

Sonar-Based Measurement of User Attention



Stephen P. Tarzia¹, Robert P. Dick², Peter A. Dinda¹, Gokhan Memik¹

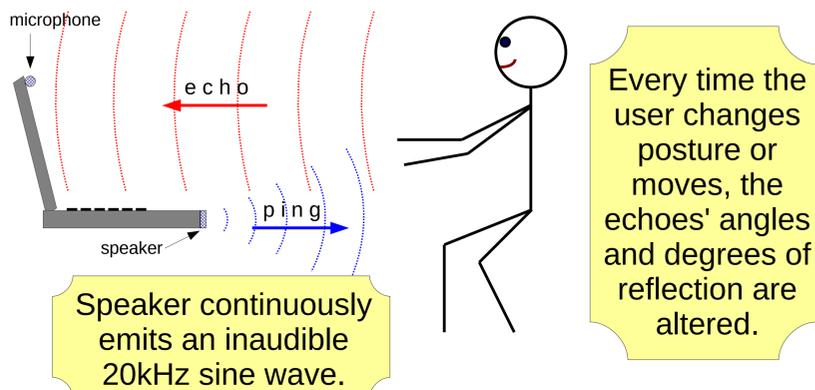
¹Dept. of Electrical Engineering and Computer Science, Northwestern University

²Dept. of Electrical Engineering and Computer Science, University of Michigan



We show how a laptop computer can use its audio hardware to determine whether or not a computer user is present without relying on mouse and keyboard activity.

Ultrasonic Sonar



Echo Signal Processing

Sonar recordings are processed as follows:

Windowing: Break the recording into a series of 100 millisecond windows.

Echo intensity: In each window, calculate energy at 20 kHz. Assume all of this energy represents sonar echoes. This gives a series of echo intensities: e_i

Echo delta: Calculate the average absolute difference in the sequence of echo intensities:

$$\Delta_e(e_1 \dots e_N) \equiv \frac{1}{N} \sum_{i=1}^{N-1} |e_{i+1} - e_i|$$

Motivation

For **power-management**, **security**, etc., the OS wants to know whether a user is present.

- Input inactivity can reliably indicate user absence only after a very long timeout period.
- Webcam surveillance can be faster, but is potentially costly and unreliable.

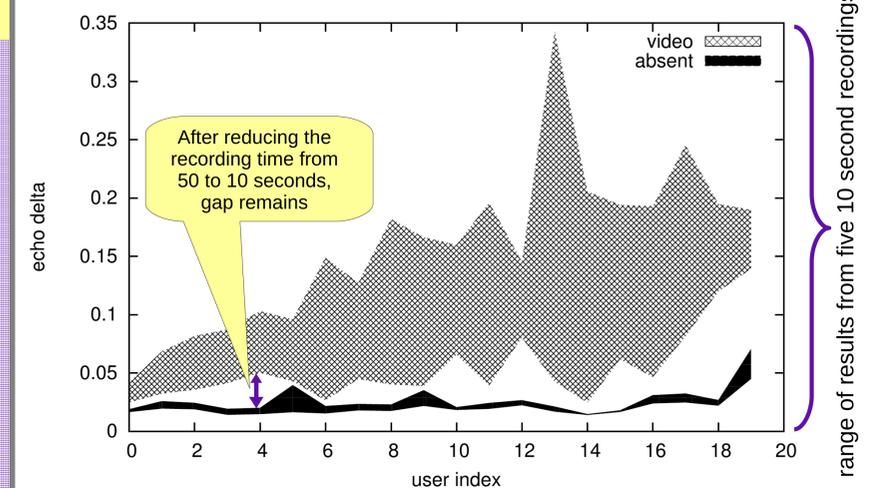
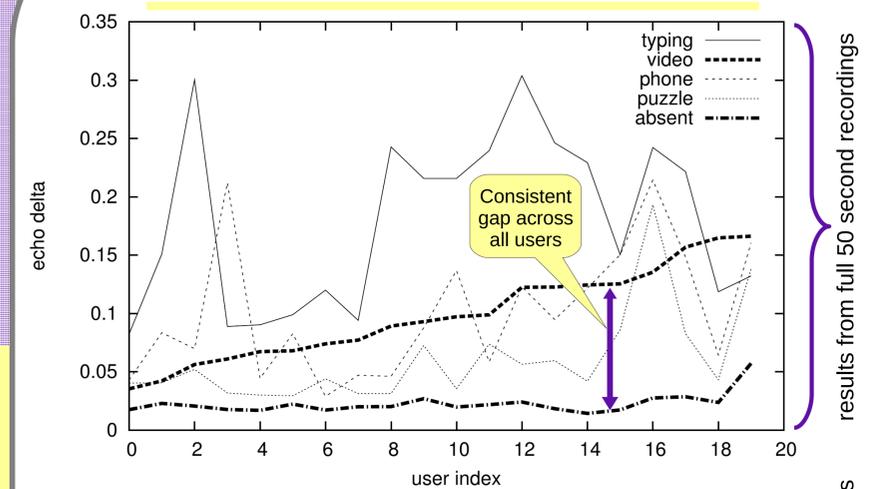
Hypothesis: sonar measurements will be much higher when user is **passively engaged** versus when user is **absent**.

User Study

Purpose was to test the correlation between user state and sonar echo delta. Sonar measurements were taken while twenty paid volunteers were guided through the following attention states:

state	definition	user study task
Active	using the keyboard or mouse	typing a document
Passively engaged	reading the computer screen	watching a video
Dis-engaged	sitting in front of the computer, facing away	using telephone beside computer
Distant	in room, but moved away from the computer	completing a puzzle on desk nearby
Absent	left the room	after the participant left

Results



Conclusion

Absent and passively engaged user states are easily distinguished by echo delta measurements using recordings as short as 10 seconds long, so presence detection is enabled by sonar.