Multiple Bounding Box Solution for DICOS v03

Abstract:
Different Prohibited Items (PI) algorithms to detect weapons, knives, blunts, etc., can be applied to the same image. Each of these PI algorithms identifies Potential Threat Objects (PTOs) within the image. In some cases, the different PI algorithms identify the same PTO. This results in multiple PTOs and Bounding Boxes (BBs) being recognized on the same object within the image. Multiple BBs on the same PTO cannot be presented to the Transportation Security Officer for resolution since redundancy will result. There are three solutions presented in this paper.

Proposed Additional Tag Attributes:

Owner Module Attributes	Tag	Type	VR	VM	Attribute Description
Bounding Box Resolution	(4010,1147)	1C	CS	1	The possible bounding box resolution methods are: • Summation • Largest Bounding Box • Highest Assessment Probability • Other
Aggregating Method for BB	(4010,1149)	1C	LT	1	Text description on how the Aggregate Application combined the different TDRs for the same PTO from different TDRs

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Background

Different Prohibited Items (PI) algorithms to detect weapons, knives, blunts, etc., can be applied to the same image. Each of these PI algorithms identifies Potential Threat Objects (PTOs) within the image. In some cases, the different PI algorithms identify the same PTO. This results in multiple PTOs and Bounding Boxes (BBs) being recognized on the same object within the image. Multiple BBs on the same PTO cannot be presented to the Transportation Security Officer for resolution since confusion and frustration will cause. There are three solutions presented in this paper. The first solution is to combine the most outer regions of each bounding box into one, the second is to select the largest BB over the PTO, the third is to select the BB of the PTO with the highest assessment probability, making this the principal characteristic of the PTO.

Bounding Box Solutions

Instead of displaying the same PTO with four different BBs, which may confuse the screener and cause them to perceive a more significant number of alarms in the bag, three solutions are provided below.

Solution 1: Outermost sum of the Bounding Boxes

Four different PI detection algorithms have generated four Bounding Boxes on a PTO as shown in Figure 1.

- BB1 – by the weapons PI algorithm
- BB2 – by the knife PI algorithm
- BB3 – by the blunt PI algorithm
- BB4 – 3D gun PI algorithm

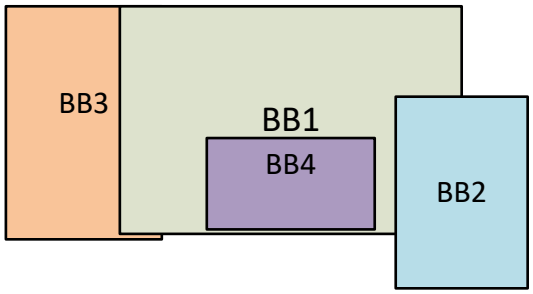

Figure 1. Four different BBs were generated by four different PI algorithms identifying a potential threat. The BBs are made more prominent for display purposes.

The BBs are combined into one oversized container. The outermost BB is composed of the outline of the overlapping BBs, as shown in Figure 2. What is displayed to the screener is shown in Figure 3. This would be the case if the bounding box is not limited to a rectangle.

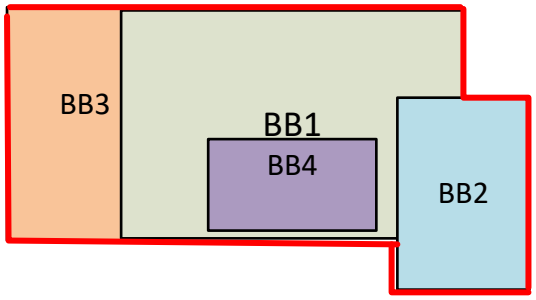

Figure 2. Generating a BB as an outline of the BBs. This is possible if the BB does not have to be a rectangle.

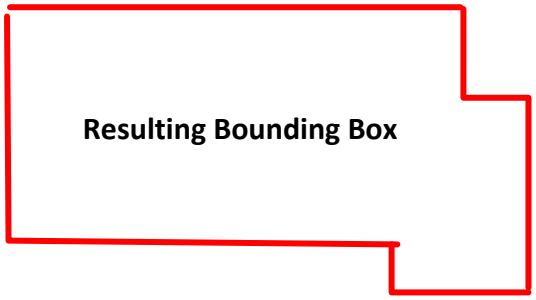

Figure 3. Shows the resultant BB for the potential PI using the outermost region of all the BBs, as shown in Figure 2. This case is possible if the bounding box is not limited to a rectangle.

If the bounding box is limited to a rectangle, the bounding boxes in Figure 2 result in the reported bounding box, as shown in Figure 4.

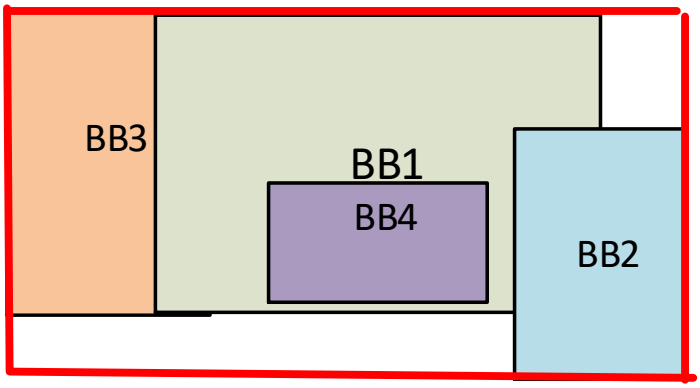

Figure 4. If the BB must be a rectangle, for Figure 2, the most extreme positions for each of the BBs are used to determine the final BB for the object. The last BB is shown in the red lines.

The method used to combine or report the associated tag attributes for this solution will be determined by the implementor. This method will be described in the *Aggregate Method for BB* attribute using long text.

Solution 2: Largest Bounding Box

In this case, the BB with the most significant area is chosen as the display BB, and the other BBs are not displayed in Figure 5.

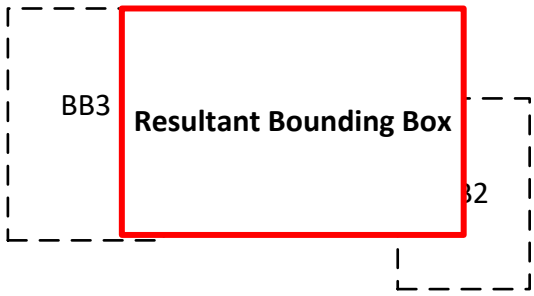

Figure 5. The BB that is displayed is the BB with the most significant area. The other BBs, in dashed lines, would not be shown to the screener for the PI.

The associated tag attributes for Solution 2 will just be a copy of the existing associated tag attributes.

Solution 3: Highest PTO Assessment Probability

The BB selected to be displayed is the one with the highest level of *Assessment Probability* for the PTO.

For the above example, the following BBs are provided along with the confidence level of each:

- BB1: by the weapons PI algorithm, 80% of weapons
- BB2: by the knife PI algorithm, 30% of knives
- BB3: by the blunt PI algorithm, 20% blunt
- BB4: 3D gun PI algorithm, 10% 3D gun

Using the confidence levels, BB1would be the Bounding Box selected for the PTO. The other BBs would be disregarded.

The associated tag attributes for Solution 3 will just be a copy of the existing associated tag attributes.

Suggestion: Add a tag attribute to the TDR that states which type of bounding box resolution method is being used and how the associated tag attributes are populated as shown in Table 1.

Table 1. Additional Bounding Box (BB) Attributes

Owner Module Attributes	Tag	Type	VR	VM	Attribute Description
Bounding Box Resolution	(4010,1147)	1C	CS	1	The possible bounding box resolution methods are: • Summation • Largest Bounding Box • Highest Assessment Probability • Other
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ACRONYM LIST

BB	Bounding Box
PI	Prohibited Item
PTO	Potential Threat Object
TDR	Threat Detection Report