STRUCTURED LIGHT PLETHYSMOGRAPHY WORKING PRINCIPLES

The Thora-3Di™ technology is known as Structured Light Plethysmography or SLP. It measures the movement of the anterior thoraco-abdominal wall by dynamic motion capture, and generates a dynamic three-dimensional (3D) reconstruction of the anterior thoraco-abdominal wall. Average thoraco-abdominal (TA) movement over time is used to produce a respiratory pattern from which respiratory rate can be derived.

During measurement, a black and white checkerboard grid pattern of light is projected on to the wall of the chest and upper abdomen. The head unit of the Thora-3Di™ device incorporates two video cameras, located at both sides of the projector, which record changes in the structured light grid. The position and angles of the cameras inside the device head are fixed to enable capture of the 3D image. Changes in the projected grid, are used to calculate the 3D reconstruction of the movement of the thoraco-abdominal wall resulting from respiration. Figure 1.2 illustrates the principle.

The head unit of the Thora-3Di™, incorporating the projector and cameras, is positioned approximately 1 meter away from the subject. Thus, the data is captured remotely and the device requires no contact with the subject and is non-invasive.

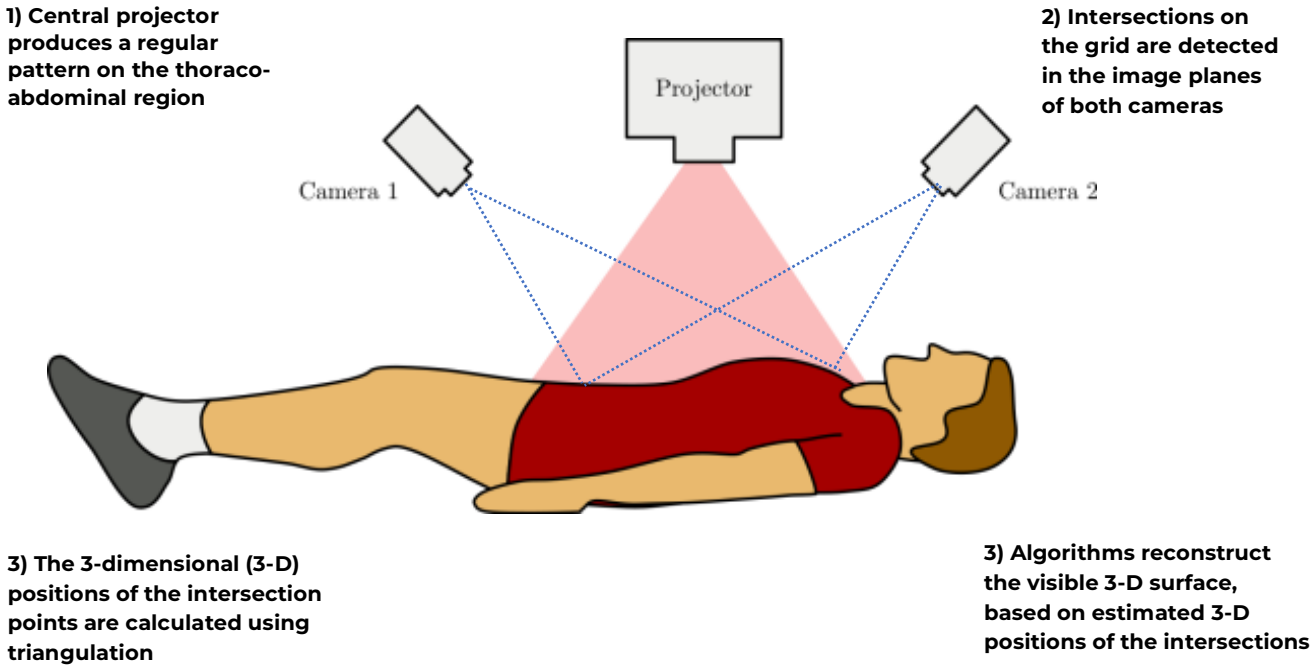

Figure 1. Principle of Structured Light Plethysmography

Structured light plethysmography relies on the modifications (distortions) to an image pattern that arise when that pattern is projected onto a surface. Comparing the known grid pattern to the observed pattern enables reconstruction of the 3D shape of the surface. As video data is gathered, a reconstructed surface can be calculated for each video frame. Chest wall movement (excursion) over time can be calculated from frame-to-frame changes in the surface.

During Thora-3Di™ recording, subjects are instructed to breathe naturally (tidal breathing). A typical pattern of tidal breathing measurement is shown in Figure 2.1. A measurement period of approximately 5 minutes is recommended. The trace pattern for the movement of the thoraco-abdominal region defines a respiratory waveform.

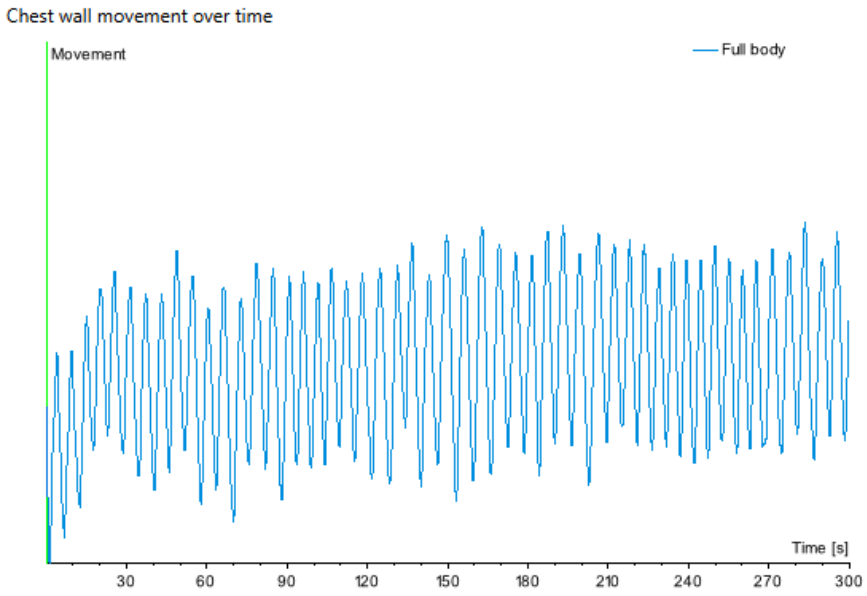

Figure 2. Chest wall movement signal generated from a typical 3D reconstruction

A structured grid of light (Figure 3.) is projected onto the subject's anterior TA wall (Top left). Displacements of this grid during tidal breathing are captured by two digital video cameras. This diagram shows the anterior TA wall split into two sections, one representing the thorax and the other the abdomen. Averaging the axial displacement of the surfaces corresponding to the thorax and abdomen, the thorax alone or the abdomen along provides a means to generate one-dimensional time series corresponding to displacement of the full body, thorax, or abdomen, respectively (bottom). A 3D reconstruction of the TA wall surface is also generated during SLP (top right). The grid top can also be divided into left and right hemithorax or any custom regions chosen for comparison.

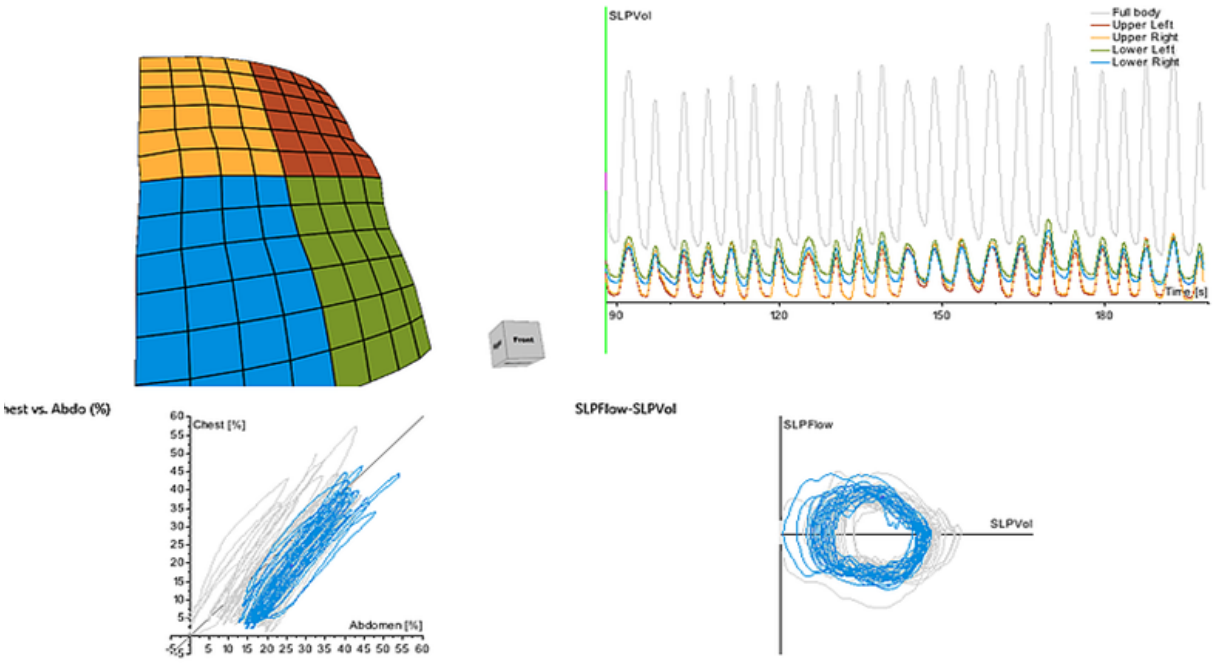

Figure 3. Thora-3Di 3D reconstruction