Human Activity Estimation by Height and RCS Information Detected by MIMO Radar

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Human posture identification technique has been considered for safety-monitoring and smart house application, where the video cameras and the wearable sensor networks have been used. However, the former has problems with privacy violation, and it works only with line-of-sight situation. The latter requires the subjects to wear the contact / non-contact sensors continuously. Microwave sensors are one of the powerful solutions for the human posture identification. Its key features are the non-privacy violation and contactless observation since it does not require any wearable devices. This paper demonstrates the measurement results showing the effectiveness of a human activity estimation method, where the temporal transition of height and Radar Cross Section (RCS) information observed by Multiple-Input Multiple-Output (MIMO) radar. In this method, the gesture recognition algorithm (T. Asano, A. Miyata, and S. Honda, J. JSPE, Vol. 77, No. 3, pp.333-337, Sep. 2011.) is introduced to identify the human activity, and this method can estimate the human motions such as falling down and getting up, etc. We conducted the experiment on estimating the human motions to verify the performance of our method in a real indoor environment.

Figure 1 shows the measurement setup. The 16 × 16 bistatic MIMO configuration was used for this experiment. The receiver and transmitter have 4 × 4 squarely arranged patch antennas. As shown in Figure 1, SP64T switch, where only 16 ports are used, was employed at the transmitting side since the switching speed is sufficiently fast compared to the vital activity. A continuous wave (CW) signal at 2.47 GHz was used. Sampling frequency, which corresponds to the number of snapshots of the MIMO channels per second, was set to 100 Hz. The time to estimate a target location and RCS was 0.64 s. When the channels were measured, the subject performed sitting down, getting up from a chair, falling down and getting up from a floor. The model codes were generated from the most frequent value of the feature out of 10 trials for each motion. Figure 2 shows the confusion matrix of the recognition rate with 4 motions estimated by the human activity estimation method. The recognition rate was calculated by 10 times recognition experiments. From this figure, it was found that the average recognition rate was 87.5 %. Therefore, our experiment proved that the proposed method well estimates the human motion at a high recognition rate.

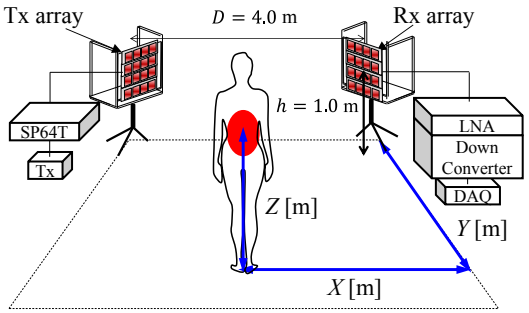

Figure 1. Measurement setup

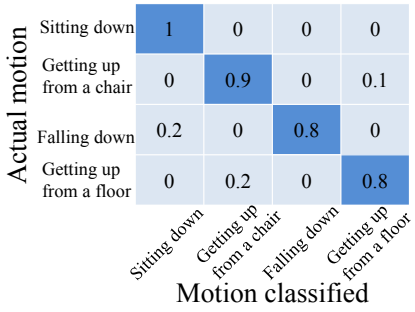

Figure 2. The confusion matrix of the recognition rate with 4 motions.