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Development of a Modularized Seating System to Actively Manage Interface Pressure

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Abstract

Pressure ulcer is a fatal complication. Many long-duration wheelchair users face this threat, because many of them have difficulties in actively redistributing the pressure underneath. Therefore, using a good pressure management method is important. There are many passive cushions in the market. However, ready-made seat cushions and custom-made cushions, air-filled or jelly-filled, are not fully satisfactory. There are also air-filled active cushions which can change pressure distribution by alternately pumping different air bags; but the performance of these is not clear and cannot be optimized. There is a need to develop a good seating system for pressure management. We proposed an active approach for seating systems based on the concept that the interface pressure is changed for different shapes of a seat surface. Accordingly, we developed a system whose seating surface was composed by height-adjustable pillars. The system was with modular design. Each four-pillar unit was composed of the force sensors, position sensors, linear actuators, signal conditioners, driving circuits, signal processors, I2C interfaces and so on. The module can be chained and assembled together easily to form different seat dimensions. Due to torque requirements and economic considerations, each pillar would take up 3cm-by-3cm that should be improved in the future. The position resolution was 0.1mm and force sensor error was within 1 gram, which met our design requirements. Through a dead-weight test, each pillar of the system could provide 49N pushing force under the speed of 2.36 mm/s. Several verification tests were performed to access the whole system's feasibility. In summary, this modularized system was capable of real-time interface pressure management.