



**NANYANG**  
TECHNOLOGICAL  
UNIVERSITY

# Sensing of Physiological Hand Tremor for Real-time Compensation in Micromanipulation

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*Presented by*

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# Engineering approaches to improve manipulation accuracy

- A number of micromanipulation accuracy-enhancement systems have been developed, including
- Telerobotic systems,
- Steady-hand robotic system ,and
- Fully hand-held active tremor compensation instrument (Micron).

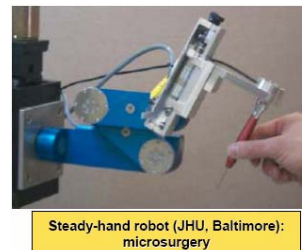
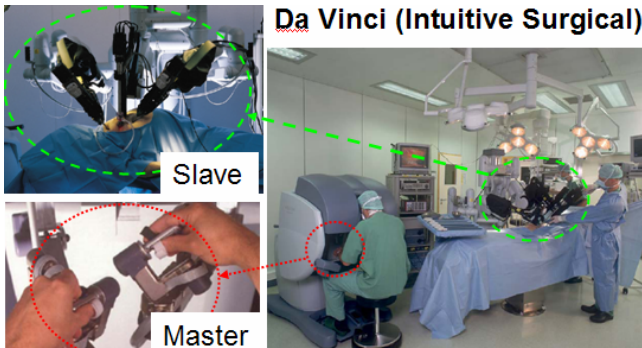
Obtrusive

> US\$1M

> US\$150K

< US\$15K

Unobtrusive



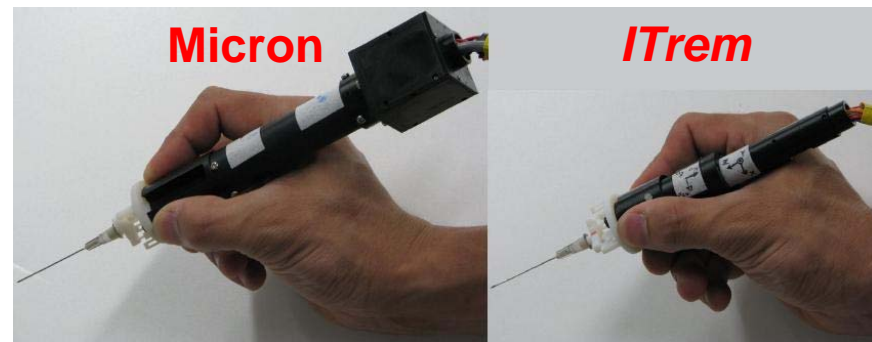
Cheap

Unobtrusive

High Dexterity

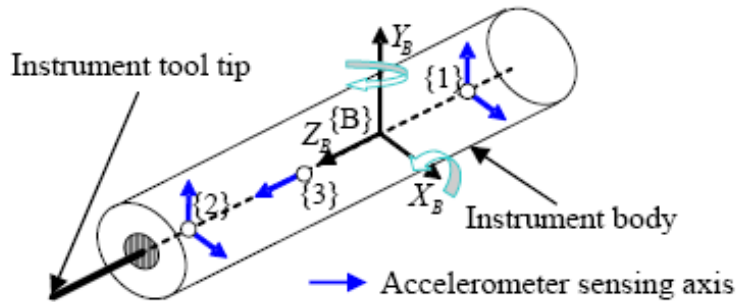
# Instrument for Tremor Compensation : *ITrem*

(A few years of research and implementation done in NTU)

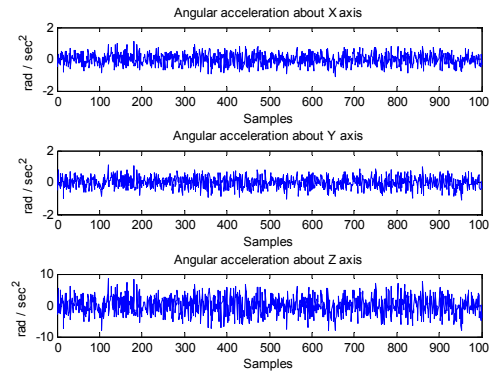


# Sensing sub-system

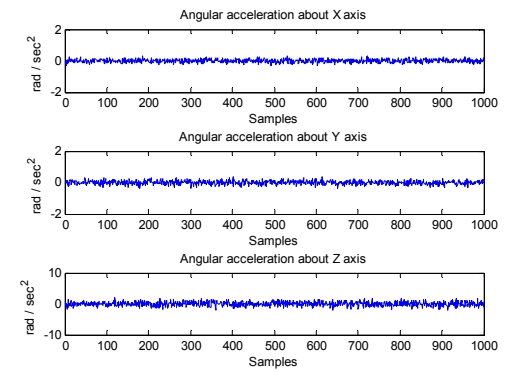
- Accelerometers only



Micron



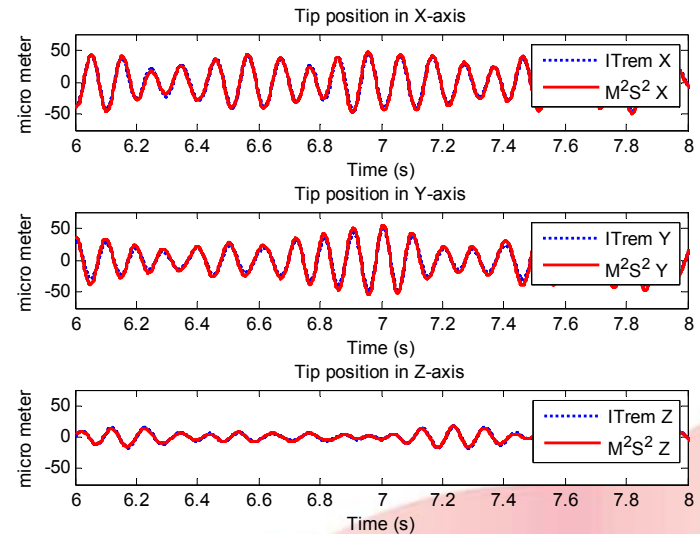
ITrem



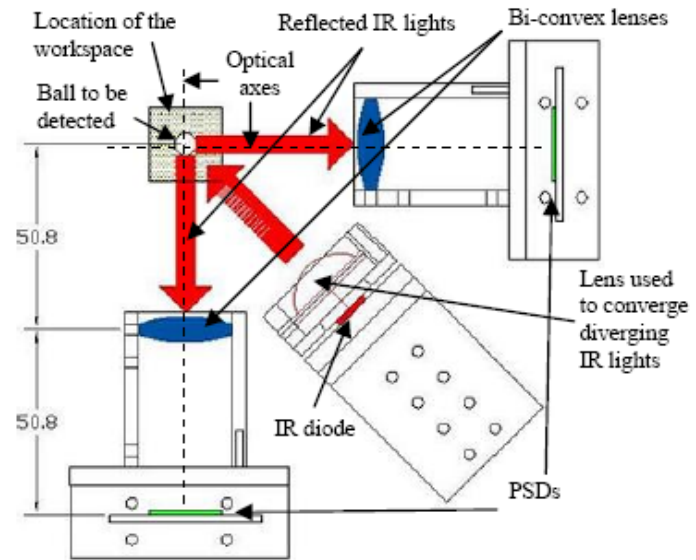
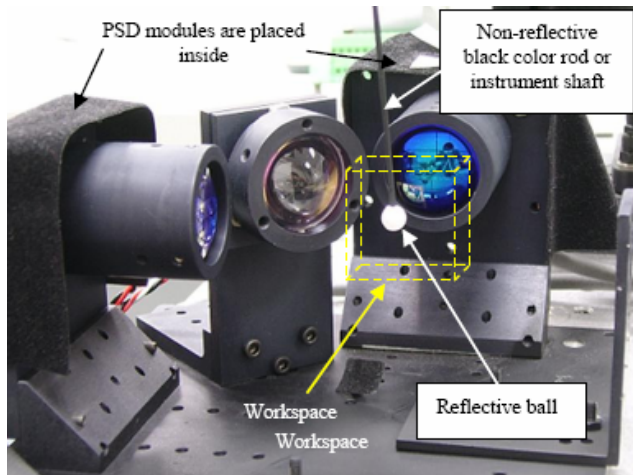
W. T. Latt, U-X. Tan, C. Y. Shee, C. N. Riviere, and W. T. Ang, "Compact Sensing Design of a Hand-held Active Tremor Compensation Instrument for Better Ergonomics", *IEEE sensors journal*. (Accepted)

W. T. Latt, U. X. Tan, F. Widjaja, and W. T. Ang, "Placement of Accelerometers in a Hand-held Active Tremor Compensation Instrument for High Angular Sensing Resolution", *IEEE International Conference on Robotics and Biomimetics*, Bangkok, Thailand, Feb, 22-25, 2009, pp.263-268.

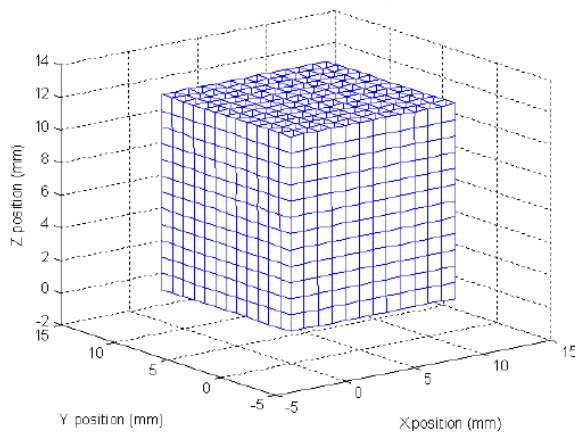
W. T. Latt, U. X. Tan, C. Y. Shee, and W. T. Ang, "Identification of Accelerometer Orientation Errors and Compensation for Acceleration Estimation Errors," *IEEE International Conference on Robotics and Automation*, Kobe, Japan, May 12-17, 2008.



# M<sup>2</sup>S<sup>2</sup> for evaluation



Neural Network Position Outputs



## System Performance

Accuracy ~ 98 %

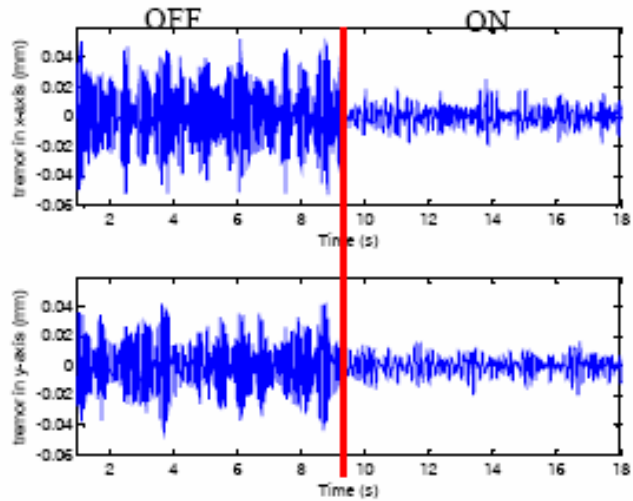
Resolution ~ 1  $\mu\text{m}$  RMS

Workspace ~ 12  $\text{mm}^3$

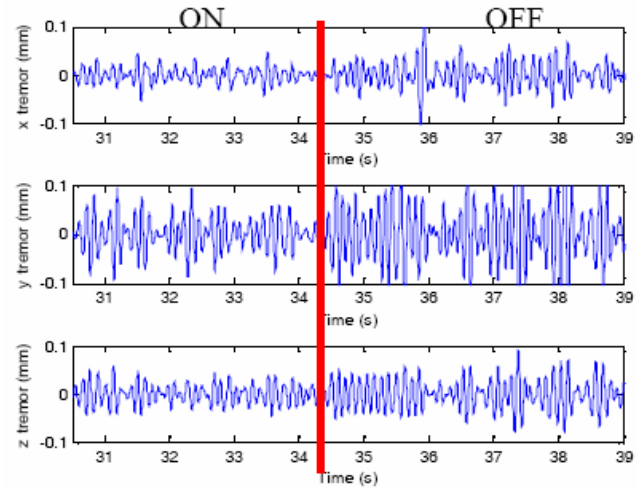
T. L. Win , U. X. Tan, C. Y. Shee, and W. T. Ang, "Design and calibration of an optical micro motion sensing system for micromanipulation tasks," in *Proc. IEEE International Conference on Robotics and Automation*, Roma , Italy , Apr. 2007, pp. 3383-3388.

W. T. Latt , U. X. Tan, C. Y. Shee, and W. T. Ang, "Handling Light Disturbances in a Micro Motion Sensing System and Investigation of the System Performance", *IEEE International Conference on Biomedical Robotics and Biomechanics* , Scottsdale, Arizona, USA, Oct 2008. pp. 463-468.

# Evaluation results



Bench test



Hand-held test

Results (Absolute rms amplitudes) of compensation performance in bench test and hand-held test

	OFF ( $\mu\text{m}$ )	ON ( $\mu\text{m}$ )	Reduction (%)
Bench test	26.0	9.4	63.98
Hand-held test	74.8	44.7	40.28

TABLE 2 COMPARISON PHYSICAL PROPERTIES OF MICRON AND *ITREM*

	Micron	<i>ITrem</i>	Improvement (%)
Length (mm)	210	189	10
Weight (g)	170	75	54.29

# Q & A