Toe-tapping test evaluates fall risk in Parkinson's patients

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Researchers have created a toe-tapping test utilizing smart shoe insoles capable of safely assessing Parkinson's patients' falling risk. Credit: Texas A&M Engineering

Out of every 200 people, three live with Parkinson's disease. A progressive disorder that impacts the central nervous system and currently has no cure, Parkinson's disease can cause mobility issues, increasing patients' risk of falling.

A team of researchers from Texas A&M University has developed a toe-tapping test for patients with Parkinson's disease that gathers

information from smart shoe insoles and transfers data to a simple phone application. The results from the test can help determine a patient's falling risk while providing insights such as symptom progression and treatment suggestions.

This study was published in *IEEE Sensors Letters*.

"We have developed a lightweight, easy-to-install, self-powered insole you can place within any kind of shoe, as well as a correlating test that can accurately determine fall risk," said Dr. Ya Wang, associate professor in the J. Mike Walker '66 Department of Mechanical Engineering. "For people living in rural or underdeveloped areas or people who may not feel comfortable taking a walking test, our technology presents a solution to monitor their disease progression."

Parkinson's disease can have a wide range of symptoms, such as tremors, muscle stiffness or degrading balance and coordination. Symptoms can differ from patient to patient, making it difficult to diagnose and treat and often resulting in extensive medical visits and medications.

"There are symptoms you can observe using your naked eyes, such as patients taking smaller steps or imbalance," said Wang. "However, many cannot be seen by using the current tests and technology available. This inability to accurately characterize symptoms takes a physical toll but can also cause psychological suffering stemming from pain and immobility."

Parkinson's disease can be diagnosed by professionals using a combination of walking and toe-tapping tests where the patient's movements are closely observed. The symptoms are analyzed using the Unified Parkinson's Disease Rating Scale (UPDRS).

However, this method presents risks to patients struggling with mobility,

both while commuting to the physician's office and while taking the test itself. Additionally, this does not consider the subtle symptoms that are not visual or may not appear during the walking tests.
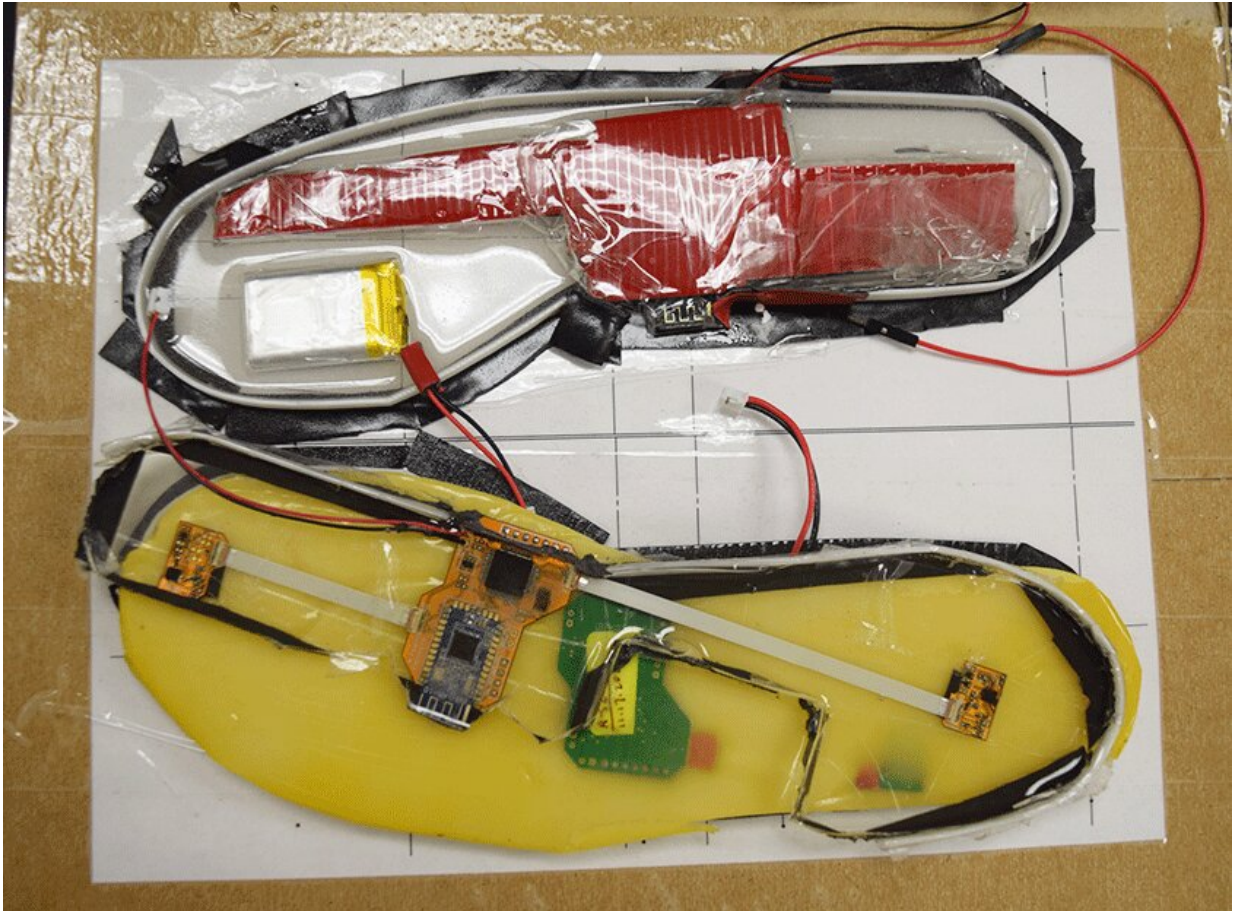
The smart insoles collect data from the toe-tapping test and transfer the information to a phone application. Credit: Texas A&M Engineering

"Experiments with patients show that when you ask them to walk, they are usually very nervous, causing differences from their normal walk," Wang said. "This can be a source of confusion when diagnosing walking behaviors and requires a long period of data."

To combat this problem, the researchers developed a toe-tapping test that uses smart technologies capable of compiling significant amounts of data, uncovering information that can help diagnose patients, characterizing their symptoms and, over time, showcasing disease progression.

The test begins by inserting a wearable insole that can be placed within any shoe. As the patient completes a series of toe-tapping patterns, the smart insole collects and transfers data in real time to an accessible phone application. The more tests a patient completes, the more elaborate and accurate the data becomes.

"From just toe-tapping, the application can tell whether a symptom is being managed appropriately and whether the management, such as physical therapy or medication, is effective," said Wang. "If the management is not appropriate or effective, the application can suggest a doctor's visit, recommend an increase or decrease of medication dosage and/or frequency or provide insight into whether new medication and previous treatments worked or did not work."

The key finding from the study is that toe-tapping tests can yield results, almost as accurately as the walking test, that indicate a patient's risk of falling according to the UPDRS scale.

Because the test can be completed at home with fewer resources, and the information gathered is readily available to the patient, it provides an avenue for those with Parkinson's disease to receive essential medical care at inexpensive costs through a safer and less taxing process.

"We are providing a way for patients to easily comprehend how their symptoms and medications are correlated while outlining risks in one easy-to-use platform," said Wang. "In the future, we want to use this technology to develop preventative measures installed within the sensors

to help ensure their safety."

More information: Rui Hua et al, Toe Tapping Based Falling Risk Evaluation for Patients With Parkinson's Disease Using Monitoring Insoles, *IEEE Sensors Letters* (2022). DOI: 10.1109/LSENS.2022.3172930

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