# Demo Abstract: Using a Sensor Network to Enhance a Standardized Medical Test

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***Abstract*—We demonstrate how a sensor network can be used for enhanced medical testing. Our work makes use of a floor construction with acrylic floor tiles, resting on cheap and simple load sensors, which are in turn connected to sensor nodes. In combination with wireless networking capabilities and output LEDs in several colors, we present a test setup for a modified Timed Up & Go Test from medical diagnosis of elderly people.**

## I. Introduction

In recent years, more and more wireless sensor network testbeds have become available. Very often these networks aim at the development and evaluation of new algorithms and communication protocols. Clearly, this is not an end by itself; instead, the final justification of the underlying research lies in new methods and tools for other sciences, and in enhancing the life of many individuals.

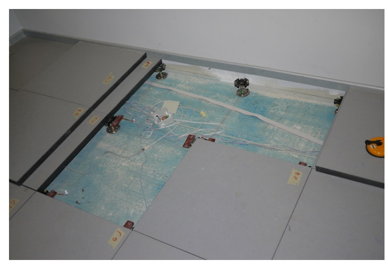
A particularly fascinating aspect of the design, development, and evaluation of sensor networks lies in the combination of local knowledge to obtain global goals, based on appropriate sensor data. To carry out such tests, we have developed a hallway monitoring system, consisting of 120 cheap and simple load sensors deployed beneath the hallway floor. The sensors are connected to a total of 30 nodes, which in turn can then exchange the measured values. Being highly correlated, these sensors serve as an ideal testbed for any algorithm performing data aggregation or in-network data analysis, such as distributed target tracking. See [2], [1] for further details.

In our demonstration, we show how this kind of technology opens up new avenues for other sciences. We illustrate this by an enhanced example of a standardized test from medicine.

## II. The Timed Up & Go Test

The “Timed Up & Go Test” ( TUG ) is a simple and widely known physical test to assess the mobility of older persons [7], [6]. For the test procedure the subject is asked to stand up from a chair, to walk a short distance, to turn around, to walk back and to sit down. The result is the time needed to complete the test. There are approaches to enhance the informative value of the test, primarily using body-worn accelerometers to distinguish between patients with Parkinsons disease [8] or even to assess the risk of falling [5].

(a) The installation site.



(b) Floor tiles rest on columns.

Fig. 1. Hallway monitoring scenario.

## III. Demonstration

We will demonstrate an application of wireless sensor networks in the field of medical computer science. As an example, our demonstration will show how the TUG can be standardized by using a controlled environment which is equipped with sensors. Our platform consists of 9 acrylic floor tiles that are deployed on a grid of 16 load sensors. Each 4 of these sensors are connected to one sensor node, which in turn is connected to one LED light and a speaker.

### A. Sensors and Actuators

The load sensors are a simple and cheap construction. They consists of strain gauges, glued to small steel plates [2], [3]. Whenever the steel is strained or deformed, even by a few nanometers, the output value of the load sensor changes. Fig. 2 shows an example data sample of two load sensors, monitoring a single floor tile on which a chair is positioned. The top figure shows a front leg of the chair, when a person sits down, waits for some time, and then stands up. The bottom figure shows a rear leg of the chair during the same test.

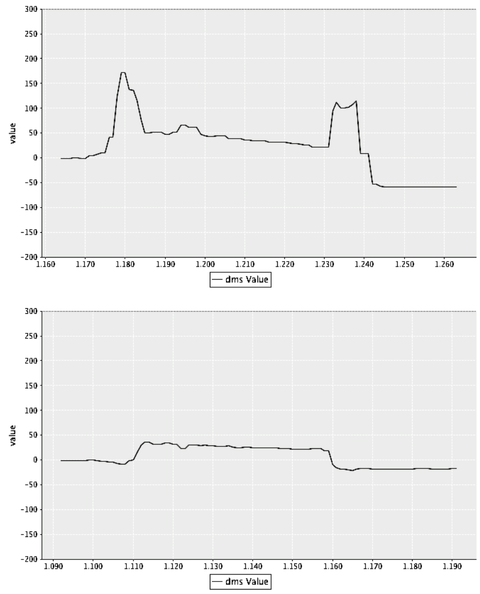



Fig. 2. Data samples of load sensors. Shown are the front and back pressure on the sensors below a chair; the first peak corresponds to a person sitting down, the right to standing up. Clearly, there is more pressure to the front of the chair than to its back.

The load sensors are connected to iSense sensor nodes [4]—each four load sensors to one node—to be used to process the data directly in the network. The floor is monitored in a distributed manner, so occupied tiles can be identified, even if a floor tile's load sensors are connected to several nodes.

Finally, each sensor node is connected to an actuator unit, consisting of a LED and a speaker to play back sound samples.

### *B. Construction*

Our demo platform is a square-shaped wooden construction with a base area of 245cm x 245cm and a height of 25cm. It has a 4x4 grid of load sensors in the interior. Each of the 9 acrylic floor tiles has a side length of 60cm and is placed on the sensors, such that each of the tiles corners rests on one sensor. The tiles are held in place by a 22.5 cm wide wooden border. The LED lights are beneath the tiles in the corners of the 3x3 tile field while the speakers are built into the frame of the platform. Fig. 3 shows the whole construction.

### *C. Demo*

Our demonstration will show how a sensory environment can be used for standardized medical testing, making results more comparable. More importantly, we show how such a standard can be enhanced by additional information. While the original TUG requires walking a straight distance of 3m, in our modified version of the test the test person has to stand up from one chair, walk along the perimeter of the platform to another chair and sit down. The test subjects will receive light and sound instructions from the platform during the test, while the platform surveys that the test person walks the right distance

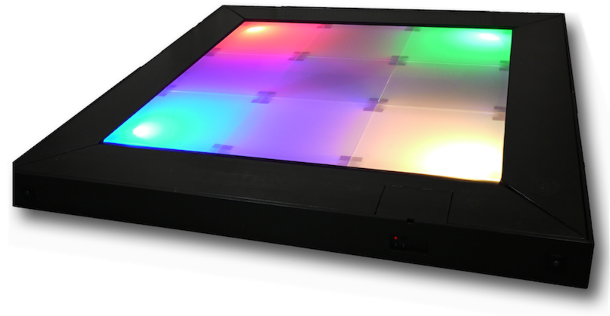


Fig. 3. The whole platform with illuminated floor tiles.

during the test and measures the time needed to complete the test. The test is controlled by our Corridor Control System (COCOS) [2] which displays the test results on the built in screen of the platform. As an additional feature, COCOS offers a client/server architecture, which allows full remote control of the demo platform and the test.

## IV. Conclusion

We will show how a simple, standardized test that originally only yields a single number (the time for performing the test) can give rise to a multitude of differential data, for example step frequency and intensity. This allows a much finer and wider range of medical diagnosis, as well as tailor-made interactive testing and subject feedback.

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