DEVELOPMENT OF OPTICAL BUBBLE MEASURING TECHNIQUES

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Bubbly flows occur in several branches of the industry, for instance in waste-water treatment or in the continuous casting of steel. In order to optimize these processes a non-intrusive measurement technique is needed, which gives information concerning bubble size and velocity next to the velocity of the surrounding liquid. For measuring spherical bubbles, Backlighting (recording the shadow of diffusely illuminated bubbles) is a proven technique. It has several drawbacks however. Most importantly, the location of the bubble along the optical axis cannot be determined leading to an impossibility to measure the void fraction or to accurately measure the interaction of the continuous and the discontinuous phase.

To this end a new optical technique is developed based on the appearance of glare points on the surface of a bubble placed in a laser sheet. For an angle of 96° and parallel polarized light this results in two visible bright spots at the surface of the bubble. The distance between these two points is a direct indication of the bubble diameter. This is the principle behind the new technique GPVS and a sketch of a typical set-up is shown in Figure 1.

Non-spherical bubbles will inevitably lead to wrong size measurements. This error can be eliminated by using a second laser sheet, which has the opposite sense as the primary sheet. Typically the reflection of the primary laser sheet on the Plexiglass water tank will suffice. This second laser sheet creates only one intense glare point for the supplementary angle of 84°, as is shown in Figure 2. The bubble size is now determined from the distance between the two externally reflected glare points, which is less sensitive to noise and misalignment. Furthermore, the relative location of the internal glare point allows us to reject particles whose non-sphericity would lead to significant sizing errors and detect a possible misalignment or the relative refractive index.

Up till now, the technique has been compared with simultaneous Backlighting measurements and this shows that the measured diameters with both techniques agree generally within 1 pixel.

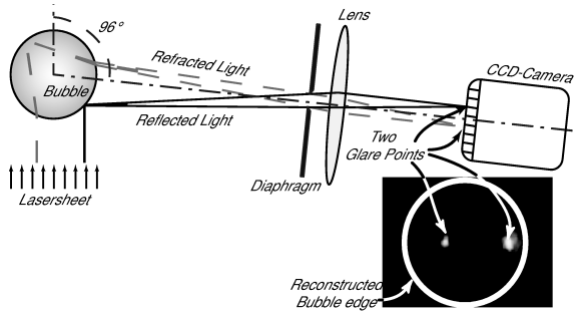

Figure 1: Basic GPVS setup

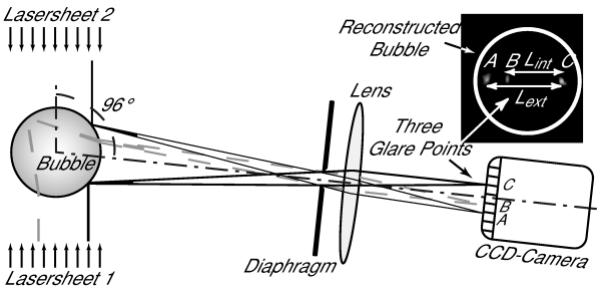

Figure 2: Extended GPVS setup