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Machine Detectable Object Camouflage

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<u>ABSTRACT</u>

Outdoor equipment (e.g., cellular telephony towers) is often camouflaged to hide it from human view which can make it difficult for field technicians to locate such equipment. This disclosure describes techniques that make such camouflaged objects easily detectable by machines equipped with appropriate sensors while remaining hidden from the human view. For example, a cellular telephony tower can be painted with material that includes a laser scintillation material. Such material can be easily detected by a LIDAR scan. Other techniques can include: use of two shades of paint that are clearly distinguishable by machine photoreceptors but appear as the same color to a human; painting with near-color match fiducial markings to enable easy detection by cameras; use of infrared reflective (IR) materials for easy passive identification; carpet patterns that include modifications that encode information; etc. Camouflage can be used on any type of object and a corresponding suitable technique to make it machine detectable can be employed.

<u>KEYWORDS</u>

- Object camouflage
- Cellular tower
- Telecommunications equipment
- Outdoor equipment
- Machine vision
- Laser scintillation
- Infrared reflective material
- Photodetector
- Passive labeling
- Fiducial marking

BACKGROUND

       Telecommunication equipment such as cellular telephony towers is deployed outdoors. To comply with government planning regulations (codes), such equipment is often camouflaged to hide it from human view. The regulations are designed for aesthetic reasons and promote a more harmonious visual environment.
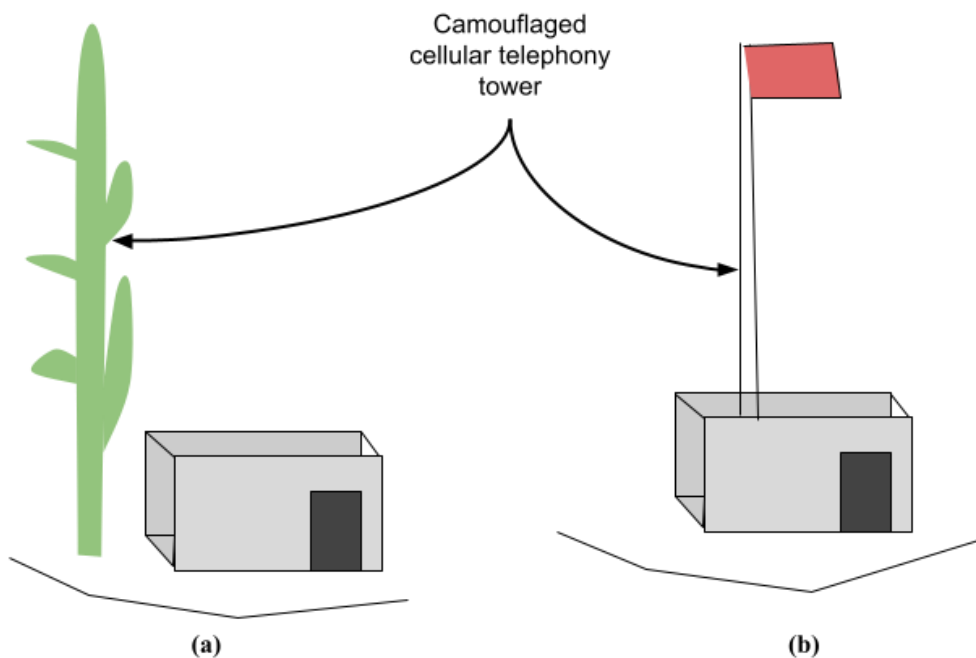

Fig. 1: Equipment camouflaged to blend with surroundings

       Fig. 1 depicts examples of telecommunication equipment that is camouflaged. Fig. 1(a) depicts a cellular telephony tower designed to resemble a giant cactus, whereas in Fig. 1(b), the cellular telephony tower is designed to resemble a flagpole. Such camouflaging can make it difficult for field personnel to locate the equipment when the equipment is to be physically accessed, e.g., to carry out repairs and/or to replace parts, etc.

DESCRIPTION

This disclosure describes techniques for the deployment of camouflaged telephony equipment or any other object in outdoor environments. Per techniques of this disclosure, the camouflaged equipment is designed such that the equipment is easily detected by machines while remaining hidden from human view.

The camouflaged equipment is constructed using materials and/or designs that enable it to be detected by machine sensor, without being visually distracting to humans.
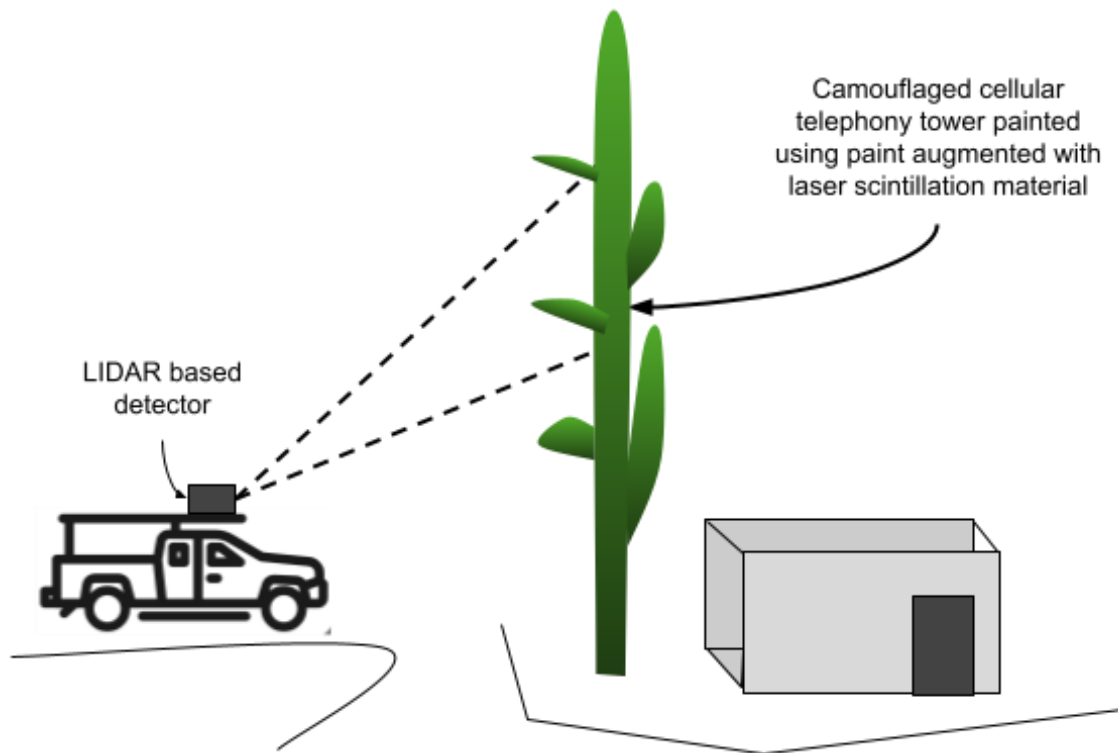

Fig. 2: Laser scintillation material enables easy detection of objects

Fig. 2 depicts an example of a machine-obvious camouflaged object, per techniques of this disclosure. In this illustrative example, a cellular telephony tower is camouflaged as a giant cactus. The object is painted with paint that includes a laser scintillation material. The tower remains camouflaged to the human eye. However, it can be easily detected by a Light Detection

and Ranging (LIDAR) scan utilized by field personnel. For example, two shades of paints can be utilized to paint an object that are clearly distinguishable by machine photoreceptors but appear as the same color to a human. Additionally, or as an alternative, machine-readable fiducial markings such as quick response (QR) codes can be utilized. These are easily detected by machine sensors but are invisible to the human eye.

Camouflage can be used on any type of object and a corresponding suitable technique to make it machine detectable can be employed. For example, infrared reflective (IR) materials can be utilized in camouflage clothing for easy passive identification, e.g., of friend-or-foe; carpet patterns in public areas such as airports can include modifications that blend in with the surrounding area but that can provide navigational guidance to automated vehicles.

Machine-obvious camouflage can also be utilized in conjunction with augmented reality (AR) applications. Indoor areas can be painted with near-color match fiducial markings to enable easy detection by sensors (e.g., cameras) to support AR applications. Machine obvious camouflage can also be utilized to provide enriched passive labeling that is machine readable, without being a distraction to human operators. For example, information such as maintenance documents or other materials can be encoded onto equipment in a manner that is invisible to humans but can be easily read and searched by a computing device equipped with a suitable sensor.

CONCLUSION

This disclosure describes techniques for the deployment of camouflaged equipment and/or objects in outdoor environments. Per techniques of this disclosure, the camouflaged equipment is designed such that they are easily detected by machines while remaining hidden from human view. A cellular telephony tower is painted with material that includes a laser

scintillation material. The tower remains camouflaged to the human eye; however, it can be easily detected by a Light Detection and Ranging (LIDAR) scan. In some implementations, two shades of paints can be utilized to paint an object that are clearly distinguishable by machine-photoreceptors but appear as the same color to a human. Machine-obvious camouflage can additionally be utilized in conjunction with Augmented Reality (AR) applications. Indoor areas can be painted with near-color match fiducial markings to enable easy detection by sensors (cameras) for AR applications.

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