Supplementary Materials: Gait Recognition in Large-scale Free Environment via Single LiDAR

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A OVERVIEW

In the supplementary materials, we present more details of the FreeGait dataset, encompassing dataset statistics, synchronization, and calibration details, and ethical considerations. The presentation is enriched with various data examples highlighting the valuable contribution of the FreeGait dataset for real-world LiDAR-based gait recognitions.

B MORE ABOUT OUR FREEGAIT

B.1 Dataset Statistics and Analyses

The statistics about the ID numbers over sequence numbers, frame numbers over points numbers, and sequence numbers over sequence lengths are depicted in Figure 1. (1) Specifically, Figure 1 (a) shows that each ID has an average of 5 sequences, similar to the GREW [3] dataset, which is also captured in real-world scenarios with cameras. (2) Figure 1 (b) illustrates that most LiDAR frames contain 100-300 points. This contrasts with the SUSTech1K [1] dataset, which averages 1000 points per frame. The relative sparsity of the FreeGait dataset introduces a greater challenge, yet it is crucial for enhancing real-world gait recognition at long-range distances. (3) Figure 1 (c) exhibits the variation in sequence length, ranging from 10 to 60 frames, reflecting the complexity of gait sequences in unconstrained scenarios due to factors such as dynamic occlusion. These statistics demonstrate the diversity and challenges of FreeGait captured in real-world scenarios.

B.2 Synchronization and Calibration

We synchronized the LiDAR and camera using the GPS clock and timestamped each frame, enabling seamless collaboration between the two modalities for a robust gait recognition system. To reconstruct geometry in 3D space, we employed Zhang's Camera Calibration Method [2] to recover both the internal and external parameters of the camera from the 2D image. Additionally, we processed the calibration matrix from LiDAR to the camera using MATLAB's calibrator tools. These steps allowed us to unify the multi-modal devices within the same coordinate system, achieving precise multi-sensor system calibration.

B.3 More Data Examples

To demonstrate the contribution of the FreeGait dataset in detail, we exhibit several examples of our FreeGait under three distinct views in Figure 2, diverse variance in Figure 3 and low-light conditions in Figure 4.

B.4 Ethical Discussion

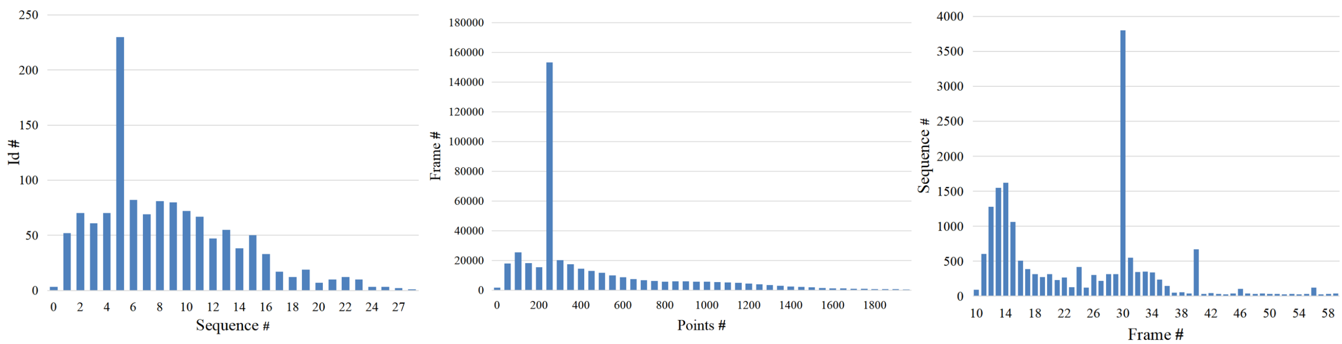
We strictly adhere to privacy-preserving rules. All staff members and students across the campus were informed via email about data collection and its purposes. They voluntarily signed an agreement, consenting to collecting, processing, using, and sharing their data solely for research purposes. To further preserve privacy, we will not release any original RGB views of subjects. The silhouettes and LiDAR point clouds, without any texture and face information, naturally protect human privacy. The agreement is shown in Figure 5.

REFERENCES

[1] Chuanfu Shen, Chao Fan, Wei Wu, Rui Wang, George Q Huang, and Shiqi Yu. 2023. Lidargait: Benchmarking 3d gait recognition with point clouds. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*. 1054–1063.

[2] Zhengyou Zhang. 2000. A flexible new technique for camera calibration. *IEEE Transactions on pattern analysis and machine intelligence* 22, 11 (2000), 1330–1334.

[3] Zheng Zhu, Xianda Guo, and etc. 2021. Gait recognition in the wild: A benchmark. In *ICCV*. 14789–14799.



(a) ID # over sequence #.

(b) Frame # over Points #.

(c) Sequence # over Frame #.

Figure 1: Statistics about the FreeGait dataset.

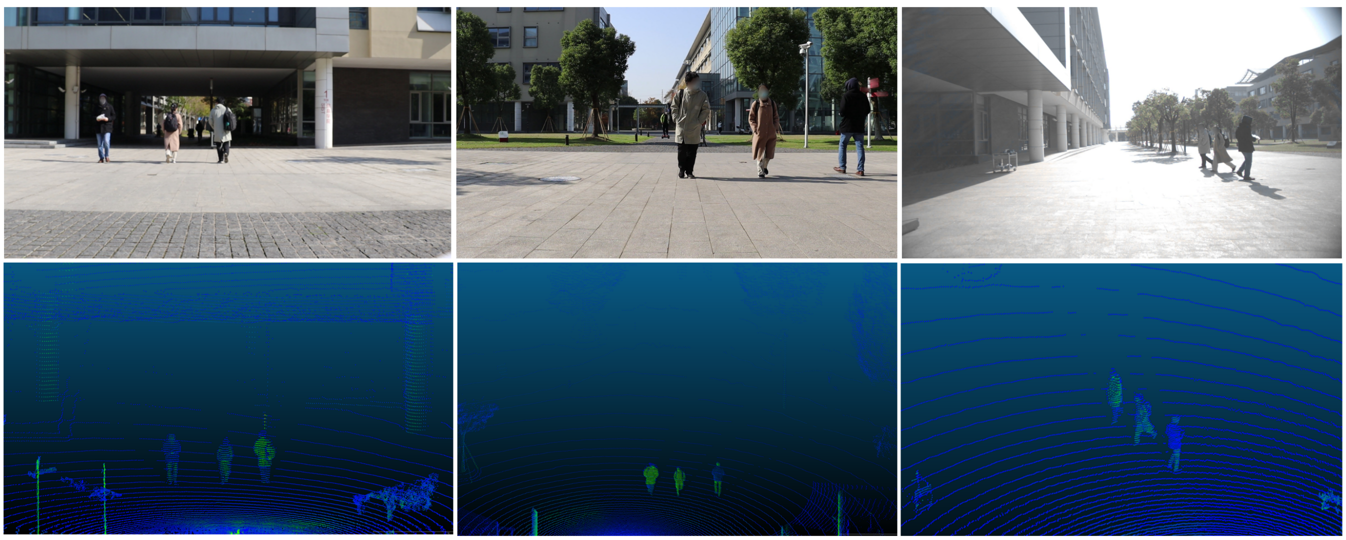


Figure 2: Exemplar frame of FreeGait dataset from three distinct views. We can observe that images bring the ambiguity of gait characteristics due to the view-dependent property and the lack of depth information. While LiDAR can capture view-independent depth information, which is friendly for extracting gait geometry and dynamic features.

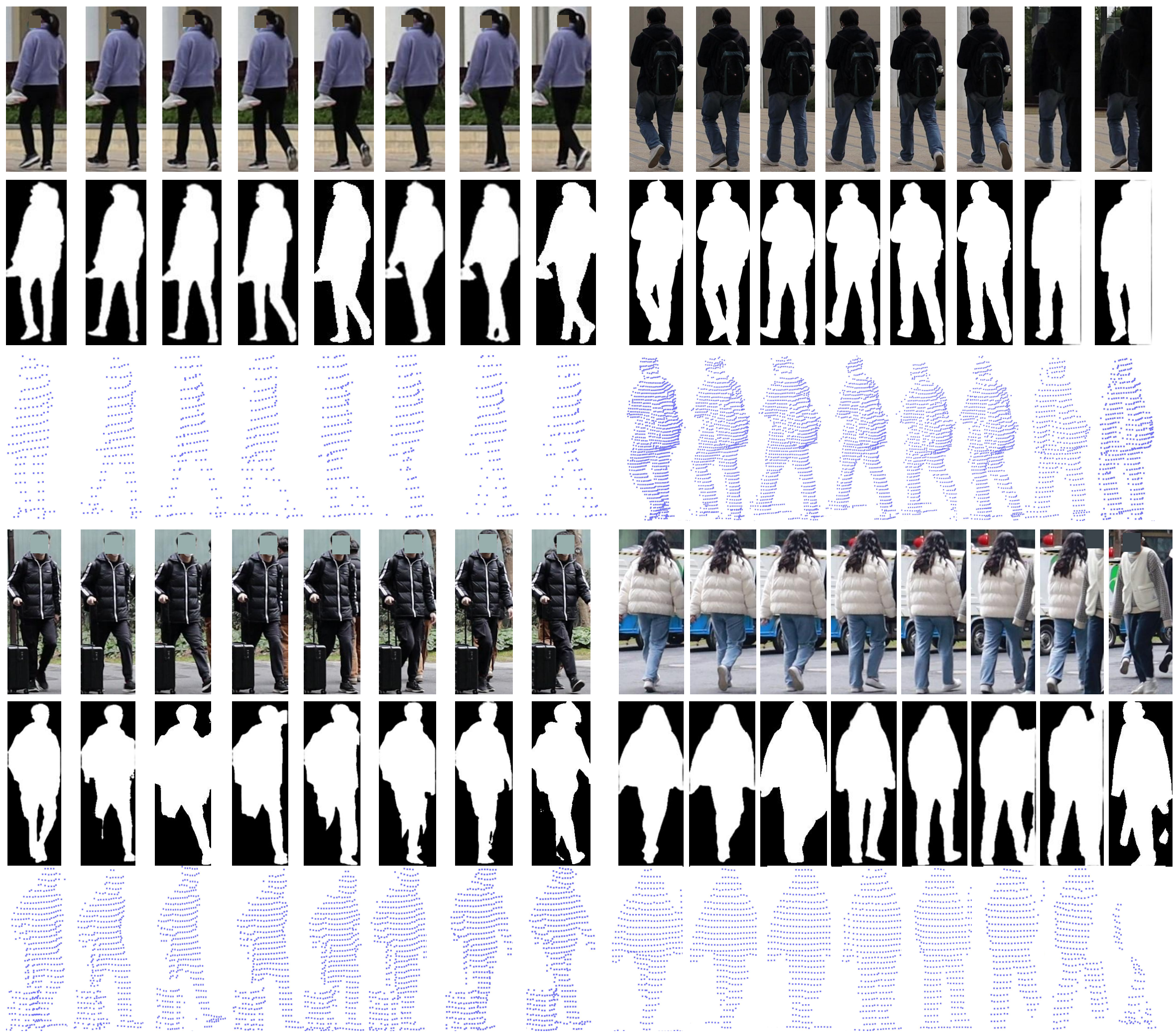


Figure 3: Exemplar sequences of FreeGait dataset with diverse variance such as carrying, bag, luggage, and occlusions in free environments. This demonstrates the diversity and real-world characteristic of our FreeGait.

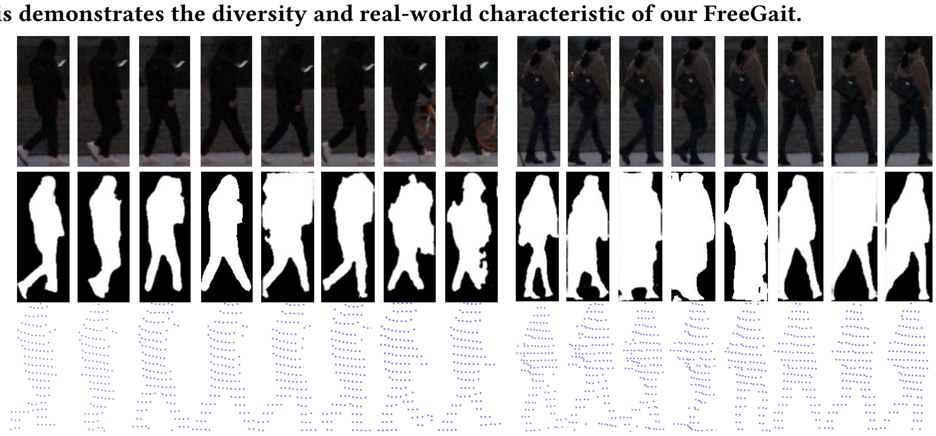


Figure 4: Exemplar sequences of FreeGait under low-light conditions. In low-light conditions, the quality of the image is greatly reduced, resulting in poor human segmentation results. In contrast, LiDAR is unaffected by light and can work day and night.

Data Collection and Usage Agreement for Gait Recognition

This Data Collection and Usage Contract is made and entered into as of [redacted], by and between [redacted] Lab, located at [redacted], hereinafter referred to as the "Lab," and Data Contributor.

Purpose:

The Lab is engaged in research and development of gait recognition technologies that involve the use of cameras and LiDAR sensors. The objective is to create and enhance algorithms capable of recognizing and analyzing human gait patterns for various applications, including security and health-related assessments.

Data Collection:

1. Data Contributor hereby consents to the collection of gait information, including but not limited to images and LiDAR data, by the Lab for the purposes stated above.
2. The data collection process will involve the use of cameras and LiDAR sensors to capture Data Contributor's gait as they walk naturally.

Data Usage:

1. The Lab shall only use the collected gait information for research and academic purposes related to gait recognition technology.
2. The Lab guarantees that the collected data, including silhouettes and point clouds derived from Data Contributor's gait, will be anonymized and dissociated from any personally identifiable information.
3. The Lab shall not publish or disclose any personal information about Data Contributor, including their identity.
4. The Lab shall only publish or share the anonymized silhouette and point cloud data without any reference to Data Contributor's identity.

Ownership and Confidentiality:

1. Data Contributor acknowledges and agrees that all data collected during the research project, including silhouettes and point clouds, shall become the property of the Lab.
2. The Lab and Data Contributor shall maintain strict confidentiality regarding all aspects of this Contract and the research project, except for disclosures required by law.

[redacted]:
Signature: ________ [redacted] ________
Date: _______ [redacted] ____________

Data Contributor: [redacted]
Signature: ____________________________
Date: _________ [redacted] ___________