OmniWarsaw: a City-Scale Omnidirectional Bimodal Dataset

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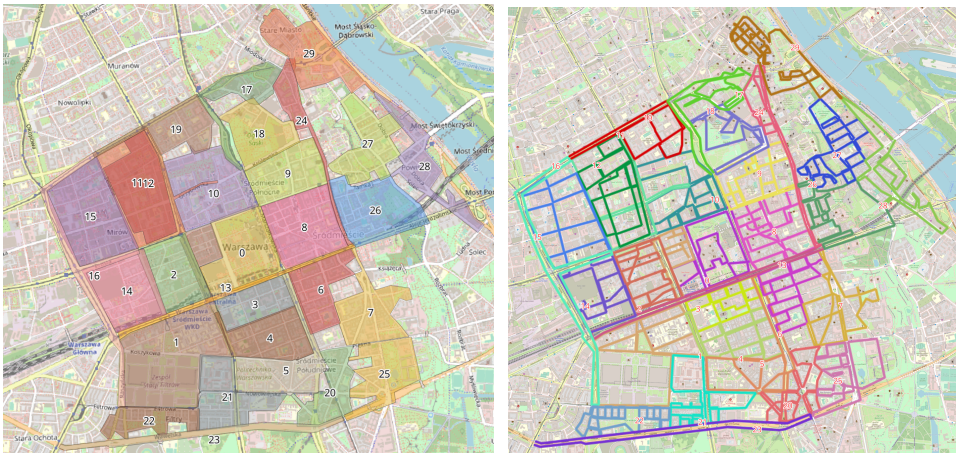
Abstract. *In this work we introduce a novel, city-scale, omnidirectional, bimodal SLAM dataset from a hand-held device. Dataset were collected using open-source open-hardware scanner consisting of non-repetitive scanning pattern Lidar (Livox Mid360) with integrated Inertial Measurement Unit (IMU), GNSS receiver, and a GoPro MAX omnidirectional camera. In total we recorded 188.73 km during in 30 separate session days. We provide raw lidar point clouds, IMU and GNSS readings, anonymized stitched imagery This paper introduces the dataset and describes the data format. Dataset can be accessed via project repository* `https://github.com/MapsHD/OmniWarsawDataset`
Keywords: *omnidirectional camera, object detection, mobile mapping*

1. Introduction and related work

Mobile mapping datasets such as KITTI [1] are used in mobile robotics to improve the Visual and Lidar SLAM algorithms as well as many other tasks including depth estimation and object detection. Since then new devices as well as technology improvement such as non-repetitive scanning patterns in lidar devices e.g. Livox Mid360 community lacks of the new large scale mobile-mapping datasets. However SLAM datasets not related to mobile-mapping using recent hardware exists such as Hilti Dataset [2] which is focused on construction areas.



(a) Covered areas with route ids. (b) Planned scanning paths.

Figure 1: Scanning plan

In a hand held setup new challenges emerge such as less predictable motion model, non-deterministic occlusions. Introduced dataset is currently the largest available dataset using a open-hardware hand-held device in a city-scale environment.

2. OmniWarsaw Dataset

The dataset was collected using open-source open-hardware Mandeye scanner - HDMapping [1] using the provided SLAM methodology [3]. Data were fused using Normal Distributions Transform [4] and motion model, which acts as a stabilizer and regularizer. Currently only IMU, GNSS, and Lidar data are used for stitching. Total length is 188.73 km, shortest trajectory (route 11 in Figure 1) is 4.85km, and the longest (route 1) is 9.46 km. Data where collected in Warsaw between 13.09.2023-06.11.2023. Figure 2 shows the scanning plan, raw GNSS, panorama image and the final registered point cloud. As the part of the dataset we also provide aerial scanning point clouds acquired as a part of ISOK (Informatyczny System Osłony Kraju) project. Qualitative comparison to ISOK data is shown in Figure 3.

[1] https://github.com/MapsHD/HDMapping

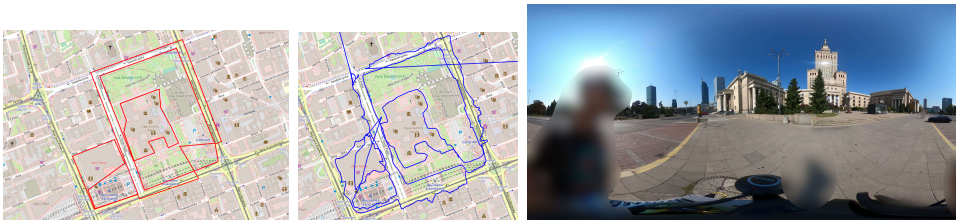
Each of routes has a separate directory with following structure:

```
continousScanning_XXXX
├── GoPro
│   ├── GSXXXXXX_frames
│   │   └── jpg stitched panoramic imagery
│   ├── GSXXXXXX_GPS_Frames.csv frames synced with telemetry
│   └── GSXXXXXX_telemetry.csv telemetry data
├── preview
│   └── lidarYYYY.laz point clouds
├── gnssYYYY.gnss GNSS data
├── imuYYYY.csv odometry data
├── scan_lio_Y.laz point clouds
├── lio_initial_poses.reg with initial poses
├── poses.reg poses after registration
├── session.json metadata file
└── trajectory_lio_Y.csv trajectory
```

Where `continousScanning_XXXX` - is route directory, `XXXX` is route number e.g. 0001. In GoPro directory panoramic imagery, extracted frames, telemetry and GNSS are stored. `GSXXXXXX_frames` directory - contains all extracted frames, in jpg format with 3 seconds interval between every frame All scans except for the route 0 have `GSXXXXXX_GPS_6_Frames.csv` file. File includes following columns: index, date, timestamp in milliseconds, latitude in degrees in WGS84, longitude in degrees in WGS84, altitude in meters, cts - timestamp in milliseconds, image path. `GSXXXXXX_telemetry.csv` is a csv file containing telemetry data. XXXXXX stands for video number, given by the GoPro camera e.g. GS010102. File includes following columns: date, timestamp in milliseconds, latitude in degrees in WGS84, longitude in degrees in WGS84, altitude in meters.

3. Conclusions and Future Work

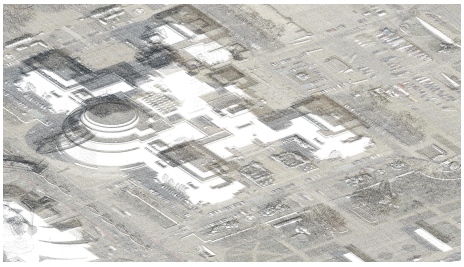
The new dataset with 360° lidar and imagery is released with the ground truth from ISOK. We provide downloadable lidar part of the dataset while imagery is being in the anonymization process. As a feature work we consider releasing a quantitative benchmark of SLAM methods visual and/or lidar as well as benchmark on tiny object detection and tracking and the release of imagery.



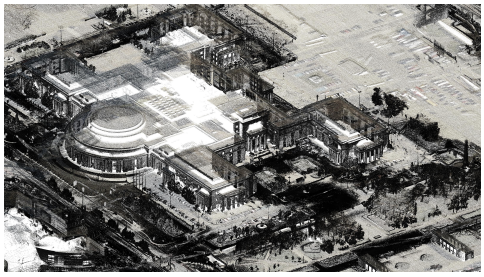
(a) Scanning plan (b) Raw GNSS (c) Sample 360° equirectangular image

(d) Aligned scan

Figure 2: Route 0 - visualization



(a) ISOK ground truth point cloud; No walls due to aerial acquisition



(b) Aligned OmniWarsaw dataset visualized in the same projection as ISOK

Figure 3: Qualitative comparison of OmniWarsaw Dataset with ISOK ground truth data

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