Haptic Eye: A Contactless Material Classification System

Tamas Aujeszky, Georgios Korres(✉), and Mohamad Eid

Department of Engineering, Applied Interactive Multimedia Laboratory (AIMLab), New York University Abu Dhabi, Abu Dhabi, UAE
{tamas.aujeszky,george.korres,mohamad.eid}@nyu.edu,
http://wp.nyu.edu/aimlab

Abstract. In this paper we demonstrate a system capable of classifying different types of materials in a contactless fashion by using active infrared thermography and machine learning algorithms. A laser diode heats the materials and the infrared camera records the thermal dissipation signature of each material. These data are then fed to machine learning algorithms to classify the materials. This system can potentially be used in teleoperation applications for robots that operate in unknown scenes.

1 Introduction

Infrared thermography has been used for decades for nondestructive testing and evaluation purposes, and recently it has started to emerge as a contactless material characterization tool that is suitable for performing thermal modeling of real-life objects [2]. The Haptic Eye prototype demonstrated material classification by subjecting samples to thermal excitation and capturing the thermal footage of their cooldown process, then applying a set of machine learning classifiers on a number of extracted features [1]. Our latest approach uses convolutional neural networks for classification between samples and regression to thermal properties.

2 Demonstration Setup

The setup of the demonstration is shown in Fig. 1. The following components are comprising the Haptic Eye demonstration: A laser source for stimulating the material by slightly changing its temperature on a specified spot, an infrared camera that is capable of capturing the thermal signature of the laser stimulation, a rotating base that rotates the Haptic Eye to target different sample materials, and a control board that controls the whole demonstration setup. For the data acquisition, the further processing and the final classification of the sample materials, an ordinary laptop is used. Figure 2 is showing the center temperature dissipation of the laser stimulation from three different materials of an experimental session.

H. Kajimoto et al. (Eds.): AsiaHaptics 2018, LNEE 535, pp. 110–111, 2019.
https://doi.org/10.1007/978-981-13-3194-7_25

In this demonstration, the Haptic Eye uses the laser diode to stimulate the first material for about 10 s, then the infrared camera records the thermal dissipation and proceeds to the next material. When data from all materials is acquired, it classifies them accordingly. A Graphical User Interface (GUI) is developed to present in detail the entire acquisition and classification processes in real time. A link to the video demonstration is available at the following URL: https://www.youtube.com/watch?v=828SEeedqbo.

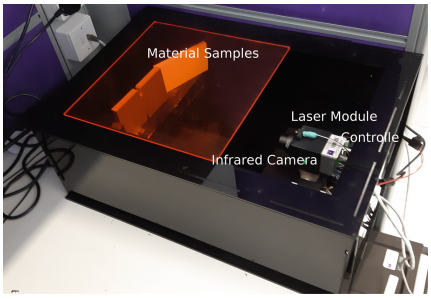

Fig. 1. The Haptic Eye system setup

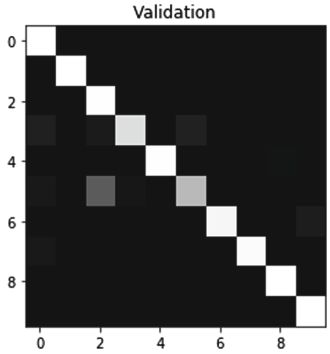

Fig. 2. Confusion matrix for 10 material samples

3 Conclusion

In this paper we present a system which is capable of classifying different materials in a contactless fashion by utilizing infrared thermography and convolutional neural networks. Haptic Eye is a very promising system which could potentially be used for accurate teleoperation procedures where a deep knowledge of the unknown environment is needed. In our future work, we will try to develop more robust classification and/or regression methods for material characterization. Furthermore, we will develop the hardware to reduce the form factor of the system in order to be used as a sensor on a tele-operated robotic platform.[1]

References

1. Aujeszky, T., Korres, G., Eid, M.: Thermography-based material classification using machine learning. In: 2017 IEEE International Symposium on Haptic, Audio and Visual Environments and Games (HAVE), pp. 1–6. IEEE (2017)
2. Aujeszky, T., Korres, G., Eid, M.: Measurement-based thermal modeling using laser thermography. IEEE Trans. Instrum. Meas. **67**(6), 1359–1369 (2018)

[1] Concrete, PE block, acrylic, coal, marble, sorbothane, LPL, HPL, steel and silicone.