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Novel Data Visualization of X-Ray Data for Aviation Security Applications using the OTAP Platform

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Abstract

This work will demonstrate the implementation of a traditional and non-traditional visualization of x-ray images for aviation security applications that will be feasible with the Open Threat Assessment Platform (OTAP). Anomalies of interest to aviation security are fluid, where characteristic signals of anomalies of interest can evolve rapidly. OTAP is an open architecture baggage screening prototype that allows 3rd-party vendors to develop and easily implement detection algorithms and specialized hardware on a field deployable screening technology. In this study, stereoscopic images were created using an unmodified, field-deployed system and rendered on the Oculus Rift, a commercial virtual reality video gaming headset. The example described in this work is not dependent on the Oculus Rift, and is possible using any comparable hardware configuration capable of rendering stereoscopic images. The depth information provided from viewing the images will aid the detection of characteristic signals from anomalies of interest. If successful, OTAP has the potential to allow for aviation security to become more fluid in its adaptation to the evolution of anomalies of interest. This work demonstrates one example that is easily implemented using the OTAP platform, that could lead to the future generation of ATR algorithms and data visualization approaches.

Introduction

- OTAP will develop and demonstrate an open architecture baggage screening prototype in partnership with several security technology manufacturers that allows third-party vendors to develop and easily implement detection algorithms and specialized hardware on a field deployable screening technology.
- An open platform is defined as a technology platform that utilizes a plug-and-play or open architecture based on standardization of data formats, interfaces, and protocols that allow for the modularization of a technology platform.

Figure 1: The Oculus Rift

Figure 2: A field-deployed X-ray system

Background

- Stereoscopic images use two horizontally offset, or rotated images to trick the brain into interpreting depth information.
- The amount of horizontal or rotational offset is called the parallax. The degree of depth perceived from an image is dependent on the degree of parallax.
- Currently, aviation security utilizes 2D projectional radiography for carry-on luggage and CT for checked luggage.
- Commercial virtual-reality headsets, such as the Oculus, have made it possible to view stereoscopic images by projecting one into each eye.
- It is possible that stereoscopic images could increase the capability of a viewer to identify anomalies of interest.

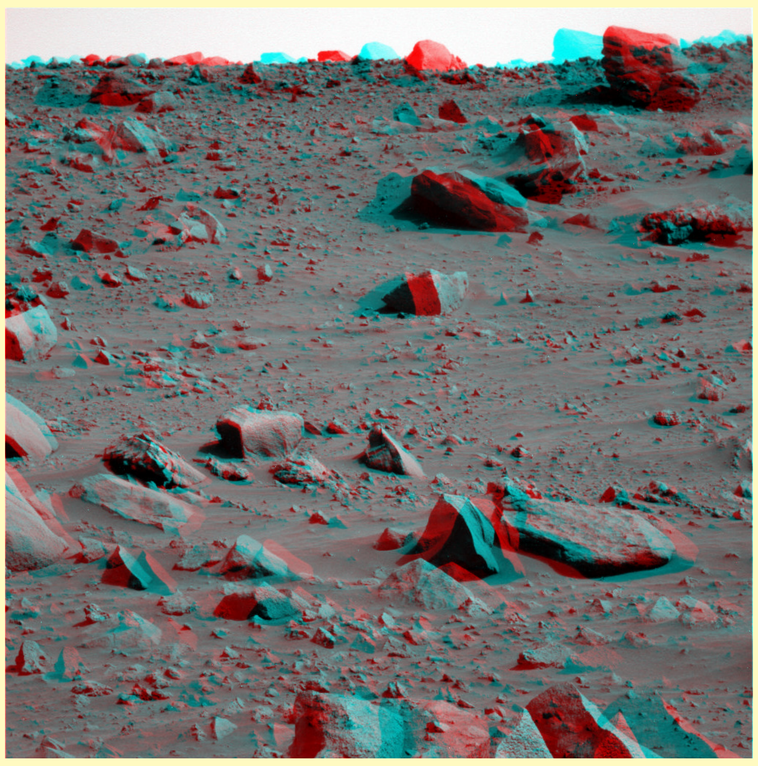

Figure 2: Concatenated stereoscopic image of a landscape.

Approach

- Two X-ray scans were taken per stereoscopic image.
- Stereoscopic images were created on a spectrum from orthostereoscopic to hyperstereoscopic.
- The non-traditional algorithms used to create these images were implemented using a method analogous to OTAP's future functionality.
- Images were concatenated and rendered using a commodity video/image display application that is capable of rendering non-traditional sized video and images.

Implementation

- The first group of figures shows images taken using a laboratory-grade CT system.
- In order to create this set of stereoscopic images, parallax was induced by rotating the object. No horizontal offset was applied to the object.
- The second group of figures shown images taken using a field-deployed X-ray system.
- Parallax was induced by horizontally offsetting the suitcase for the second of the two images. No rotation parallax was applied to the object.

Results

- We successfully extracted stereoscopic images from a laboratory-grade CT system.
- We successfully extracted stereoscopic images from a field-deployed X-ray system.
- We observed that different people had varying degrees of success viewing the stereoscopic images from both machines.
- In order to view the stereoscopic images on the Oculus, the object in question needed to be close to the center of the image.

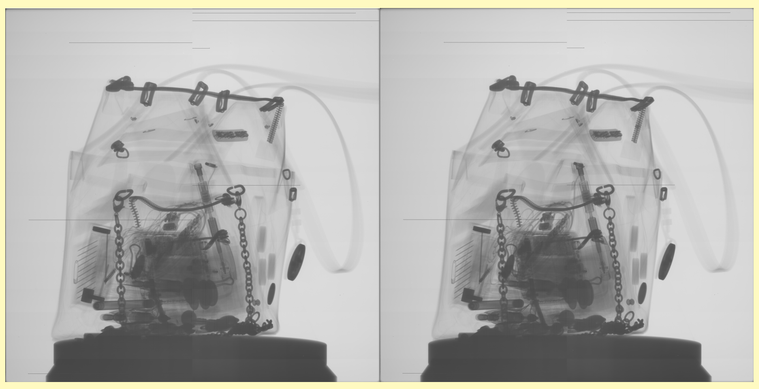

Figure 3: Two scans of a purse, offset by 3.6°

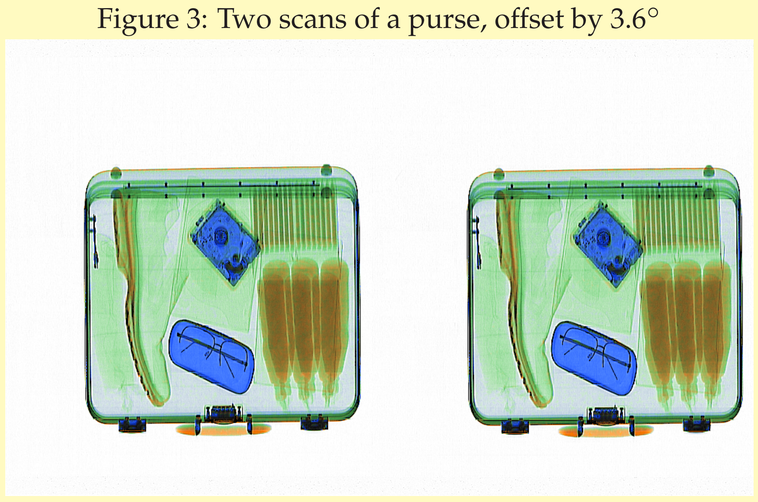

Figure 4: Two scans of a packed suitcase, offset by 1.4 cm

Conclusions

- This work demonstrates the future cabability of OTAP to produce non-trivial visualization techniques, and was analogous to how OTAP will operate in the future.
- In the future, OTAP could be utilized to push out new visualization algorithms to all field-deployed machines.
- This new method of visualization demonstrates how field-deployed technology can be incremented upon by utilizing OTAP.
- Stereoscopic imaging of X-rays could lead to new forms of ATR algorithms being developed.
- The capablities of OTAP could help to push 3rd party developers to produce new algorithms rapidly, in an attempt to adapt to the fluidity of aviation security.
- This experiment was limited by the resolution capabilities of the field-deployed system. It is possible that the poor resolution of the system could make it difficult to perceive the stereoscopic effect.
- The exact geometries of the field-deployed system were unknown during sampling. In order to calculate the parallax required for creating stereoscopic images, estimates were made into the required horizontal offset of objects.

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