Compressive Sensing Based Threat Object Detection using Reconfigurable Reflectarray

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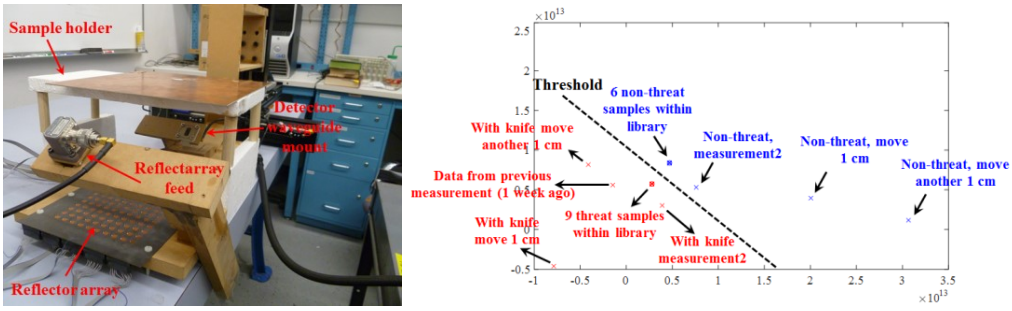
Compressive sensing is a novel sampling/sensing technique that enables significant sampling and computation cost reduction for signals with sparse or compressible representation. By employing compressive sensing technique, the number of measurements needed for a specific task can be greatly reduced compared to conventional sampling methods when the signal is sparse in certain basis. The fundamental idea behind compressive sensing is that rather than sampling at high rate first and then compressing the sampled data, it would be much better to directly sample the data in a compressed format.

In this work, a compressive sensing based threat object detection system for shoe object scanning is investigated. A 10 x 10 elements reflector array with tunable varactors is employed to control the measurement patterns and implement the compressive sensing technique. A Fisher linear discriminant (FLD) algorithm is used to separate threat and non-threat samples. In this example, a knife with size of 1.5 cm * 5 cm inside various shoes is used as the threat object. System calibration and library construction is performed by applying different shoe samples with different size, different material at different locations, with and without threat objects at different locations inside the shoe sample. After applying the FLD algorithm, the required measurement patterns can be obtained to distinguish threat and non-threat cases. Fig. 1(a) illustrates the system configuration for the threat detection measurement. Fig. 1(b) shows the detection results to distinguish whether there is threat object in the shoe sample. The red points are all threat cases and the blue points are all non-threat cases. It can be seen that threat objects are clearly detected from the non-threat objects.



(a) (b)

Figure 1. (a) System configuration for the threat detection measurement. (b) Detection results to distinguish whether there is threat object in the shoe sample.