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学术论文

# 基于Wi-Fi信号的细粒度人体呼吸感知

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From Fresnel Diffraction Model to Fine-grained Human Respiration Sensing with Commodity Wi-Fi Devices
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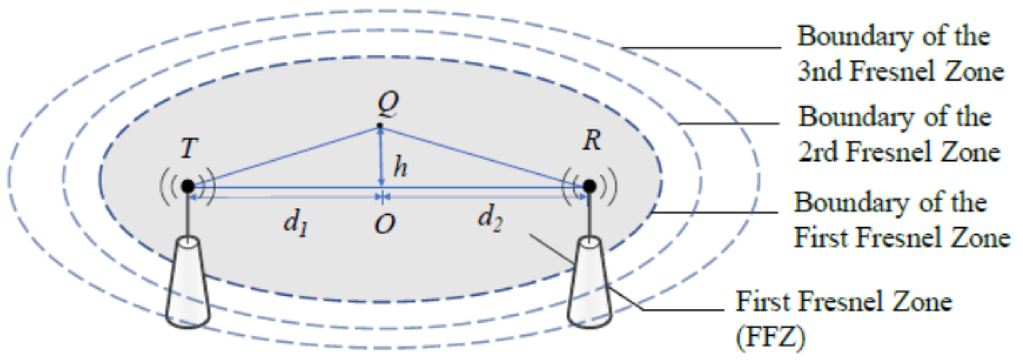
## Motivation

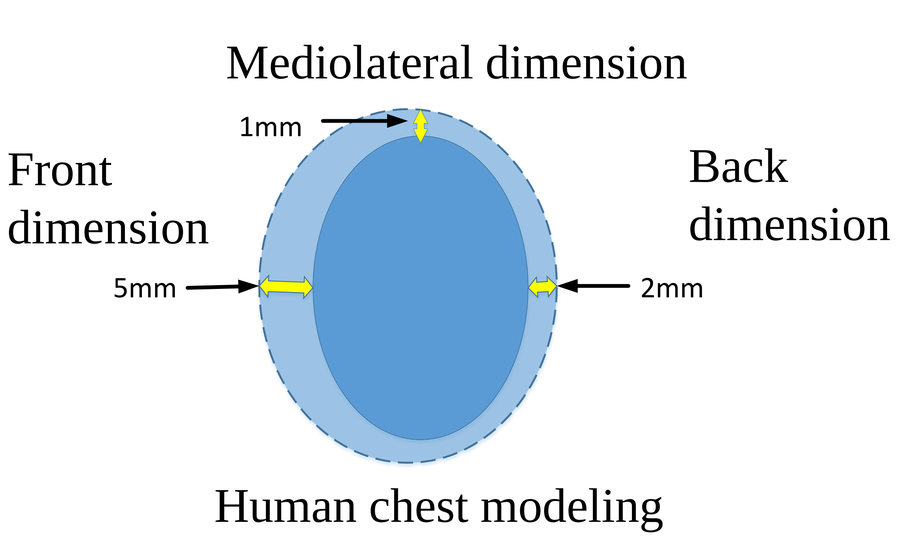
- Respiratory rate is an important vital sign, which can be used not only to monitor the progression of illness and decline in health, but also to predict emergencies that require immediate clinical attention
- The compelling need for a non-intrusive and cost-effective vital sign monitoring system has led us to exploit cheap Commercial Off-The-Shelf (COTS) Wi-Fi devices already widely available at home environment for human respiration sensing

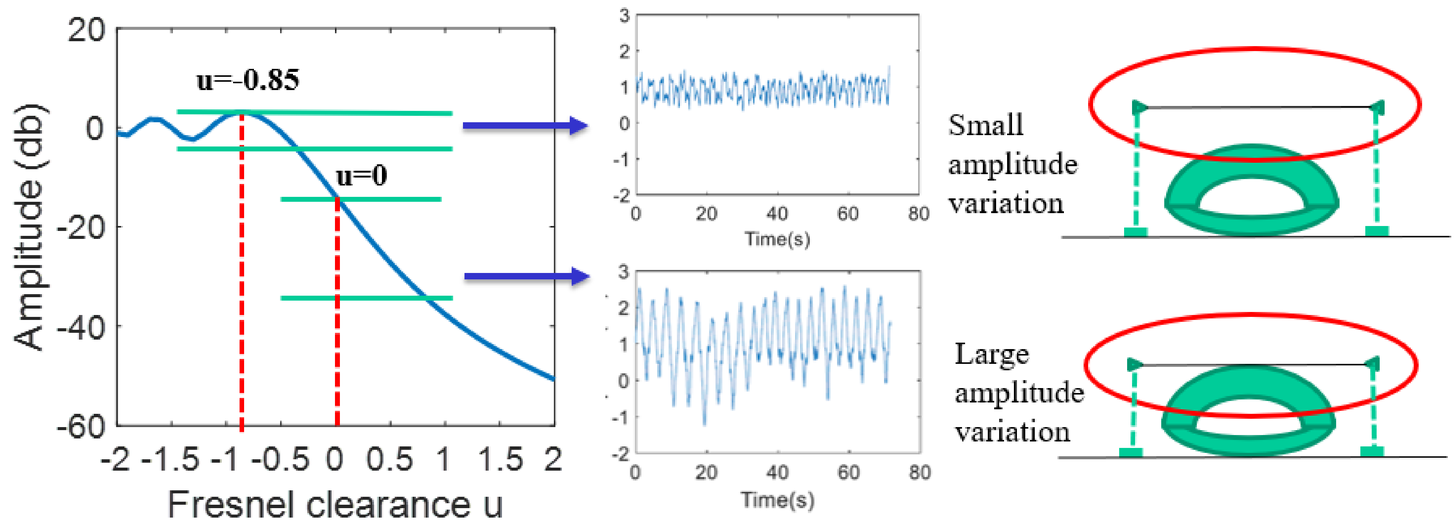


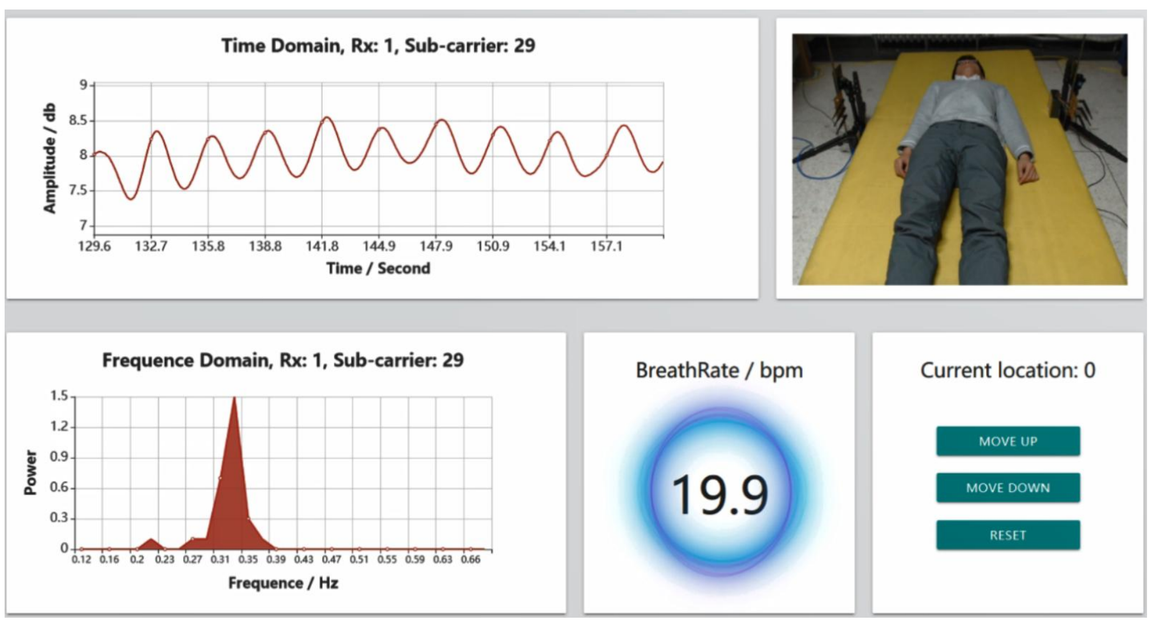

## The Proposed Fresnel Diffraction Model Based Approach

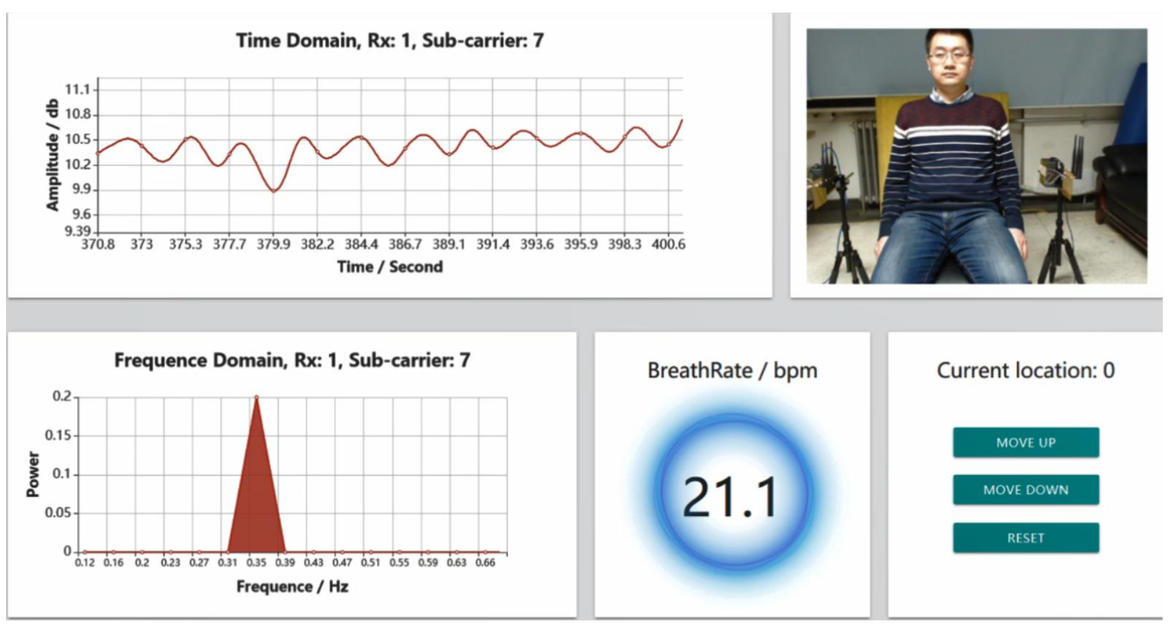
### Sensing Human Respiration in the First Fresnel Zone

- Modeling human respiration (e.g., chest displacement during respiration is 4.2~5.4 mm in front dimension)
- Converting chest displacement to phase change (Fresnel clearance $u=\frac{h}{r}$, $h$ is the distance from the edge of the target to Line of Sight (LoS), $r$ is the radius of Fresnel zone)
- Impact of chest location inside the FFZ, impact of body thickness and body orientation



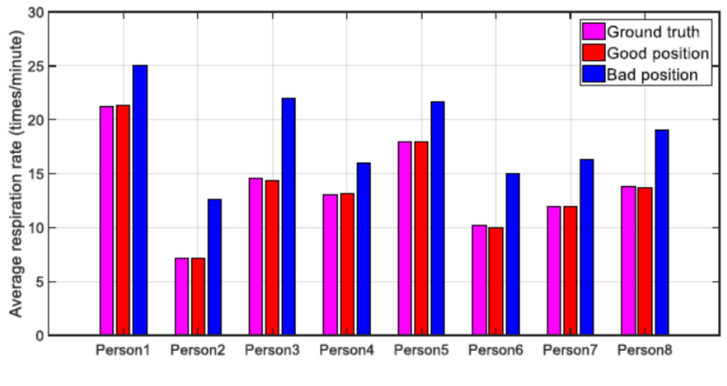



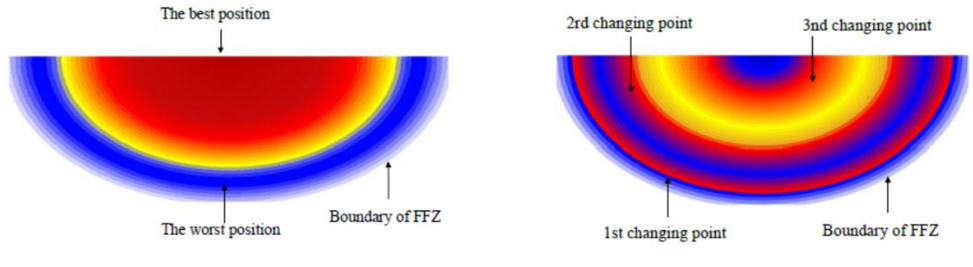




## Evaluation & Results

- We recruit eight participants including one female and seven male students for evaluation. We ask them to lie on the bed and breathe naturally. We record a set of monitoring data for each participant
- We employ a heatmap to visualize the performance of respiration detection at all locations within the FFZ




Respiration rates of different participants




(a) The heat map of lying postures　(b) The heat map of standing/sitting postures

Heat maps of two scenarios (viewed positions in color)