Phase Sensitive Computer Tomographic Measurement using a Single Shot Interferometry Technique

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Abstract: A computed tomographic measurement based in sensing the introduced phase changes of a transparent sample is implemented. The interferometry system is composed by a Polarizing Michelson interferometer coupled to a pixelated camera in order to acquire the necessary phase shifted interferograms instantaneously. By obtaining measurements at different angles of rotation, added with computed tomographic algorithms, inner information of the sample is obtained. Characteristics and limitations of the implemented system will be explained and experimental results showing the inner distribution phase change of a high temperature torch will be presented.

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1. Introduction

Single shot interferometers, based on polarization phase shifting techniques, are becoming of great interest due to its stability to external vibration and potential implementation in industrial environments. The main property of these interferometers is the capability to obtain the necessary information to retrieve the phase information on a single capture. These systems are commonly based on replication methods like: amplitude/phase gratings [1], add extra components for getting replicas of the interferograms [2,3] or by using a pixelated polarizing camera [4,5].

A pixelated polarizing camera presents the characteristic of having a special mask aligned with the CCD sensor. This mask is composed by a special pattern where a linear polarizer at different angles is associated with each pixel on the CCD sensor. By taking into account this intrinsic characteristic, phase demodulation algorithms and interferometric systems can be proposed with the final purpose to retrieve the phase information of the sample in a single capture and with a stability to associate with physical properties of the sample.

2. Experimental Setup

In this work, we implemented a computed tomographic measurement system based on sensing the introduced phase changes of a transparent sample. The interferometry system is composed by a polarizing Michelson interferometer coupled to a pixelated camera in order to acquire the necessary phase shifted interferograms instantaneously, figure 1.

Figure 1.- Polarization Michelson Interferometer using pixelated camera.

Figure 2 shows a single phase measurement obtained by the implemented system. By the phase demodulation process a filtering process is added on the information retrieved to overcome the issues of noise. The 2D phase unwrapping algorithm is the 2D Goldstein branch cut algorithm.

Figure 2. - High temperature torch used as a sample was placed on the sample arm of the interferometer. a) Pixelated interferogram, b) wrapped phase and c) unwrapped phase.
By obtaining measurements at different angles of rotation, computed tomographic algorithms can be implemented and inner information of the sample could be retrieved. Experimental results are presented in Figure 3 corresponding to a single slice measurement. By combining each slice we were able to retrieve the 3D volume of phase change obtained on the flame, Figure 4.

![Figure 3](image-url)  
**Figure 3.** Inner phase distribution change obtained by computed tomographic algorithms.

![Figure 4](image-url)  
**Figure 4.** Volume phase distribution.

### 3. Conclusions

A preliminary result was obtained for a computer tomographic measurement based on sensing the phase change obtained on a pixelated interferometer.

### 4. Acknowledgments

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### 4. References


