Transcoding texture information acquired contactless to tactile signals in the context of a remote touchless inspection system

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***Abstract*— This paper presents an algorithm to transcode surface texture information into tactile feedback signals in the context of a touchless remote inspection system. The texture information is obtained in the form of point cloud data produced from a structured light sensor. The algorithm is split into two stages: haptic data extraction, and mapping. The extraction is done by calculating the acceleration based on both the position and the velocity of the fingertip of the user relative to the texture. The acceleration data is then run in open-loop-control and mapped to an LRA actuator.**

I. Introduction

Physical inspection poses significant risks, such as exposure to hazardous [1], or even impossible working situations like the presence of rotating parts. Remote inspection with robotic platforms is therefore an established method [2]. In such hazardous cases, contacting the surfaces may not be possible even remotely, although tactile information may provide relevant details on the situation at hand. Thus a touchless sensor system is needed. In this paper, an algorithm is introduced to extract surface texture information based on point-cloud-data extracted from a structured light sensor used in remote-inspection-scenarios.

II. Methodology

To fulfill the requirement of µm accuracy for extraction texture information, Mech-Eye UHP-140 structured light sensor was used with an accuracy of 30 µm at 0.3 m range. Fig. 1 shows an example of the produced point cloud. The raw point cloud is filtered from outlier points by removing 2 mm from all sides.

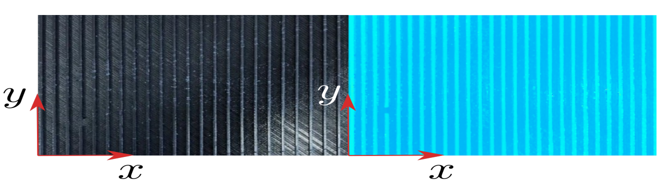

Fig. 1. Capture of the structured sensor. Left: top view RGB image of the object, Right: Produced point cloud

A. Texture information extraction

The algorithm serves the remote inspection scenarios. Constant exploring hand speed in the direction shown in Fig. 2 is assumed, and the fingertips are represented by a point in space. The positions of the fingertips are calculated based on the hand speed. The corresponding z-positions are then extracted from the point cloud. If more than one point is extracted at the same fingertip position, the median of these points in x- and y-axis is calculated and the z-position of the median is extracted. The position data are differentiated twice to calculate the acceleration in the z-axis.

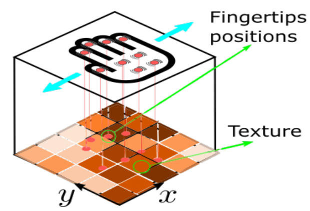

Fig. 2. Sketch of the relative position between the fingertips and the texture

B. Mapping of extracted acceleration data

Acceleration data is mapped to an 'LRA 08235L A' actuator driven by the driver 'DRV2605L'. The acceleration data is mapped to a PWM signal in the range from 0 to 255.

III. Preliminary Results

The algorithm was tested on the sample shown in Fig. 1. Fig. 3 the preliminary results at two different hand speeds (10 and 100 mm/s). These results show that the texture details extracted at higher speeds are less.

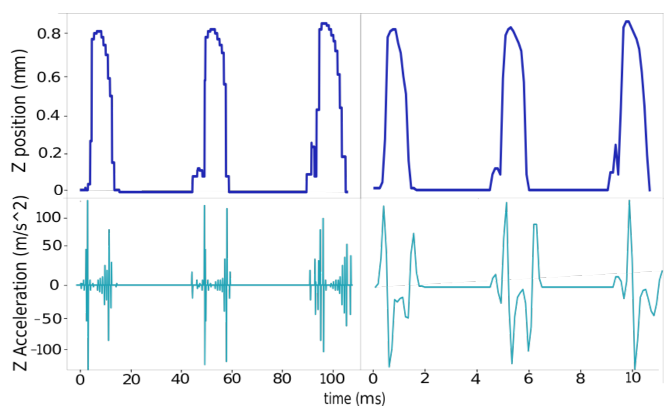

Fig. 3. Extracted z-positions from point cloud and the calculated accelerations based on constant hand speed of 10 (Left) and 100 mm/s (Right)

IV. Next Steps

To approach a realistic inspection scenario, the hand speed would be considered to be varying with time. Moreover, the fingertip would be modeled as a surface area rather than a point. Last but not least, a statistical filter algorithm would be used on the raw point cloud data.

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