Communication-Efficient Federated Learning for Multimodal Automatic Target Recognition

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Motivation and Background

- **Client Heterogeneity.** **Individual heterogeneity** is seen in minor feature variations, while **group heterogeneity** arises from physiological and background differences. **System heterogeneity** is influenced by external factors, such as the age of data collection devices. Moreover, in mmFL, some clients may **lack certain modalities**.

- **Learning Efficiency.** Efficiency is influenced not only by the balance between performance and communication, also by varying data sizes across different modalities, leading to **differences in modality model sizes**. Furthermore, the **complexity of information patterns** inherent in data modalities affects the ease of learning.

- **Impact of Modality and Client.** It remains an open question as to which modality or combination of modalities should be **prioritized in the predictions**, considering their information richness. Moreover, the extent of client participation, influenced by factors such as data availability and quality, also plays a vital role in determining the effectiveness of different modalities.
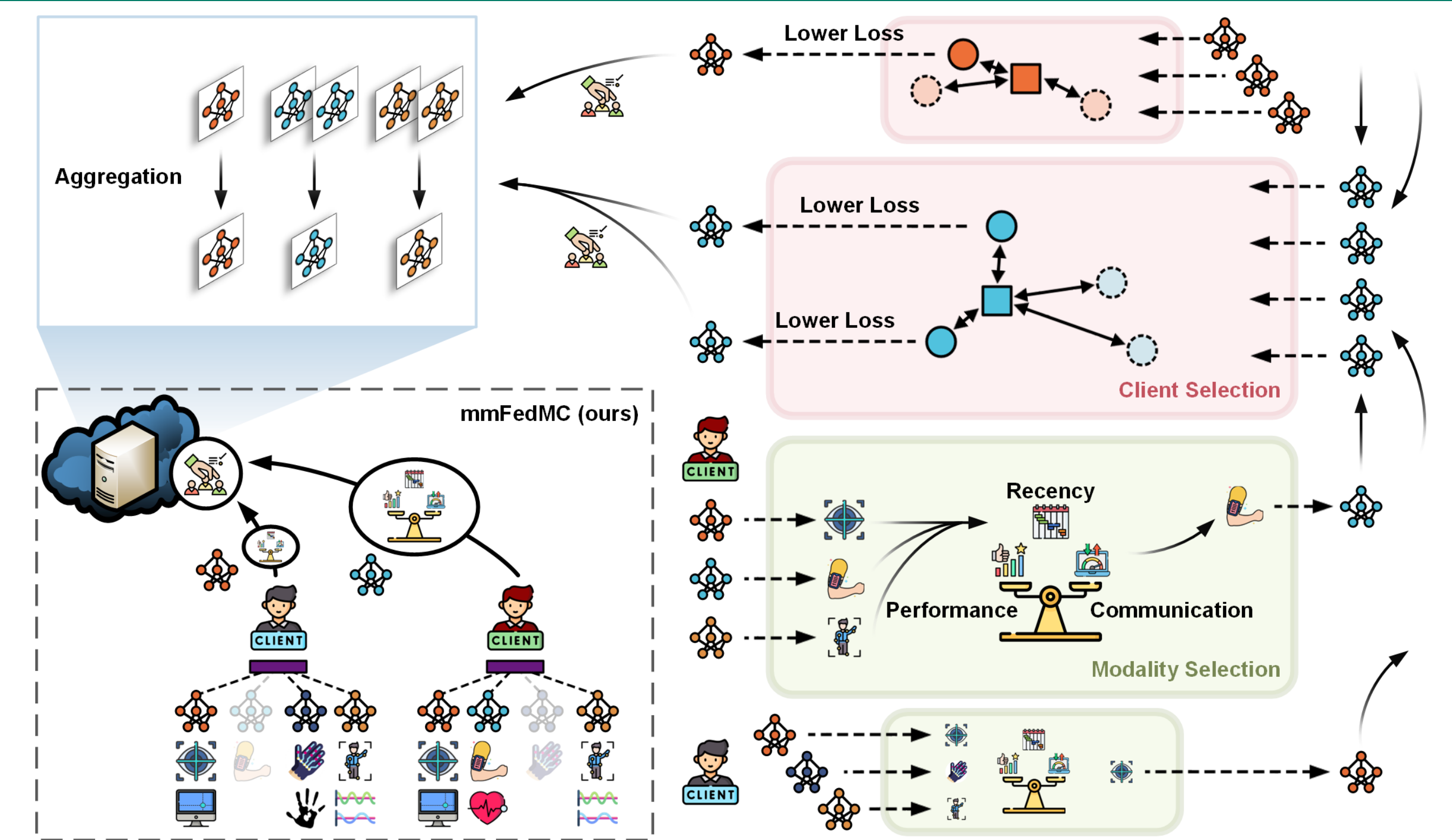
Traditional vs. Proposed
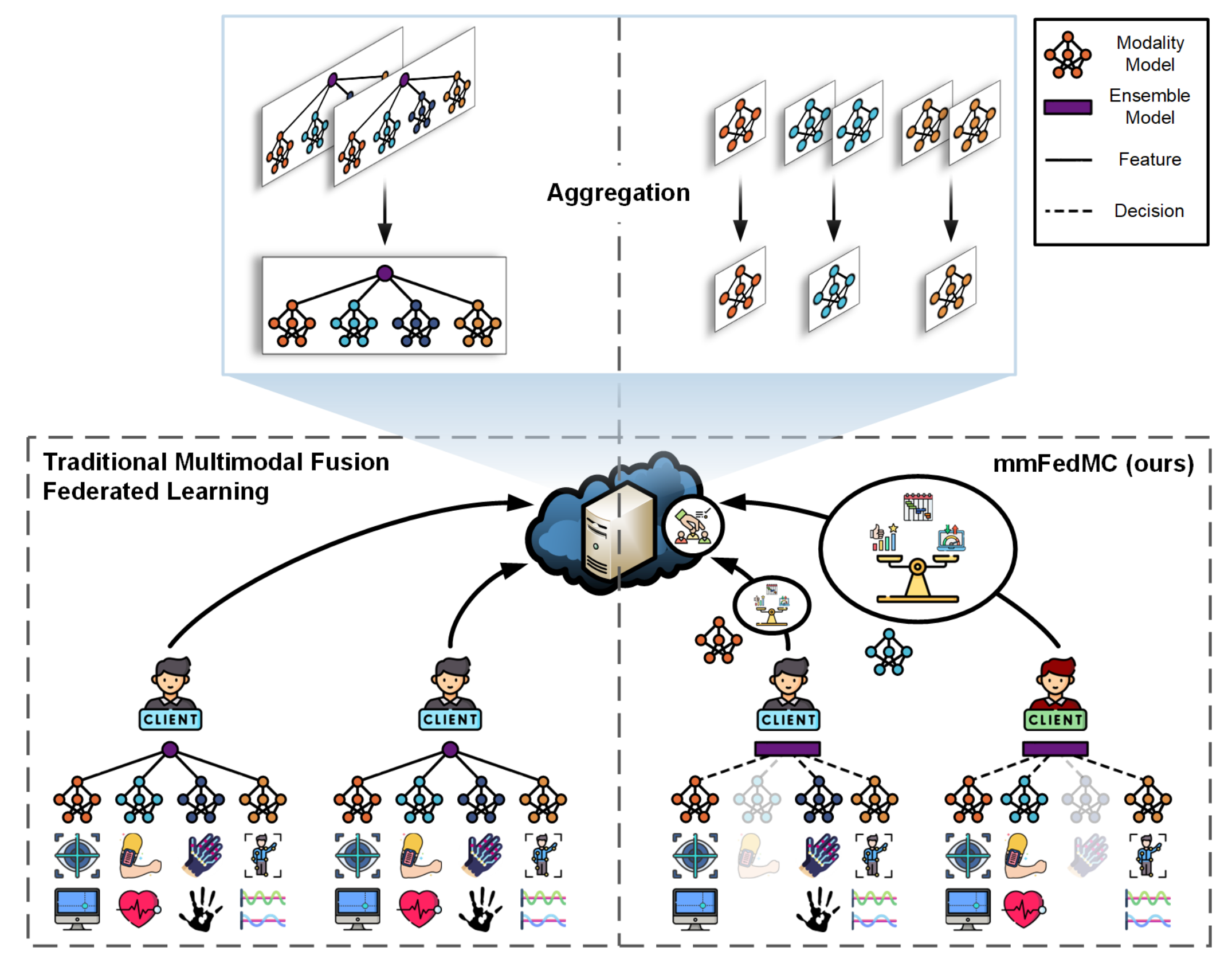
Acknowledgements

Joint Modality Selection and Client Selection

Contribution & Solution

- **Multimodal Federated Learning with Decision-level Fusion** - Personalization through local ensemble model

- **Communication-Efficient Joint Modality and Client Selection** - Ensure performance and reduce communication overhead

- **Analytics on Modality Impact** - Show which modality is more impact

Methodology: Joint Modality Selection and Client Selection

- **Modality selection** via Shapley value (modality performance), modality model size (communication overhead), and recency (generalizability).

- **Client selection** via lower loss of modality modal training process.
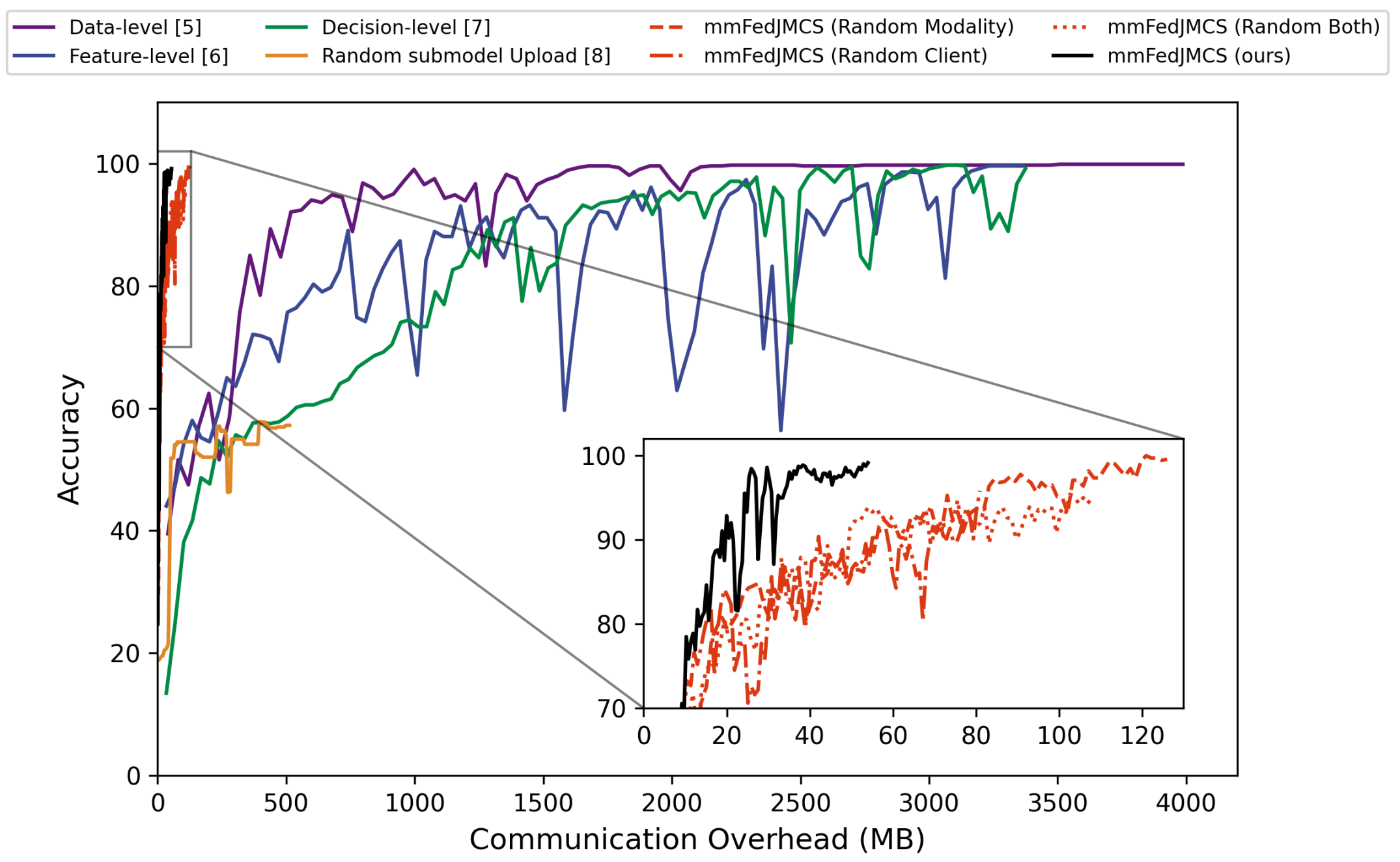
Multimodal Dataset & Experiment Setup

- Human activity recognition
- 9 subjects
- 20 Activities
- 6 modalities

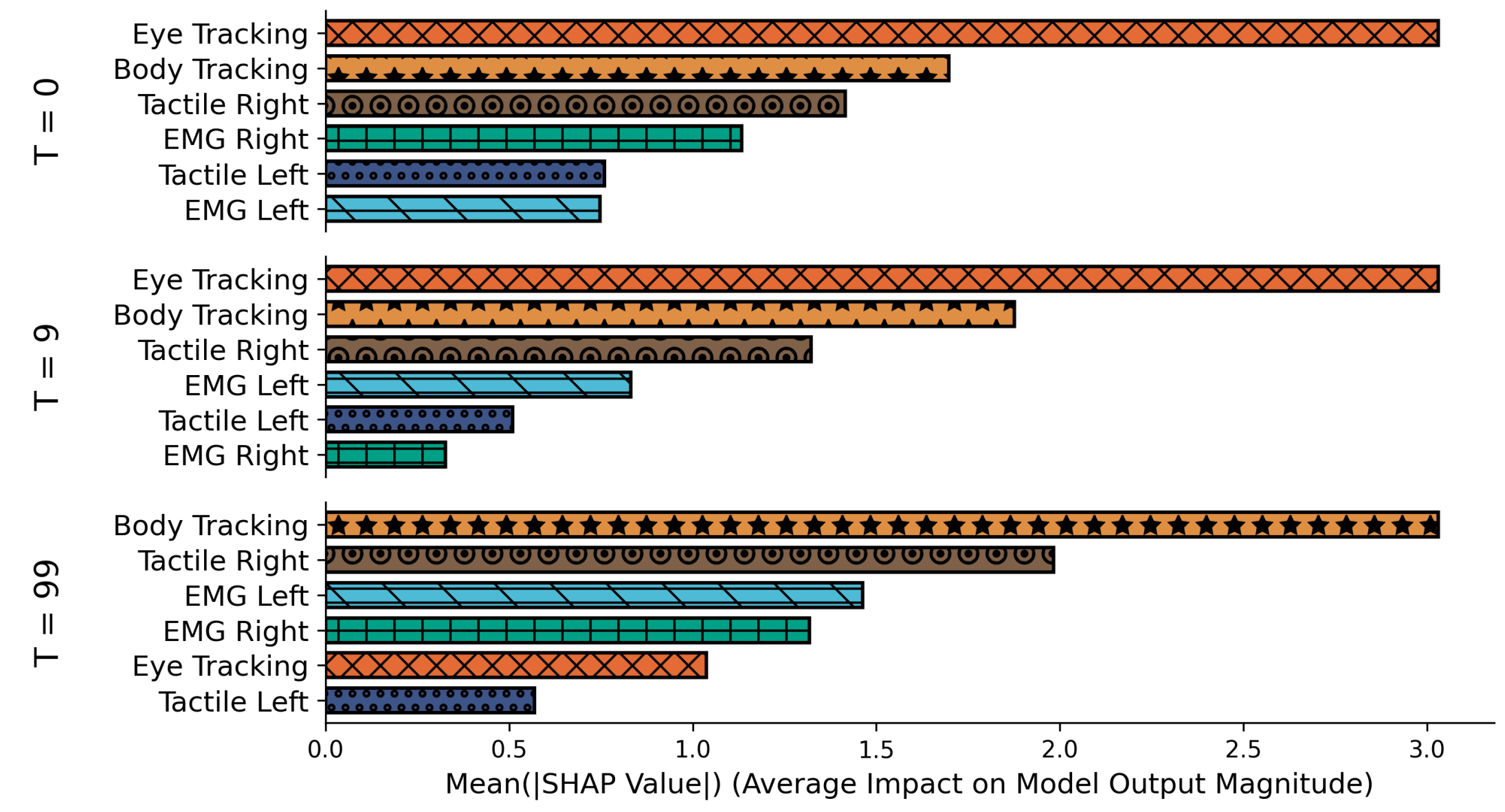**S06 - S09 missing Tactile Left and Tactile Right modalities**
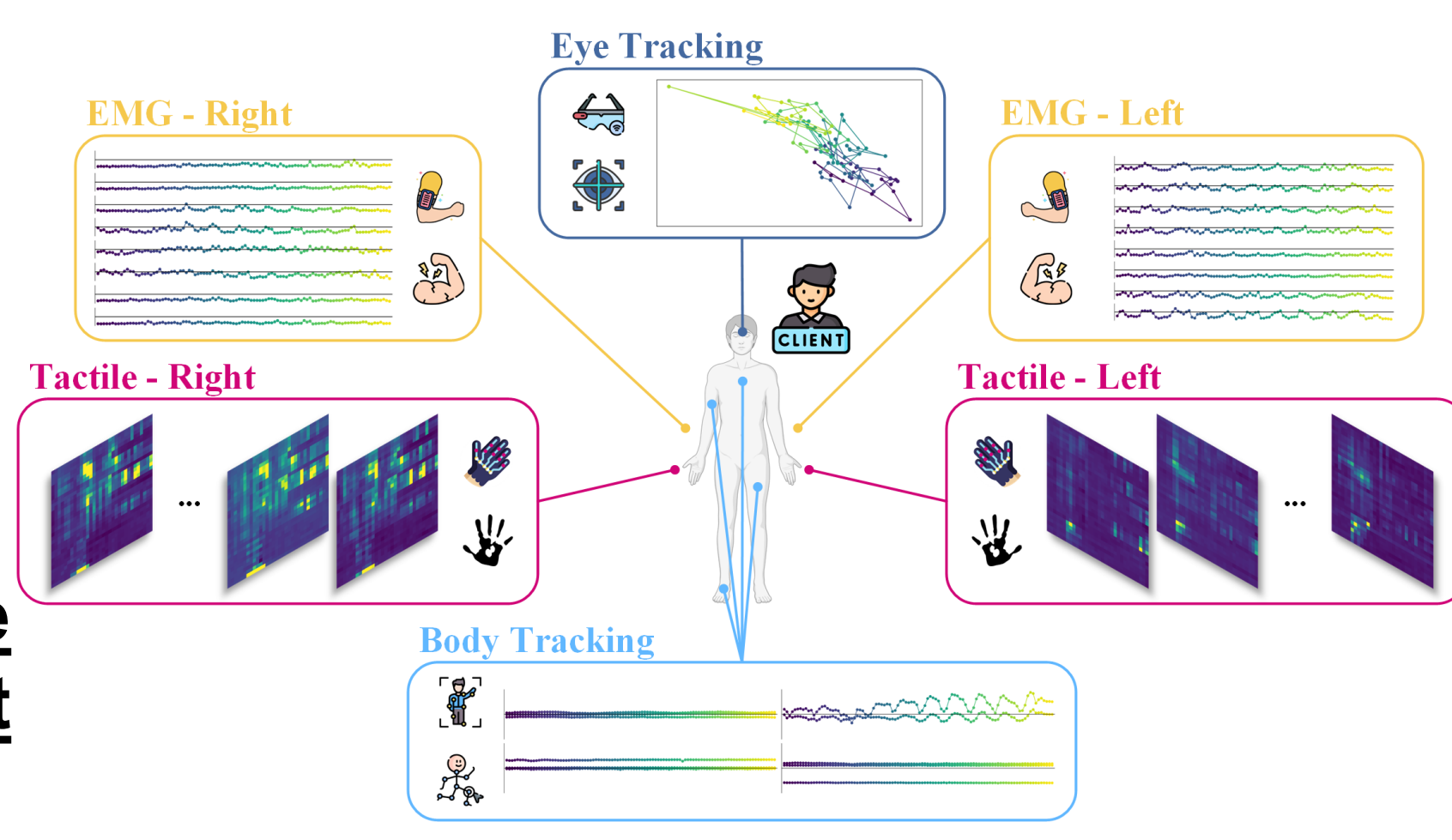
Results and Conclusion

Accuracy vs. Comm Overhead

Impact of Data Modality

Experiment on the real-world dataset demonstrate the ability of mmFedMC to achieve comparable accuracy to several baselines while **reducing the communication overhead by over 20x**.

Project Website
Demo Available!