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Development of the Wearable Knee Joint Sensor to remove Skin movement noise

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Introduction
The present paper deals with the development of a wearable knee joint angle measurement sensor. A new design sensor cover is also proposed which reduces noise signals related to virtual knee joint angle errors caused by change of coordinate location that is attributable to the motion of skin soft tissue during walk.

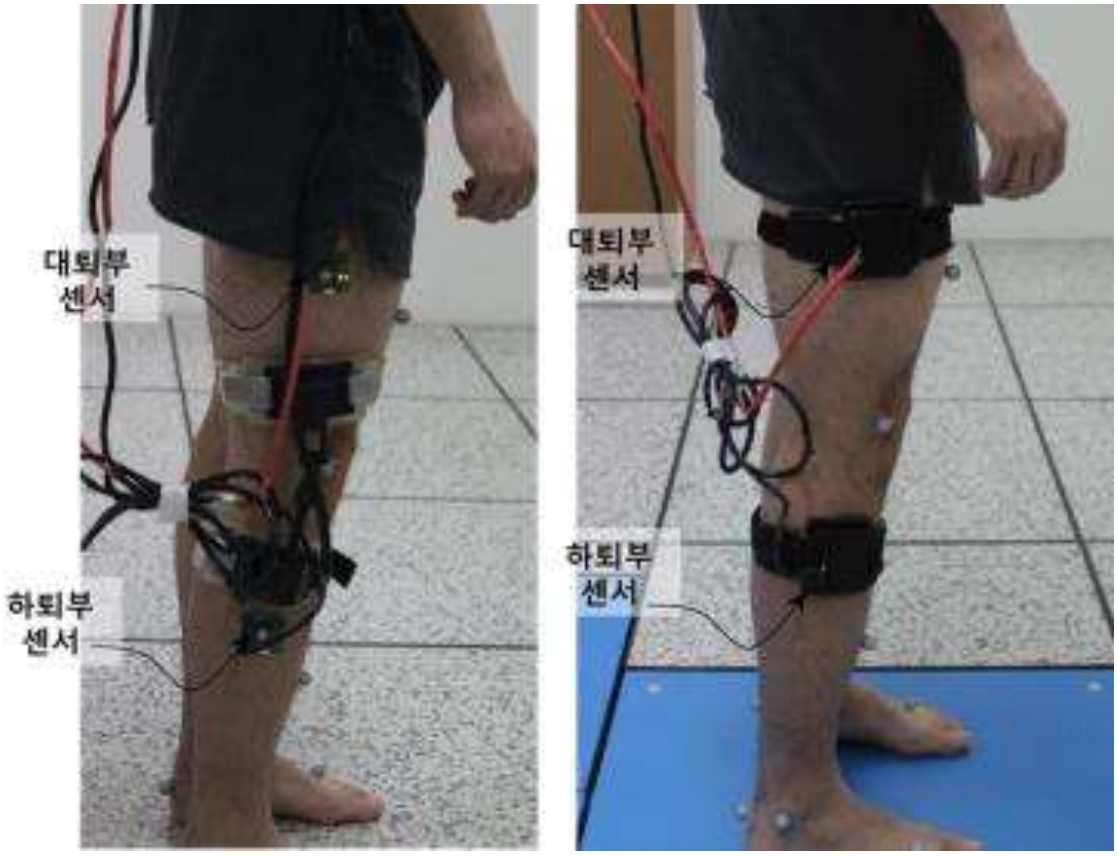
Objective
The study was designed to evaluate the efficacy of wearable knee joint sensor, compared with a three-dimensional infrared gait analysis system

Methods
The sensor module of this measurement system is based on inertial measurement uits(IMUs) sensor that can measure 2 DOF (Degree of Freedom) knee joint angles. The structure of the system allows sensors to be wearable on a thigh and a lower extremity respectively. The sensor thus developed was evaluated by Vicon®, a three-dimensional infrared gait analysis system. The experiment for the evaluation was conducted three times with the gait velocity of 3 km/h, 4 km/h and 6 km/h.

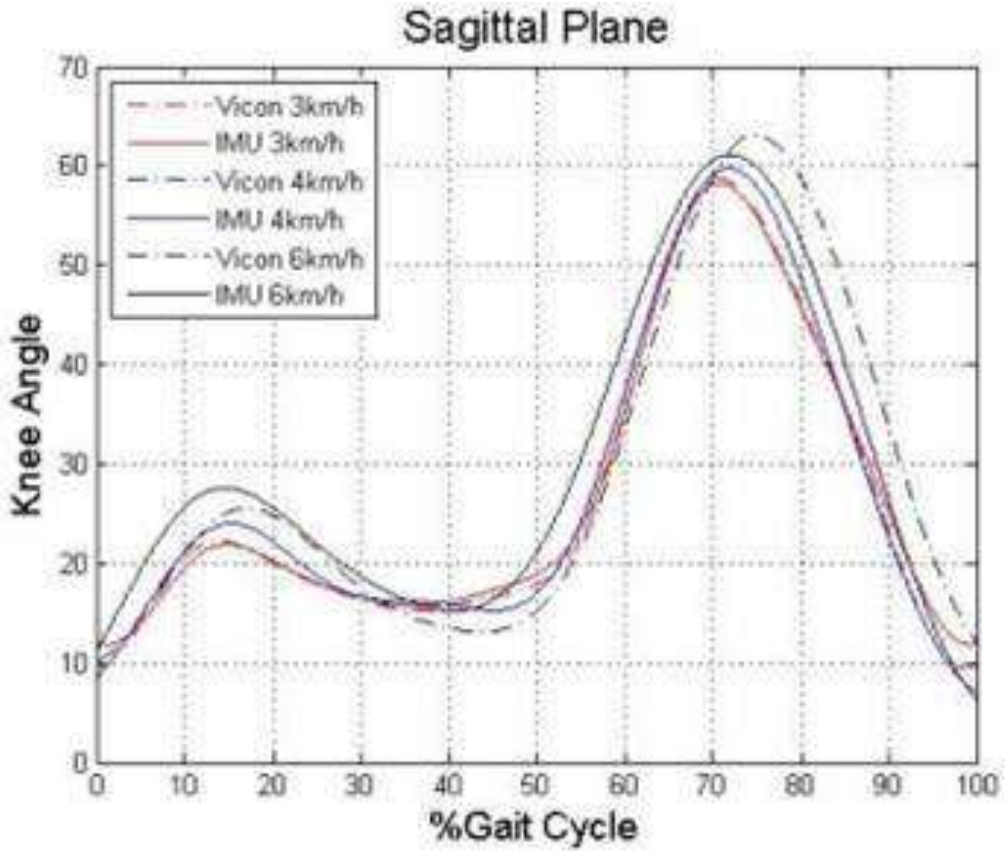
Results
The measurements obtained in a sagittal plane showed that the lowest root mean square error was 1.0˚±0.3 at gait velocity 3 km/h and the highest one was 3.4°±0.4 at gait velocity 6 km/h. It turned out that the proposed wearable knee joint angle measurement system had an error range that can ensure compatibility with Vicon®.

Conclusion
As the system enables a real-time analysis of normal and abnormal gaits of those who wear an artificial lower limb or have knee joint deformity, useful data will be provided to improve gait quality.

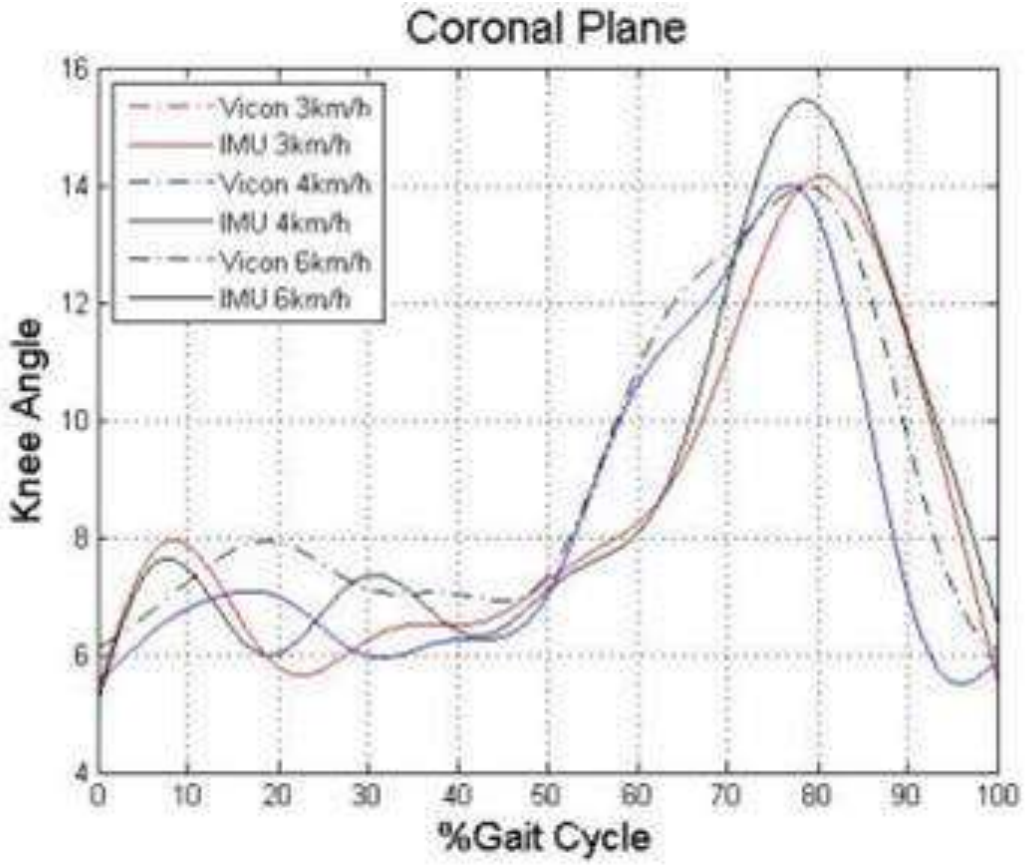
Keyword
Knee Joint, Skin movement, Wearable sensor, Soft tissue artifact, Lower-Limb



Placement of inertial measurement units(IMUs) and optical markers on the legs. The optical markers are placed at the typical physiological landmarks. The IMUs are attached using body straps



Comparision of the developed IMU-based knee flexion/ extension measurement with the results of Vicon®



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