Recognition and Classification of Body Posture and Gestures Using Multifrequency Signals

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A variety of technologies have been developed to facilitate human-computer interaction through recognition of body posture and gestures. The first efforts in this area were based on the use of: 1) video cameras and on-body markers, 2) on-body sensors such as three-axis accelerometers equipped with high-speed short-range data links and 3) on-body sensors based upon UWB precision ranging technology. The constraints and inconvenience associated with: 1) the requirement for a clear line-of-sight between the user and the camera, 2) computational loads associated with real-time processing of video signals, 3) the inconvenience associated with requiring the user to wear special equipment, 4) the cost of providing specialized equipment for the purpose and, perhaps most importantly, 5) privacy concerns associated with use of video cameras have spurred interest in the development of techniques that do not suffer from these limitations.

In recent years, there has been considerable interest in the recognition and classification of changes in limb position and body posture by observing the manner in which these actions affect the wireless propagation channel. Such techniques avoid most of the privacy, cost and inconvenience issues associated with previous methods but at the cost of vastly reduced resolution. To date, most of these RF-based efforts have focused on change in the received signal strength and analysis of the micro Doppler spectrum associated with changes in limb position and body posture. A few previous works have also considered the manner in which these actions transform the polarization of the probing signal. While changes in limb position and body posture and the rate at which such actions take place are readily detected using such techniques, it is much more difficult to distinguish between the different types of actions, especially between small and large movements, and their directions.

Here, we have considered the use of a pair of probing signals at very different frequencies to distinguish between large displacements associated with movement of limbs or bending of the torso of a passenger seated in a car and the much smaller displacements associated with bending or rotation of the head and rotation of the torso of the passenger. The choice of the two frequencies is determined largely by the amount of displacement that is expected in each case. Our results confirm that both types of movements are visible as deep fading at the higher frequency (typically > 6 GHz) while only the large movements lead to deep fading at the lower frequency (typically < 2 GHz). This behaviour lends itself to processing and classification using machine learning techniques and is a valuable new technique in this area.