Bed-type oscillator for MR Elastography

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1. Introduction
- Magnetic resonance elastography (MRE) has been developed to provide noninvasive measurements of elasticity for human tissue.
- In MR Elastography method, external oscillations are applied to the object with known frequency, and the acoustic strain waves caused by the oscillations are visualized in MR images.
- Then the shear modulus and Young's modulus are calculated by measuring transverse and longitudinal wavelength from the images[1].

- Purpose of this research
  - The aim of our research is to create an oscillator that generates a flat transverse wave in a large area.

2. Background
- Calculation of the elasticity from the wavelength
- Transverse wave
- Longitudinal wave
- Shear Modulus : \( G = \frac{4\pi^2\rho}{\lambda_t^2} \)
- Young's Modulus : \( E = \frac{2G\xi_t^2}{1-\xi_v^2} \)

- Probe-type oscillator (Previous method)
  - In most MRE studies in vivo or ex vivo, a small probe that contact the target object was used to provide oscillation [1].
  - The probe-type oscillator generates spherical wave.

- Limitation of the probe-type oscillator
  - Difficult to calculate \( \lambda_t \) and \( \lambda_v \) at each point.

3. Methods
- Bed-type oscillator
  - To produce pure transverse wave, we designed a bed-type oscillator.
  - The system has a moving plate under the measuring object to generate a flat wave.

- Feature of the bed-type oscillator
  - The bed-type oscillator generates a flat wave in the measurement object.
  - A flat wave is propagated along every line orthogonal to the moving plate.
  - It facilitates the analysis of wavelength.

4. Phantom study
- In the first experiment, a silicon phantom was imaged by the probe-type oscillator and the bed-type one.

- Results
  - Bed-type
  - Probe-type

5. In vivo study
- In the second experiment, right calf of a healthy volunteer was examined in vivo.

- Results
  - Bed-type
  - Probe-type

6. Conclusion
- We realized the bed-type oscillator which produced a flat transverse wave in a large area of a material.
- The phantom experiment showed that the bed-type oscillator generated a flat wave.
- The human calf experiment in vivo showed that the bed-type oscillator propagated a flat transverse wave in a large area.

- Future work
  - Various parts of human body will be imaged with bed-type oscillator so as to realize quantitative measurement of elasticity.
  - The direction of oscillation of the bed-type oscillator will be changed to generate a flat longitudinal wave for measurement of Young's modulus.

References