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Human Activity Detection Using Radio Waves

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Our thought into tracking motion in the channel is making use of CSI(Channel State Information). Previously, our method is using channel equalization. We tried to make use of pilot sequence p to build channel equalizer to recover the sequence from the one that is received from channel into p_{est}. So if channel remains unchanged, the subtraction $p - p_{est}$ shall remains approximate zero, otherwise it changes to non-zero.[2] But recently we found it inapplicable because it only detects the change in the channel instead of motion. If an object changes position, even though it stopped after removal, the $p - p_{est}$ remains non-zero.

Now we have a new technique. Suppose at discrete time instant i we have CSI:

$$H(i) = [H_1(i), H_2(i), ..., H_n(i)]$$

Human moving inside the channel shall induce dispersion on receive signals, we can portrait this dispersion by correlating among successive measurements. Within time interval T, suppose we have N CSI measurements so that we stack them into matrix $H = [H(i), H(i+1), ..., H(i+N)]^T$. Then we correlate each pair for their amplitudes and phases such that we have correlation matrix $A = [a_{ij}]_{N\times N}$ and $C = [c_{ij}]_{N\times N}$. In the case where there is motion in the channel, the dependency between successive measurements shall be low, so normalized largest eigenvalues of both A and C shall be small. If the channel stays stationary, high correlation shall be exhibited, eigenvalues shall be large enough to be close to 1.[3] We can indicate the intensity of movement by the eigenvalue of correlation matrix. The advantage of this approach is it only tracks the movement.

Before we assume we already have CSI. Channel parameter estimators are tools to acquire this information. Most of them make use of Maximum Likelihood criterion. A high resolution estimator is proposed in [4]. We just decide to take this algorithm, and we are in the progress studying this.

There's another "short-cut" we found for CSI estimation, which is in [5, 6]. It's an open-source tool extracting CSI from Wireless card in the laptop calculated based on OFDM sub-carriers from Wi-Fi. I don't know if we are allowed to use this. If so, we do not need stand alone receivers anymore. We just put a wireless router in the room, and make use of the CSI information calculated by the Network Interface.

Next, we plan to finish coding the channel parameter estimators on Matlab, see what performance we can achieve.

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