A Framework for Group Identification using Smartphone & Wearables

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What is Group?

Motivation

- ✓ Human beings are social by nature
- ✓ Understanding the **user behaviour**, studying group is essential
- ✓ Team **formation** among the **individuals** are the key factors behind **organizational efficiency**
- ✓ Performance of students in **institution** impacted by the groups

Challenges

- ✓ **Colocation:** Conceptualized as **localization** problem
  - Retrieving **highly precise location** information is challenging
- ✓ **Context: User list** are **not predefined** in physical world group
  - Getting **prior context** of the users is challenging

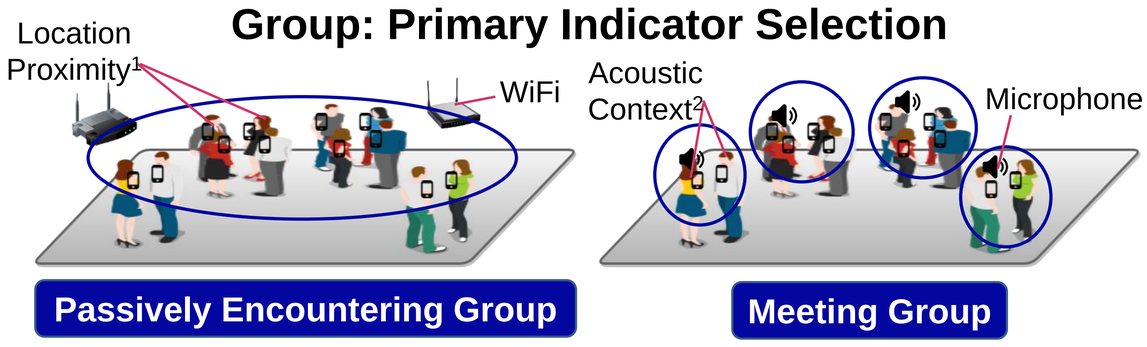
Limitations

- ✓ For **informal group** capture, deployment of **fixed infrastructure** is an **overhead**
- ✓ Capturing the indoor scenario with the only **GPS** is a challenging due to the **low coverage**
- ✓ **Similar inertial sensing** metric discards the group members with the **heterogeneity** property
- ✓ **Pre-trained** information almost unavailable for **instantaneous** group members

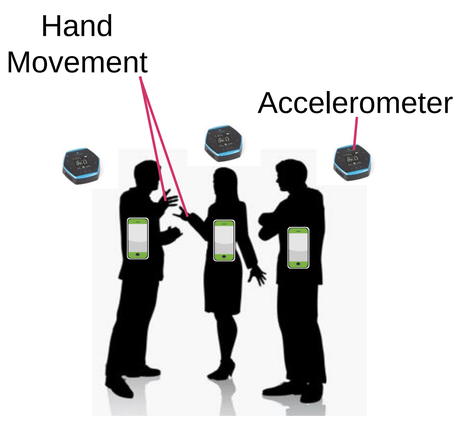
Objectives

- ✓ *Developing a Lightweight Framework for **Passively Encountering Group Identification** using Smartphone**
- ✓ *Developing a Lightweight Framework for **Meeting Group Identification** using Smartphone*
- ✓ *Developing a Lightweight Framework for **Group Role** and **Type** Identification using Commodity used Devices*
- ✓ *Designing a System for analysing the **Group Dynamics***

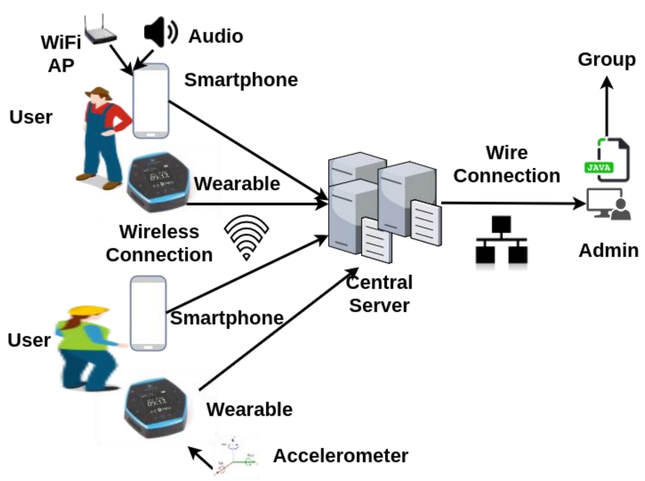
Group: Primary Indicator Selection



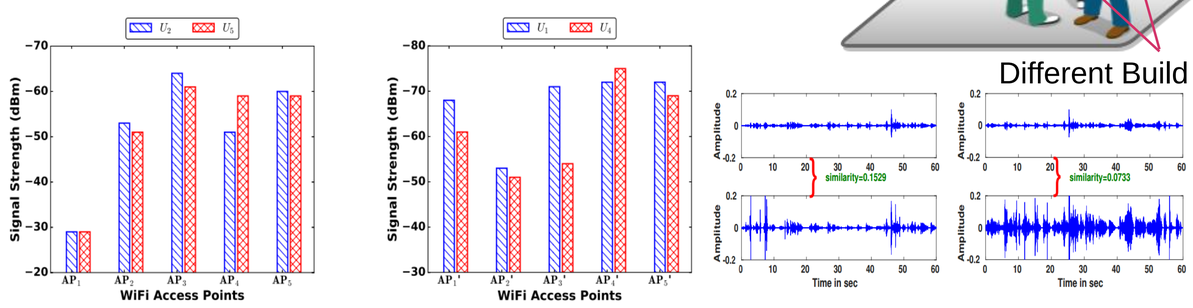
Group Role: Primary Indicator Selection



Data Collection Framework



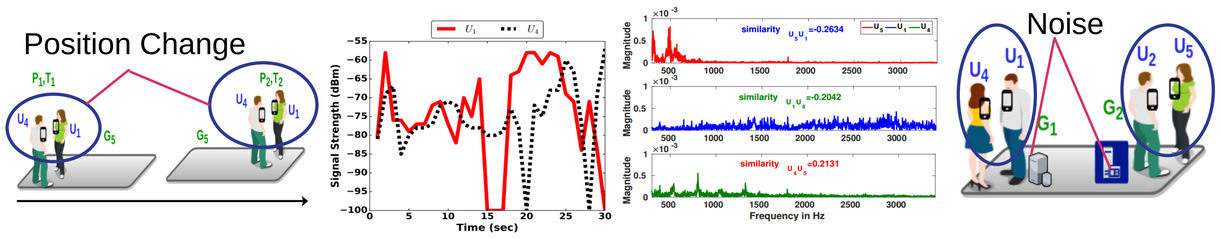
Device Heterogeneity



WiFi Similarity & Dissimilarity in **Same & Different Build**

Audio Similarity & Dissimilarity in **Same & Different Build**

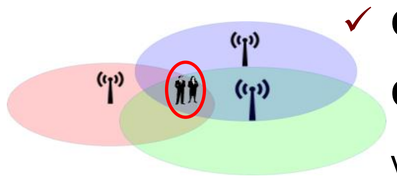
User Mobility & Environmental Noise



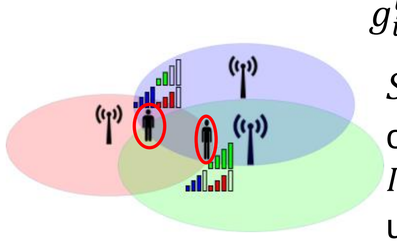
Effect of **Mobility** on WiFi RSSI

Deviations of Frequencies in Presence of **Noise**

Feature Generation: Measuring Proximity



- ✓ **Overlapping WiFi APs** using **Jaccard Coefficient** $J_{ij}^t = \frac{|B_i^t \cap B_j^t|}{|B_i^t \cup B_j^t|}$, $B_i^t = \{B_{i_1}^t, B_{i_2}^t, \ldots, B_{i_m}^t\}$ vector of WiFi APs scanned by the subject u_i at time t
- ✓ WiFi **Signal Strength**



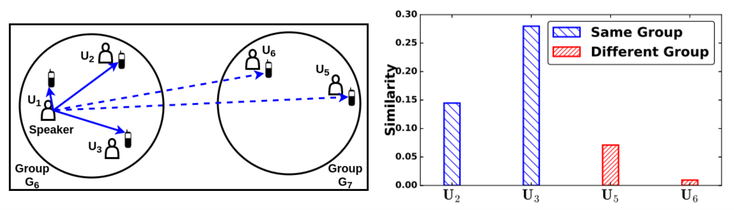
$g_{ij}^t = \frac{1}{|I_{ij}^t|} \sum_{(SS_{i_k}^t, SS_{j_k}^t) \in I_{ij}^t} ((SS_{i_k}^t - SS_{i_1}^t) - (SS_{j_k}^t - SS_{j_1}^t))$

$SS_i^t = \{SS_{i_1}^t, SS_{i_2}^t, \ldots, SS_{i_m}^t\}$ vector of signal strength of WiFi APs scanned by the subject u_i at time t

I_{ij}^t : set of **overlapping APs** scanned by the subjects u_i, u_j

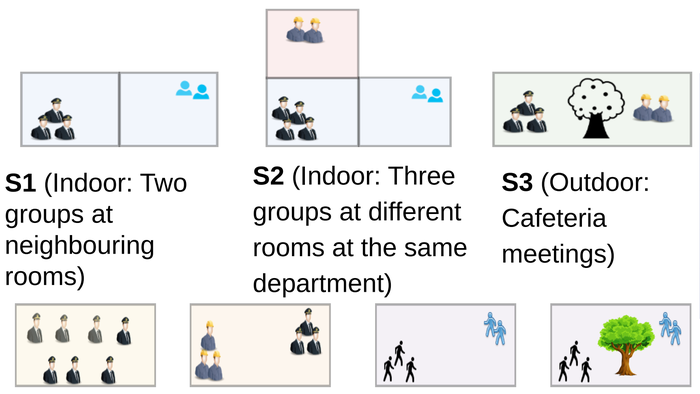
- ✓ **Proximity** Feature $F_{ij}^t = \frac{J_{ij}^t}{g_{ij}^t}$

Feature Generation: Measuring Acoustic Context



- ✓ Audio **Tone** Extraction $CCEP(S) = IFT(log(FT(S)) + j2\pi l)$

Experimental Scenarios & System Performance



S1 (Indoor: Two groups at neighbouring rooms)

S2 (Indoor: Three groups at different rooms at the same department)

S3 (Outdoor: Cafeteria meetings)

S4 (Indoor: Large single group)

S5 (Indoor: Two different groups at a large lab)

S6 (Indoor: Two roaming groups)

S7 (Outdoor: Two roaming groups)

ID	PEG Model		ID	PEG Model	
	F_1Score	Modularity		F_1Score	Modularity
S1	1.0000	0.2879	S5	1.0000	0.3801
S2	1.0000	0.1760	S6	1.0000	0.0000
S3	1.0000	0.3642	S7	0.6500	0.0976
S4	1.0000	0.0000	ALL	0.9421 (±0.13)	0.2114

- ✓ On an average F_1-Score is more than 90% for *PEG Model*

Conclusion

- ✓ Developed **PEG model**, a smartphone based methodology to infer various **passively encountering groups**
- ✓ Developed a novel **unsupervised methodology** to process the context information for inferring the groups
- ✓ **Device independence** and **lightweight** computable system

References

1. P. Sapiezynski, A. Stopczynski, D. K. Wind, J. Leskovec, and S. Lehmann. “Inferring Person-to-person Proximity Using WiFi Signals.” in Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies 1, 2 (2017), 24.
2. J. Baker and C. Efstratiou. “Next2Me: Capturing Social Interactions through Smartphone Devices using WiFi and Audio signals.” In EAI International Conference on Mobile and Ubiquitous Systems: Computing, Networking and Services 2017.

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