FoGMap: Wearable Freezing of Gait Detection, Pose Estimation and Mapping in Daily Living Spaces

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1 Motivation

Freezing of Gait (FoG) is a major cause of falls in Parkinson's disease, described as the feet feeling "glued to the floor."

Its manifestation varies across individuals and daily-life contexts, motivating richer **real-world observation**.

- **Clinical / laboratory assessment:** Short observations cannot fully capture FoG as it occurs in daily life.
- **IMU-based FoG detection:** FoG can be detected, but the environmental and motion context remains unknown.

FoGMap estimates when, where, and how FoG occurs in daily living spaces using a neck-worn device with optional wrist / foot IMUs.

2 Contributions

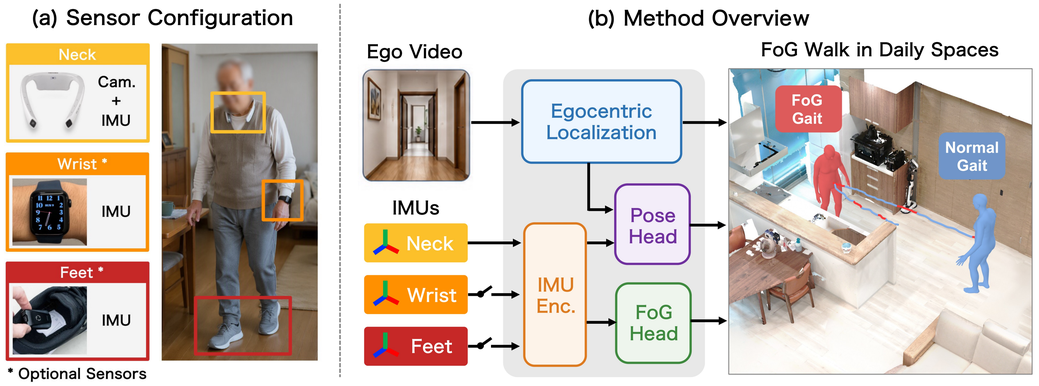

Fig 1. FoGMap: wearable sensing for localization, 3D pose estimation, and FoG detection.

3D FoG Mapping

Neck-camera localization + IMU pose estimation map FoG motion in 3D living spaces.

Joint Dataset (WearGait-PD [1], CARE-PD [2])

[1] real IMU, reconstructed motion, FoG labels

[2] syn. IMU, real motion, manual FoG labels

Any Sensor Subset

Each sensor is treated as a token and fused using presence-masked attention.

[1] Anderson et al., Sci. Data '26, [2] Adeli et al., NeurIPS '25

3 Architecture

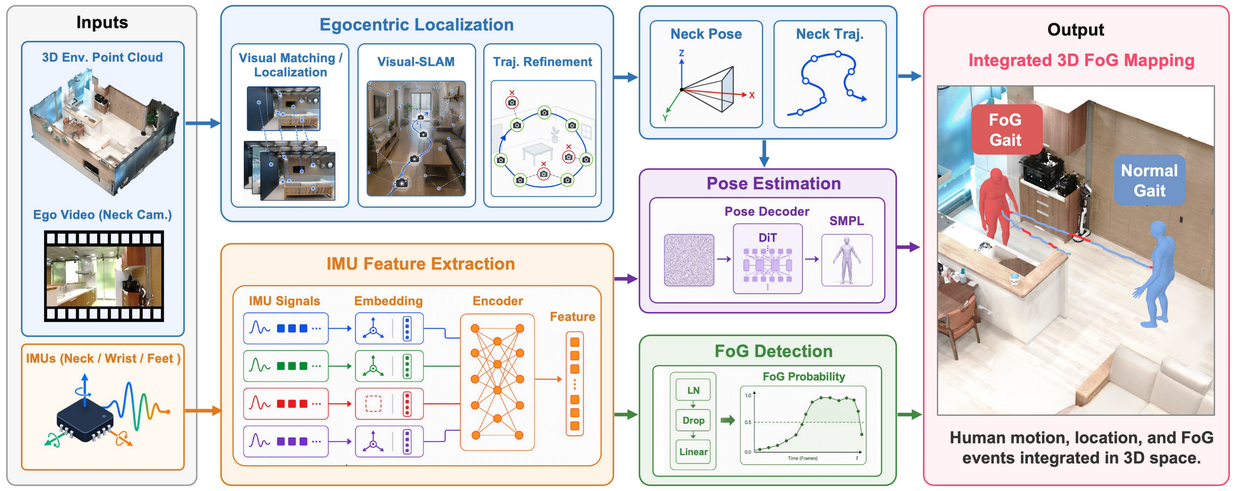

Fig. 2. FoGMap pipeline. Colors match the four modules below.

Egocentric Localization

Registers ego video to a pre-scanned 3D point cloud to recover absolute neck pose and trajectory. (Map-Mono-Ego, ICIP 2026)

IMU Feature Extraction

Encodes each sensor as a token and fuses available sensors with presence-masked attention into shared motion features.

Pose Estimation (Diffusion)

Generates full-body SMPL pose from sparse wearable features using a bidirectional DiT diffusion decoder.

FoG Detection

Predicts frame-wise FoG probability from the shared motion feature with a lightweight classifier.

4 Results

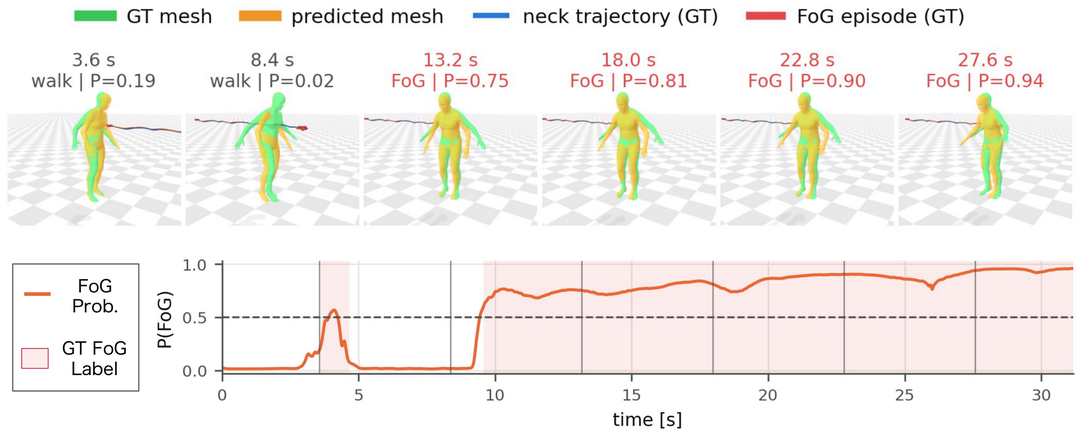

Fig. 3. Qualitative results on CARE-PD: pose (upper) and FoG Probability (lower).

Table 1. Quantitative Results

Sensors	AUROC ↑	AUPRC ↑	MPJPE ↓
neck only	.898	.731	81.0 mm
+ wrist	.921	.779	75.9 mm
+ wrist + feet	**.943**	**.818**	**75.3 mm**
	FoG Detection		Pose

More sensors improve performance

Wrist + feet improve FoG detection and pose.

Better gait motion with diffusion

Outperforms regression model in gait motion.

Accurate 3D localization

Ego-video achieves 1.1 cm trajectory error.

5 Conclusion

Summary

- Ego-cam + IMUs → FoG, 3D pose, and location
- More sensors improve accuracy
- Diffusion better captures gait motion

Future Work

- Deploy on PD patients in daily life
- Evaluate at realistic FoG prevalence (~2%)
- Validate localization in real homes

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