Classification of Threats Via a Multi-sensor Security Portal

Amar Singh and Lawrence Holder

Department of Computer Science and Engineering,
University of Texas at Arlington,
Arlington, TX 76019, USA
amar.singh@uta.edu, holder@cse.uta.edu
http://prodigy.uta.edu, http://www.cse.uta.edu/~holder

Classification of threats has always been a major security decision issue when a person walks through a security portal. To classify threat by combining data from multiple sensors like Millimeter Wave (MMW) imagery and Multi-zone Metal Detector is proposed and studied. Decisions made according to data from multiple sensors are analyzed. We present results for processing the fused sensor data and study the performance of several learning algorithms on this task. Usually the decision is being made based on single types of sensors, e.g., pulse induction metal detectors. We wish to identify the threats which are not determined by metal detectors alone.

There are numerous papers in the literature on the conventional way of fusing data from multiple sensors. The focus has been to identify the kind, shape, and location of weapons; whereas, the concern is to determine if a person is a threat or not irrespective of what object is being carried.

In this paper, we propose a decision technique based on a multi sensor security portal. The decision is made by a classifier, which is learned based on the vector level fused data from multiple sensors. We show an improvement in performance of a security portal at detecting threats by combining multiple sensors.

Currently, our portal consists of a walk-through pin-point metal detector (MD) sensor and a millimeter-wave (MMW) imagery sensor. Results in this paper are based on the fusion of the MD and MMW sensors, but we also plan to incorporate additional sensors like infrared cameras and vapor trace detectors.

To keep the data as low level as possible with no intervention of human knowledge in the form of image processing, pixel-level fusion techniques have been used. We averaged to a factor of 25 to reduce an image from 200 x 200 to 8 x 8. Two Millimeter Wave Images are taken of a person, one of the upper half (Figure 1- First from left) and another of the lower half (Figure 1- Second from left). The metal detector gives sensor values for 19 different zones of the archway through which a person passes (Figure 1- Third from left). Emulating a real-life scenario the set of sensors were placed in a room operating at room temperature.

Our model is provided profiles for training purpose. Each profile represents a sample case of a person passing through the portal. Information given as a profile includes the upper body MMW image, lower body MMW image, 19 metal detector zone readings and a possible classification. The combination of the MMW and MD sensor

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values is given to the learning algorithm. The learning algorithm finds classifiers capable of distinguishing threats from non-threats. The knowledge gained by the learning algorithm based on the training data is then used for prediction on the testing dataset.

Fig. 1. First from left: Millimeter Wave Image of person carrying suspicious object on their upper chest. Second from left: Millimeter Wave Image of person carrying suspicious object on their right thigh. Third from left: Person walking through Pin-point Metal Detector. Fourth from left: Lights getting illuminated when person carries gun.

Various learning algorithms were used to classify the profiles. For conducting the experiments we used the Weka (The Waikato Environment for Knowledge Analysis) data mining tool. Among the classifiers used was Decision trees (J48), Multi-layer perceptron (MLP), and SMO (Sequential Minimal Optimization). The table below presents the percentage of test cases correctly classified for the various algorithms. Using both sensors outperforms either sensor individually.

	J48	SMO	MLP
Both sensors	90.32 %	97.58 %	95.96 %
Only MMW Image	77.41 %	87.90 %	85.48 %
Only Metal Detector	88.71 %	75.8 %	83.87 %

Until now, threats have been detected in a person based on a single sensor or based on multiple sensors for identifying the object a person is carrying. The idea of using multiple sensors has shown better accuracy as compared to a single sensor looking at the results of all the algorithms above. Furthermore, various other sensors can be introduced to augment the sensor data.