

#### Purpose:

The accuracy of delivering gated-radiation therapy to lung tumors using an external respiratory surrogate relies on the degree of correlation between the marker serving as a surrogate from breathing and motion of the anatomic structures. The irregular breathing during an imaging and treatment session and from one session to another may cause the dose distribution actually delivered to be different from the intended dose. The purpose of this work was to use the diaphragm images acquired from Ultrasound system and abdominal motion signal from Real-time Position Management (RPM) system, to study the relation between diaphragm and external surface motion during uncontrolled breathing cycles.

#### Methods:

The ultrasound images of diaphragm were captured at the same time as RPM signal acquisition for three volunteers from our staffs. After capture, one point at the image of diaphragm was selected and tracked for the whole breathing cycles using a proposed automatic tracking method which combines moving average strategy with Gaussian filter. Then, the diaphragm motion was compared to the respiratory signal from RPM system.

#### Results:

On three normal volunteer data sets: (1) the phase shifts were measured between the RPM signal in the abdominal region and diaphragm motion. Three volunteers showed the diaphragm motion either leading or delay abdominal motion with the mean time around 0.2-0.4 second; (2) the phase shifts at difference breathing cycle for the same people were different; (3) there is no significant difference between the phases at the end of inhale and exhale.

#### Conclusions:

We conclude that the external monitor can be used to predict internal respiratory motion. However, it may be important to check with Ultrasound images or fluoroscopy of diaphragm for possible time delays. We found that the Ultrasound can be a more reliable non-ionizing method than RPM system used for respiratory gating in radiation therapy.