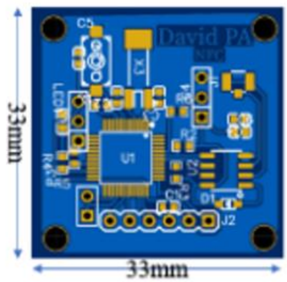
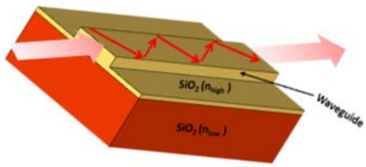
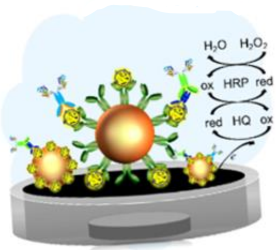
UM OLHAR SOBRE OS SENSORES NA PENÍNSULA IBÉRICA E AMÉRICA LATINA: ANO 2022

UNA MIRADA A LOS SENSORES EN LA PENÍNSULA IBÉRICA Y AMÉRICA LATINA: AÑO 2022

A LOOK AT SENSORS IN THE IBERIAN PENINSULA AND LATIN AMERICA: YEAR 2022







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12º Congresso Ibero-Americano de Sensores

Aveiro – PORTUGAL

M. Teresa S. R. Gomes e Marta I. S. Veríssimo

(coordenadoras)

FICHA TÉCNICA

Título:
Um olhar sobre os sensores na Península Ibérica e América Latina: Ano 2022

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M. Teresa S. R. Gomes, Marta I. S. Veríssimo

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Design e paginação:
Marta I. S. Veríssimo

Editora:
UA Editora
Universidade de Aveiro
Serviços de Documentação, Informação Documental e Museologia
1ª edição – Julho 2022

e-ISBN:
978-972-789-792-6

DOI:
https://doi.org/10.48528/h76t-t092

Agradecemos o apoio financeiro ao CESAM através da FCT/MCTES (UIDP/50017/2020 + UIDB/50017/2020 + LA/P/0094/2020UIDP), através de fundos nacionais.

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DETECTION OF DEFECTS ON DISPLAYS BASED ON MICROSCOPIC AND OPTICAL COHERENCE TOMOGRAPHY EXAMINATION

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Introduction

The use of displays in control car panels, smartphones, notebooks and LCD TVs has increased in the last decade. The large-scale manufacturing of new products emphasizes the need for fault detection at an early stage in the assembly process to detect the presence of scratches and particles. Therefore, fast, reliable and efficient displays inspection equipment is essential in order to reduce production-line stoppages, increase productivity and ensure the product reliability.

The fact that these defects may range from a few to hundreds of micrometers poses high demands on the measurement technology to ensure the quality of the product. Also, the metrology techniques should be non-destructive and non-contact, and have automated image processing and analysis capability. Current inspection techniques use machine vision based on a charge-couple device camera [1]. These techniques provide a top view of the display panel surface, which allows quantifying the surface extension of the defect. However, it is not able to provide information on the depth of a scratch or the effect on the structure of the surface caused by particles. Other types of techniques are available for metrology, such as X-rays, computed tomography and ultrasonic imaging, but they do not provide depth resolution at the required scale [2], [3].

In this work, we evaluate the use of: an inspection microscope Nikon Eclipse L200N combined with the microphotography camera Nikon DS-Fi3 and a commercial Optical Coherence Tomography (OCT) system, Telesto II-1325LR from Thorlabs, for analysis of the presence of scratches and particles on the surface of display panels. OCT is a non-invasive and non-destructive modality that may be used for imaging microstructures at the micrometer scale. This work was performed in the scope of an industrial research project with ITEC company. ITEC company is specialized in the development of automatic inspection equipment for manufacturing quality control.

Methods

OCT is a well-established imaging technology for high-resolution, cross-sectional imaging of biological tissues. Imaging processing and light attenuation coefficient estimation allows to further improve the OCT diagnostic capability.

The operating mechanism of OCT bears resemblance to ultrasound imaging, with the difference that light is used instead of acoustic waves. Near-infrared (NIR) light is the most commonly used. The optical configuration of OCT is based on low-coherence interferometry (LCI), which measures the time delay and the intensity of backscattered light by interference with light traveling along a reference path. The most common configuration of LCI for OCT technology is based on the Michelson interferometer shown schematically in Figure 1. The light beam from a source is split into two parts in a beam splitter; with one part directed to a reference mirror and another to the sample being analyzed. Depending on the properties of the sample, the light can be reflected, refracted, dispersed and absorbed. The light backscattered from the sample interferes with the light reflected from the reference mirror at the beam splitter and the resulting intensity is detected with an optical detector system at the interferometer output. The mathematical description of the operating mechanism of OCT is extensively described in literature [4].

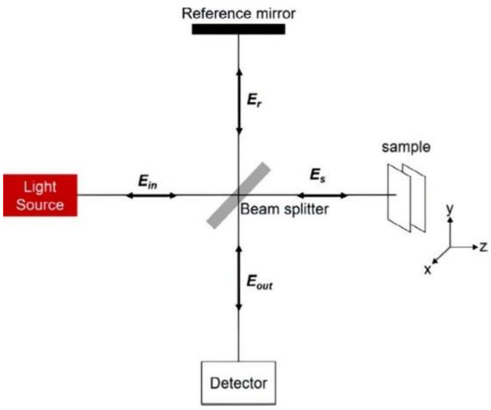

Figure 1 – Michelson interferometer, LCI configuration for OCT technology. E_{in}, E_{out}, E_r and E_s, correspond to the optical fields in the input, output, reference and sample arms, respectively.

Results

The results of the inspection microscope Nikon Eclipse L200N combined with the microphotography camera Nikon DS-Fi3 are excellent to detect defects higher than 5 µm in dimension. However, this technique only allows for a surface level inspection and does not provide a depth-resolved view of the defects. By use of this microscope, as shown in Figure 2 (a) and 2 (b), it was proven possible to detect surface level scratches in LCD screens of roughly 9.5 µm and 6 µm wide in dimension, respectively.

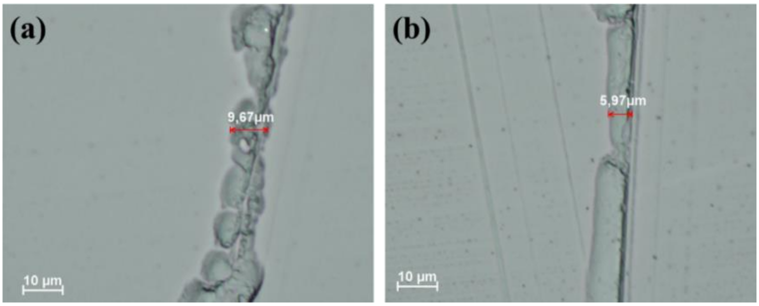

Figure 2 – LCD screens scratches inspection via Nikon Eclipse L200N microscope, where it is possible to detect defects of roughly, (a) 9.5 µm and (b) 6 µm wide.

The commercial OCT system, Telesto II-1325LR from Thorlabs, mounted in a spectral domain (SD) configuration is presented in Figure 3. The OCT system uses a super-luminescent diode (SLD) centered at 1325 nm and presents a theoretical axial resolution of 12 µm/ 9 µm and an imaging depth of 7.0 mm/ 5.3 mm (air/water). Lateral resolution of the OCT system is decoupled from the axial resolution: while the axial resolution is controlled by the spectral bandwidth of SLD, the lateral resolution is controlled by optics.

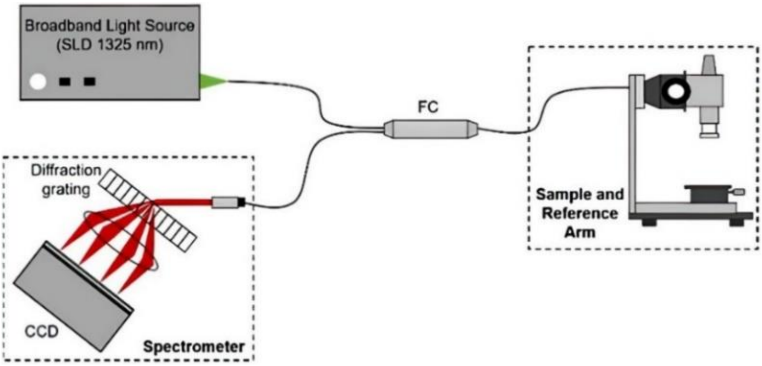

Figure 3 – Schematic of the SD-OCT system Telesto II-1325 LR, from Thorlabs. Reproduced with permission from [5] Thorlabs, Inc.

The imaging probe of Telesto II contains a Michelson-type interferometer, two galvanometric scanning mirrors and a telecentric scanning objective (OCT-LK4 optical kit from Thorlabs, which provides a lateral resolution of 20 μm). The spectrometer specifications fixed a pixel size vertical resolution of 6.91 μm well established in a depth of approximately 0.5 mm, nevertheless this parameter is limited by the optical source and the optical properties of the sample and has been shown to be capable to estimate up to 2 mm in depth [6].

Conclusions

Both methods (the inspection microscope Nikon Eclipse L200N combined with microphotography camera Nikon DS-Fi3 and the commercial OCT system, Telesto II-1325LR from Thorlabs) have shown to be excellent tools for analysis of the presence of scratches and particles on the surface of display panels. However, in order to properly analyze these defects in depth, the use of imaging processing and light attenuation coefficient estimation allows to further improve the OCT diagnostic capability. The OCT light attenuation coefficient estimation eliminates the subjective analysis provided by the direct visualization of the OCT images.

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Acknowledgments

This work was supported by project MME and project "ITEC Smart Automation I4.0", FEDER with the reference NORTE-01-0247-FEDER-045073, POR Norte, Portugal 2020.