly. There are a number of illnesses that cause balance disorders, ranging from ear infections, head injuries and poor blood circulation to Parkinson's, spinal stenosis and stroke, and these patients could benefit from such a device.

"When I realized how big this problem was, we started searching for available solutions," said Sarkar. "Initially, my thought was to design something to prevent falls, but after more thought and a little experimenting we quickly realized that this was not practical. The next

best thing was to determine how to reliably estimate the fall risk so that intervention can be applied when a person's risk gets so high that they could fall at any time."

Currently, physical therapists estimate falling risk by observing the patient walking back and forth between two lines under a variety of conditions—slow and fast, looking right and left, stepping over obstacles, while blindfolded, up and down steps. The therapist then employs a standardized rating scale to evaluate how steady the patient is on each task and combines the ratings into an overall risk estimate.

However, this test cannot always capture a patient's full experience throughout the day, or from day to day, or within their usual environment. Nor can it capture problems the therapist may be unable to see.

Sarkar and graduate student Joshua Wade wanted to develop a tool that could help therapists collect much richer data about their patients' gaits as they went about their everyday lives, enabling therapists to intervene more quickly if needed.

Most current research into that area requires patients to place sensors on their body or in their shoes, which the researchers say isn't ideal. "Body sensors require a significant extra effort on the part of patients. We wanted an approach that was as easy as possible for people to use," said Wade, who decided to work on the project because of its potential health benefits. "We decided to instrument a cane because it is familiar. Most people with balance problems already use one, and the only thing extra that they have to do is plug it in at night."

The engineers rigged an off-the-shelf offset cane with inertial and force sensors connected to a wireless microcontroller that provides real-time data on how a person uses the cane while walking. The data is fed into an

algorithm that analyzes the sensor data and pulls out information about the steadiness of the user's gait.

When they had a design that worked, the engineers tested the system with nine patients. First, they asked the patient to walk around using the IntelliCane. Then they were asked to participate in a standard risk assessment procedure called the Dynamic Gait Index in the presence of a physical therapist, who scored their performance. After analyzing the cane data, the researchers determined that they could predict each patient's DGI score with a high degree of confidence.

"i think it is quite innovative," said Patricia Fleming, a physical therapist at Vanderbilt University Medical Center who participated in the test. "Many people don't have access to a sophisticated gait lab, so a device such as this could augment what we do in the clinic. Almost everyone who comes to the neurological clinic where we work has a balance problem and many of them use a cane. So, we think it's exciting to be part of this project."

Now that the initial study has validated the basic approach, Sarkar and Wade are convinced that it could have a number of benefits. If a person with a balance problem uses the cane regularly, for example, it may be able to detect when its user's sense of balance begins to deteriorate and report this to his or her doctor. They also think it could be applied to other devices such as wheeled walkers and crutches.

With more advanced analysis, the IntelliCane might even be capable of providing detailed enough information to enable doctors to diagnose specific diseases that affect a person's sense of balance. For example, Parkinson's might alter a person's gait in a manner that is detectably different from multiple sclerosis, they speculate.

Vanderbilt has applied for a patent on the technology, and Sarkar and

Wade have formed a company called Adaptive Technology Consulting to commercialize it.

Provided by Vanderbilt University