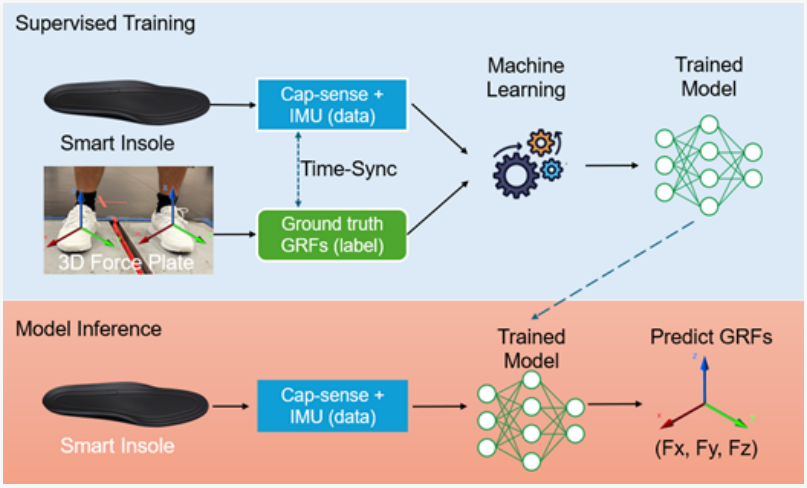
Smart Insoles Transform 3D Ground Reaction Force Estimation

GA, UNITED STATES, February 27, 2025 /EINPresswire.com/ -- A group of UK Researchers have developed an innovative method for accurately estimating three-dimensional ground reaction forces (3D GRF) using a low-cost smart insole system combining advanced artificial intelligence techniques. This portable solution overcomes the limitations of traditional measurement platform devices in terms of cost and convenience.



HOW THE SMART INSOLE ESTIMATE 3D GRFs BY USING AI Model.

What if a pair of insoles could do more than support your feet? Imagine insoles that monitor your health, improve your workouts or help doctors treat injuries. A team of researchers in the UK did just that – making smart insole system a reality. In particular, the system can accurately measure the body's interaction with the ground, opening new possibilities in sports science and healthcare by estimating ground reaction forces (GRFs).

Accurately measuring movement patterns has always been an important goal for specialists in sports science and medical professionals. However, traditional methods have struggled to meet the real-world demands.

“Traditional tools like force plates or treadmills are expensive, bulky, restricted to lab environments and may disrupt natural gait patterns,” explains one of the researchers behind the study Dr Dinghuang Zhang. “We wanted to create an affordable and portable alternative that people could easily integrate into their daily lives. If an insole-based system can provide similar results to force plates, it represents not only a major breakthrough for the force plate industry but also a game-changer for healthcare, sports science, and rehabilitation, making advanced motion analysis available to everyone, anywhere."

To that end, the team created the TG0 smart insole, which captures fine-grained movement information such as the pressure distribution under different parts of the foot, while the built-in

inertial measurement unit (IMU) provides precise motion tracking.

“This combination makes it an exceptionally versatile data acquisition platform, not only for supporting research but also for practical applications in healthcare, rehabilitation and sports science,” explains Dr Liucheng Guo, the project lead and CTO of TG0.

Leveraging the advanced TG0 Smart Insole with an innovative artificial intelligence (AI) method, their method demonstrated extremely high accuracy with an error rate as low as 4.16%. Specifically, the team designed and implemented an experimental setup involving various movement protocols.

Earlier methods, such as motion sensors or pressure insoles, typically had error rates ranging from 8% to 20%. Even advanced systems with high-tech sensors struggled to achieve better accuracy. In contrast, the TG0 Smart Insole system dramatically outperformed these approaches, offering a reliable and affordable solution for monitoring movement in real-world scenarios.

What sets this study apart is that the team also created a publicly available dataset that combines sensor data from insoles with gold standard force plate readings. This dataset is the first of its kind dataset includes multi-modal sensor data from smart insoles with force plate readings and could accelerate research in biomechanics and wearable technologies.

“This opens up exciting opportunities,” adds Dr Guo. “Athletes can easily analyze their sports performance, reduce injury risks, and optimize their training.

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