Visualising Breath

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1. INTRODUCTION

The visualising of breath using digital in-line holography is challenging due to the issues of the relative scale of the human breath in relation to the recording area of the hologram. In this collaborative project between artist Jayne Wilton and physicists Professor Peter Hobson and Dr Ivan Reid a number of approaches, including the use of spatial filtering (Hobson and Hong 1988), are being used to record the human breath.

The use of holography to capture vapour bubbles is well documented. Bubbles clearly can be containers of breath, yet the investigators are currently also exploring the impact of breathing into an air chamber rather than through a liquid. A variety of methods are being examined ranging from breathing into a cloud generated by liquid nitrogen and breathing into a chamber of fine particles to allow the holographic visualisation of the trajectory of the spent breath.

2. OPTICAL SET UP

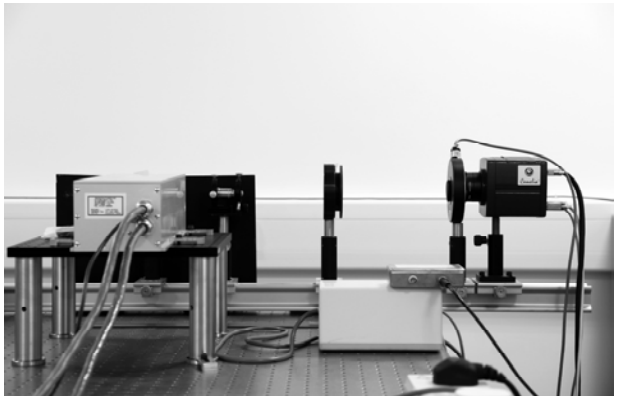

Figure 1: *The configuration of optical equipment. From left to right we have the pulsed laser, the beam expander, the shutter and the camera.*

A fast green pulsed laser (2ns pulse from a doubled Nd-YAG) is used to ensure that the moving cloud droplets are frozen in time. The beam is expanded using a microscope objective and an f=150 mm achromatic lens. The collimated beam then passes through the region in which the cloud droplets form and is then recorded with an 8M pixel monochrome CCD-based camera with 12-bit dynamic range (ATMEL Camelia 8M); Figure 1 shows the actual setup.

Breathing gestures as diverse as the sigh, the gasp and the basic expiration are performed into the cloud field and recorded (30 second shutter opening, laser pulse frequency one pulse per second).

2.1 Holographic processing

The captured data (Figure 2) is then processed using specially developed code, HoloMovie4Windows, running on NVIDIA GPU (Reid, Nebrensky & Hobson 2012). Our software allows for an interactive involvement with the audience who is able to navigate through the depth of the replayed hologram (Figure 3) and therefore explore the dynamic forms created by the breath.

3. REFERENCES

Hobson, P. R., Hong, J. (1988) Spatial filtering in multiplex holography. *J. Phys. D: Appl. Phys*. 21, S106.

Reid, I. D., Nebrensky, J., & Hobson, P. R. (2012) Challenges in using GPUs for the reconstruction of digital hologram images *Advanced Computing and Analysis Techniques in Physics Research* September 5-9, 2011, Uxbridge, London. To appear in *Journal of Physics, Conference Series*.

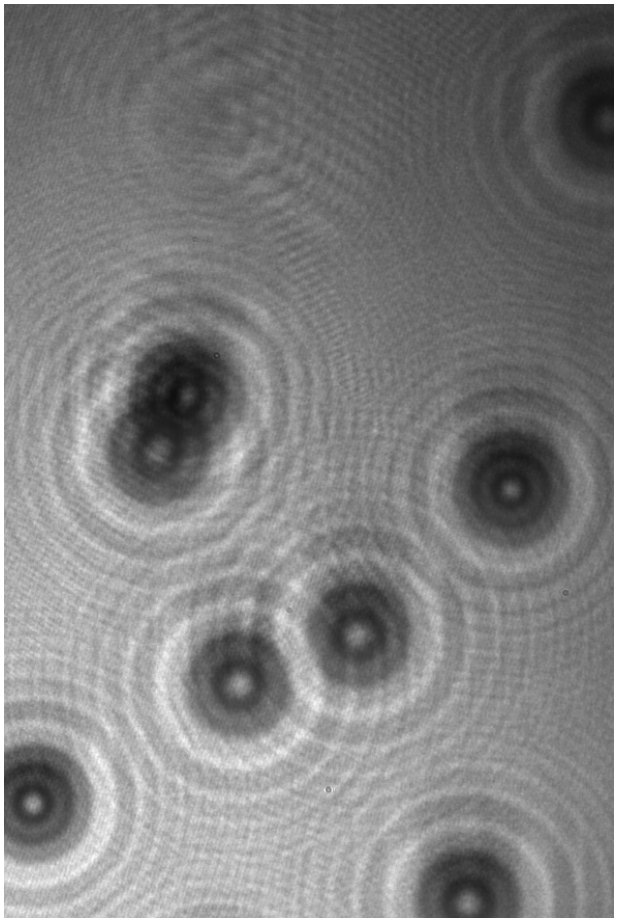

Figure 2: *Digital in-line hologram of bubbles.*

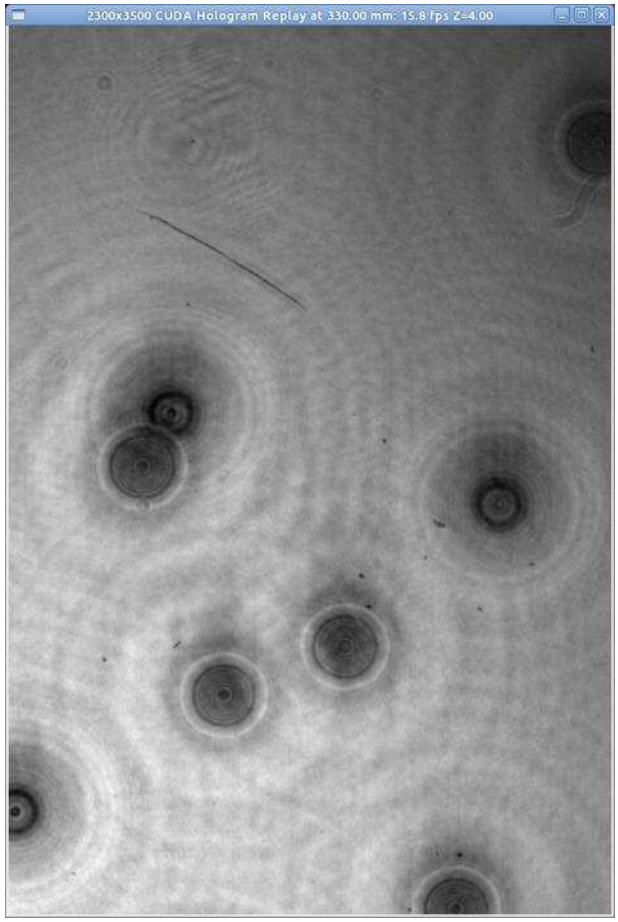

Figure 3: *One of the replayed images from the bubble hologram.*

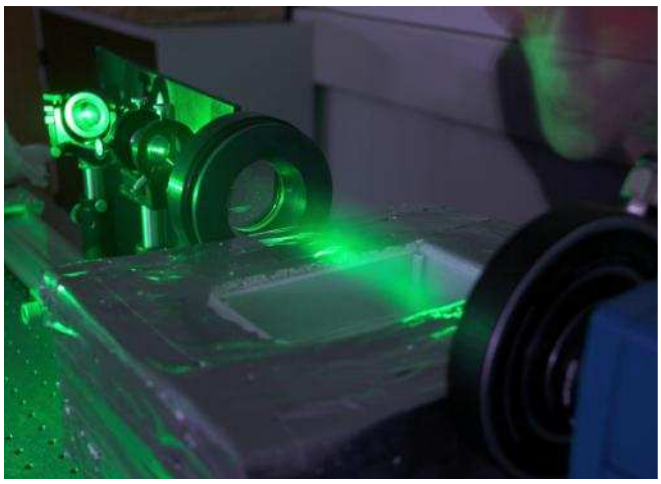

Figure 4: *Recording a digital hologram of breath. The insulated box below the achromatic lens contains a refrigerant to produce the mist.*