

# Smart sensors to test seniors' cognitive functions

## Researchers track memory, movements and sleep patterns to identify any impairment

**Theresa Tan**  
Senior Social Affairs Correspondent

A team of researchers has found a novel and promising way to gauge seniors' cognitive functions – without testing them through conventional methods – by using a network of sensors to track their memory, movements and sleep patterns over a period of time.

In about seven out of 10 cases, they correctly identified the seniors who had been diagnosed with mild cognitive impairment, based on data generated by the sensors.

Mild cognitive impairment causes a slight but noticeable decline in cognitive abilities, such as memory and thinking skills. A person with such impairment has a higher risk of developing dementia.

Associate Professor of Information Systems (Practice) Tan Hwee Pink described the study results as promising. Prof Tan, from Singapore Management University's (SMU) School of Information Systems, is the study's co-principal investigator, while Dr Iris Rawtaer, a consultant at Sengkang General Hospital, is its lead investigator.

The other researchers in the team are Associate Professor Rathi Mahendran, Professor Kua Ee Heok and Associate Professor Ng Tze Pin – all from the National University of Singapore; Assistant Professor Tan Hwee Xian from SMU; and Associate Professor Lee Tih Shih from Duke-NUS Medical School.

The study was published in the Journal of Medical Internet Re-

search in May.

The pilot study is the first of its kind in Singapore and it is noteworthy given Singapore's rapidly ageing population and the growing number of elderly diagnosed with dementia, said Prof Tan Hwee Pink.

He said the researchers wanted to detect mild cognitive impairment at an early stage, which could give a senior the best chance to reverse the impairment or at least delay the deterioration with appropriate treatment.

However, many patients depend on their loved ones to report decline in their cognitive ability and this is often noticed when the decline is relatively advanced.

Doctors currently ask the patient a series of questions and perform other tests to determine his cognitive ability. These traditional tests usually catch cognitive impairment at a later stage, Prof Tan Hwee Pink said.

Hence, the researchers felt they could use a network of smart sensors to be the "eyes and ears" to flag seniors who may be showing signs of mild cognitive impairment. This would complement the traditional screening tests.

The study involved 49 seniors, aged between 65 and 85, and who live alone.

Before the start of the study, 28 of them had been diagnosed with mild cognitive impairment, although the researchers did not know their identities. The rest had healthy cognition.

All the seniors had a network of sensors installed in their homes for two months. They included motion

## Get smart – sensing seniors' situation

Researchers used a network of sensors installed in the seniors' flat to track their memory, movements and sleep patterns over a period of time.

- 1. Gateway**  
All non-gateway devices transmit their data wirelessly to the gateway, which aggregates and sends the data to the server via the internet for the researchers to analyse.
- 2. Tap usage sensor**  
This is used to determine if the senior had forgotten to turn off the tap before moving away from the designated area.
- 3. Sensorised medication box**  
Each time the box is opened, data is generated and used to determine how frequently the seniors forgot to take their medicine.
- 4. Motion and environmental sensor**  
This is to detect motion.
- 5. Bed occupancy sensor**  
Placed under the mattress, this sensor provides data on the length and quality of sleep.
- 6. Contact sensor**  
This sensor is placed at the flat's main door and on the medication box to detect if they are open or closed.
- 7. Smart plug**  
It monitors the usage of the appliance it is connected to based on voltage measurements.
- 8. Wearable**  
Activity bands worn by the seniors measure their heart rate.



**9. Beacon tag**  
Proximity beacon tags (right) are attached to the seniors' keychain and wallet. Through these tags and wearable motion sensors, researchers are able to determine if the seniors had taken their wallet and keychain with them when they left their home.

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sensors placed in their bedroom, living room and bathroom. There was also a bed sensor under the mattress that provided data on the user's length and quality of sleep. A medication box fitted with a

sensor was also given to the seniors. Each time the box was opened, data was generated and this was used to determine how frequently the seniors forgot to take their medicine. Proximity beacon tags were at-

### VALUE OF SAFETY

Many of them saw the value of it from the safety perspective, as there is an alert system built in and if they did not move for more than eight hours, a doctor would be alerted. So they felt that if they fell, someone would know about it (and help them).



**ASSOCIATE PROFESSOR TAN HWEE PINK**, on some seniors asking if the sensors could be placed in their homes permanently.

The study is noteworthy given Singapore's rapidly ageing population and the growing number of elderly diagnosed with dementia, says its co-principal investigator Tan Hwee Pink. ST PHOTO: LIM YAOHUI

tached to the elderly person's keychain and wallet. Through these tags and wearable motion sensors, the researchers were able to determine if the senior had taken his wallet and keychain with him when he

left home. This was another measure of memory.

The seniors also wore an activity band that measured heart rate and the number of steps they took daily.

Prof Tan Hwee Pink said cameras were not installed in their flats to protect their privacy.

Based on the data gleaned on their sleep patterns, the researchers were able to identify accurately about seven in 10 seniors who had been diagnosed with mild cognitive impairment. They found that those with mild cognitive impairment had more interrupted sleep at night. They also forgot to take their medicine more frequently and were less physically active than those who had healthy cognition.

Prof Tan Hwee Pink said most of the seniors found the move to install sensors in their homes for the study acceptable and some even asked if they could be placed there permanently. "Many of them saw the value of it from the safety perspective, as there is an alert system built in and if they did not move for more than eight hours, a doctor would be alerted. So they felt that if they fell, someone would know about it (and help them)."

theresat@sph.com.sg