An Improved Method for the Stable Transmission of Quantitative Information through Human Skin, Characterized by Low Error Rates and Long-term Reliability

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We investigated mechanisms for spatial perception via human skin because of our interest in Human-Machine Interfaces. Although others have studied qualitative data communication, we wanted to learn to what extent quantitative information could be transmitted. As a platform we chose a drone transmitting distance and temperature variables. We created a prototype arm-harness with vibration motors connected to a controller receiving signals from the drone; and a sensory keypad with buttons to transmit human reaction. Fifteen test subjects safely interacted with the drone while we collected data. Subjects placed fingers on the keypad while vibration motors were in contact with parts of their arms. The vibrations varied in duration and pattern depending on drone's position from its target. We learned that when transmitting information via skin, many parameters influenced perception quality. We tested several variables: vibration motors' location on the body, relative position to each other, the shape of current flowing through the motor coils, and time patterns. Also, we investigated how external distractions affected subjects' perception of the signals. We also tested nervous system reactions to extended vibration. Data analysis revealed dependencies: the correlation between the number of drone control errors and parameters like distance between vibration motors and time of effect is nearly a parabolic curve. Error dispersion patterns depend directly on time of effect. A rectangular signal pattern yielded the most accurate drone control. The most significant result is reliable quantitative skin-perceived data acquisition. The number of simultaneously controlled parameters of any HMI improves by adding quantitative tactile feedback.