VibCat : Vibration Categorization for input & interaction

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NAVER UNDERGRADUATE POSTER COMPETITION

Contribution & Goal

New press interaction & Object recognition

This poster suggests new interaction & object recognition technique using only *commodity built-in vibration motor* and *accelerometer* in smart phone.

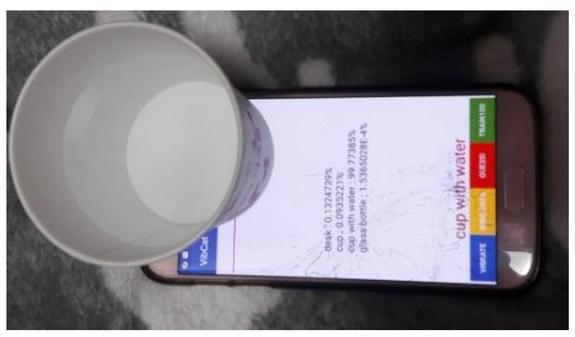


Fig 1. VibCat Object Recognition

Fig 2. VibCat New press interaction

Approach & Method

Forced oscillation & natural frequency

$$x(t) = X_0 \sin(\omega t + \phi)$$

$$X_0 = \frac{KF_0}{\left\{\left(1-\omega^2/\omega_n^2\right)^2 + \left(2\varsigma\omega/\omega_n\right)^2\right\}^{1/2}} \qquad \phi = \tan^{-1}\frac{-2\varsigma\omega/\omega_n}{1-\omega^2/\omega_n^2}$$

(where $\omega_n = \sqrt{\frac{k}{m}}$, $\varsigma = \frac{\lambda}{2\sqrt{km}}$, $K = \frac{1}{k}$, X_0: amplitude of motion, ω_n : natural frequency)

Equation 1. Motion of objects in forced oscillation

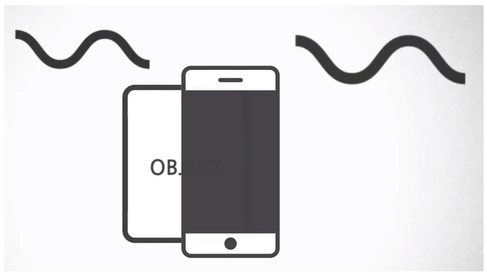


Fig 3. Forced Oscillation diagram

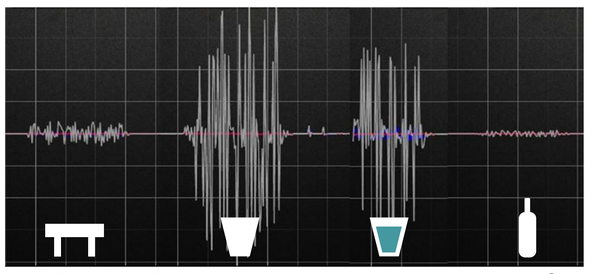


Fig 4. The acceleration graph of various objects

Collect data
vibration data from accelerometer

Data Smoothing
Savitzky golay filter

Arrange the wave
The highest peak is in first position

Feature selection analysis
40 data points + 40 absolute + average + root mean square(rms) + min +max

Train
Softmax classifier

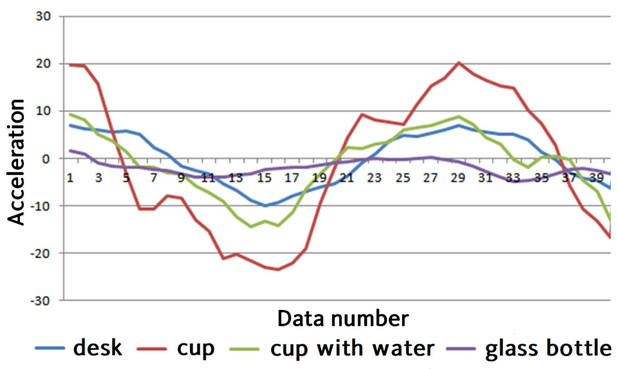


Fig 5. Acceleration graph of each object

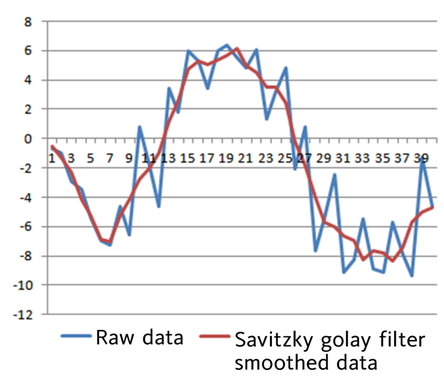


Fig 6. savitzky golay filter result

Evaluation

Experimental Condition

- Samsung galaxy S7 (with OEM Vibration Motor) with silicon case to prevent the mobile device from vibrating on either axis.
- Placing the objects ten times randomly, each time capturing ten samples.
- Vibrate during 1000msec and measure 40 acceleration values every 7msec after 500msec.

Fig 7. The objects for VibCat test: desk, cup, cup with water, and glass bottle

Result

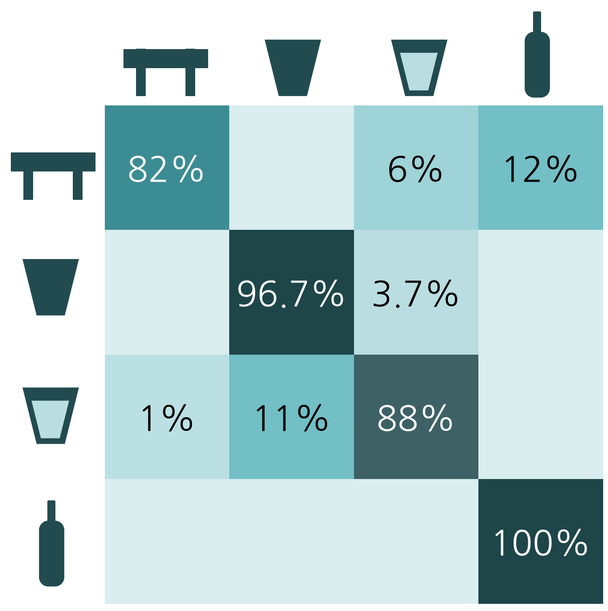


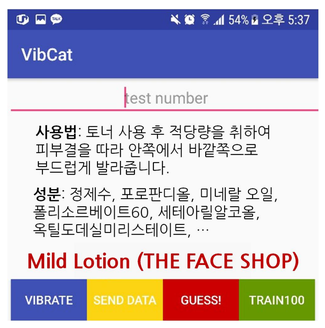
Fig 8. Confusion Matrix

Fig 9. VibCat Design

Application

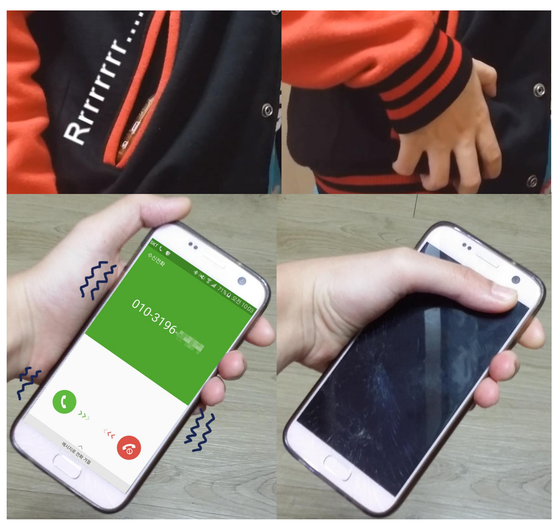
Services for blind

Predict lost device location



Interactive Dictionary

Bring real objects to VR



New ‘press’ interaction
(interaction without touch)

Waste sorting, Auto refill,
Self checkout

Future work

-Root the kernel and control the vibration intensity. Then collect the various channel’s result and train it.

-Extend the accelerometer measure region.

- Control the vibration intensity. Then find the natural frequency directly.

Demo video

VibCat github

Reference

-Hui-Shyong Yeo, Gergely Flamich, Patrick Schrempf, David Harris-Birtill, and Aaron Quigley. 2016. Radarcat: Radar categorization for input & interaction. In Proceedings of the 29th Annual Symposium on User Interface Software and Technology. ACM, 833-841
- Gierad Laput, Robert Xiao, and Chris Harrison. 2016. ViBand: High-Fidelity Bio-Acoustic Sensing Using Commodity Smartwatch Accelerometers. In Proceedings of the 29th Annual Symposium on User Interface Software and Technology (UIST ’16). ACM, New York, NY, USA, 321-333.