Metal Detectors Using Imaging Techniques for Autonomous Systems

Introduction

Metallic objects contain chemical properties and physical properties that allow for them to be easily differentiated from other objects. To accurately discern the size of metallic debris, imaging, in which the location and the size of the metallic debris is shown within a graph, can be used in conjunction with hardware that can track the location, depth, and shape of the target metallic object. This technical review summarizes some metal detectors which use imaging technologies on the consumer market and the implementation of such technology.

Commercial Applications for Metal Detectors Using Imaging Techniques

Archeologists and treasure hunters often use commercially available metal detectors to look for metallic objects underground. The current high-end models involve using imaging technologies, such as the Invenio Pro from Nokta Detectors. Using their proprietary Integrated Positional Tracking Unit (IPTU) Sensor, the Invenio Pro can operate at 3 different frequencies (5kHz/14kHz/20kHz) to capture an image of the buried object in real time, allowing the user to determine the shape and size of the object [1]. Another similar metal detector is the Easy Way Plus 3D Imaging System, a phone-sized box with the detector inside that pairs with a tablet which outputs a graph composed of images obtained in multiple scans [2] and can also capture the location and size of the metallic object, albeit at a slower speed. The Invenio Pro costs $11,900 [1] while the Easy Way Plus 3D Imaging System costs $4500 [2].

On the other hand, airport security also uses metal detection technologies to detect dangerous objects a passenger may possess. A full-body scanner used by the TSA incorporates the Advanced Imaging Technology (AIT), which uses millimeter wave to “screen passengers for metallic and nonmetallic threats” [3]. However, this type of scanner is costly compared to the traditional non-imaging detector, with the former costing $250,000 per unit while the latter costing $30,000 per unit.

Technology of Metal Detectors Using Imaging Techniques

Millimeter-wave images is often used because of its ability to see through clothing, plastics and fabrics. Automatic detection and tracking of metallic objects concealed on moving people is possible with this technology. Research has shown that using a Probability Hypothesis

Density filter can assist in tracking a variable number of targets and estimate the number of targets as well as the location [4]. For singular targets, using a combination of the millimeter-wave images and a Particle Filter also showed an excellent rate of success [5].

For metallic objects underground, the Demining Technology Center had developed a system usable by both human and autonomous robots for detecting mines as well as metallic debris. By using a combination of a ground penetrating radar and a metal detector (for imaging purposes), the setup can differentiate between a mine and other metallic objects [6].

Implementation of Metal Detectors with Imaging Technologies into Autonomous Systems

While imaging technologies in metal detectors has improved significantly over the years, it is still difficult to integrate this technology into autonomous systems without sacrificing the accuracy of human eyes. For example, the Full-Body Scanners used by the TSA to detect metals still relies on the employee without any automated functions [3]. While the mine detector could produce images of different types of metallic objects underground, it is still prone to triggering false alarms when objects that produce a similar image to a mine is shown [6]. In addition to that, an integration of such a system is also costly, with a cheap commercial system costing $4500 [2]. However, with the mine detector as an example, ongoing research regarding the implementation of such systems are steadily advancing, and the combination of imaging technologies into autonomous metal detectors should be possible in the future.

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[2] *3D metal detector - Easy Way Plus - 3D Imaging system*. (2018). [video] Turkey: United International Group Company.

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