Hackathon Problem Statement – Synthetic Data Generator for Human Activities of Daily Living

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Agenda

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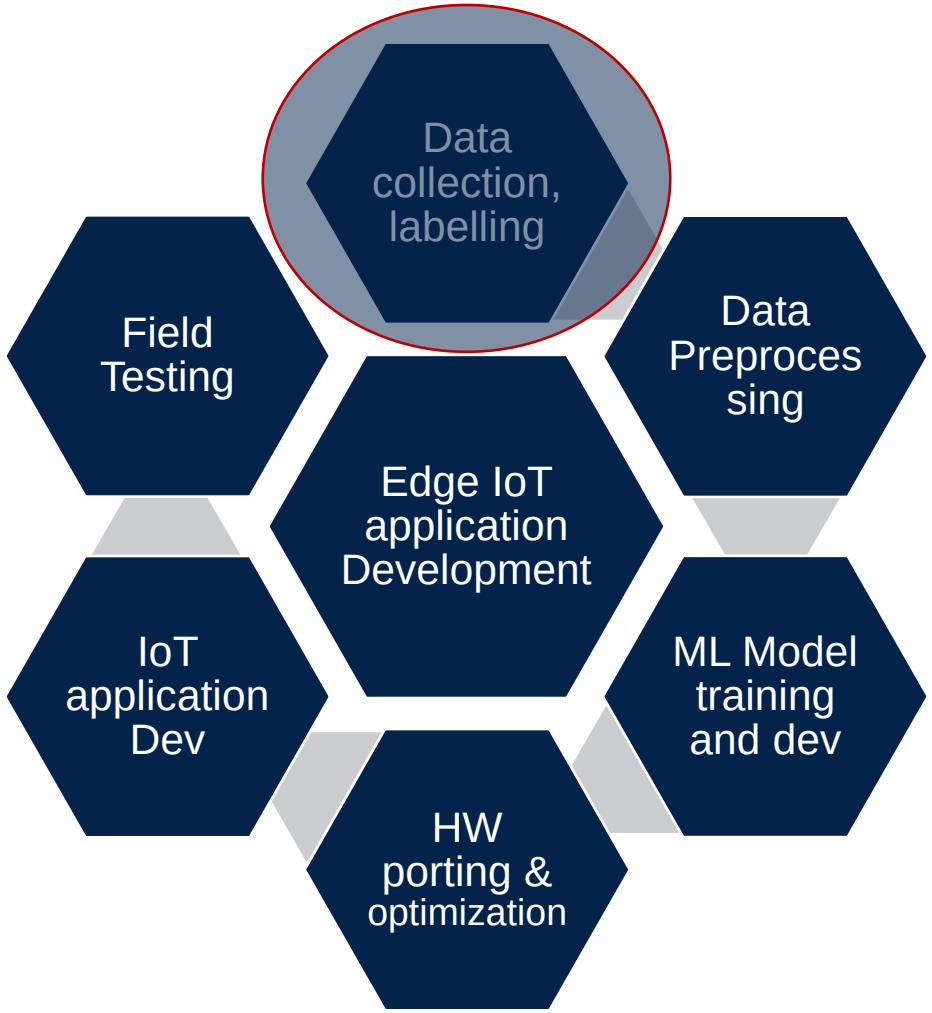
Background

- MEMS sensors can be used to collect motion data corresponding to human activities of daily living like walking, running, swimming, resting, yoga pose etc.
- ST hardware platforms like B-L475E-IOT01A and STEVAL-MKBOXPRO1 have 3D MEMS accelerometer and gyroscope sensors like LSM6DSL mounted on them
- Collecting real MEMS sensor data can be tricky, as it requires:
  - Access to HW platform which incurs logistical and financial cost
  - Physical setup has to be attached to a person's wrist, waist etc. which can be inconvenient
    - e.g. attaching the hardware kit to wrist using some physical arrangement
  - Knowhow about usage of data collection software like High-speed data logger (FP-SNS-DATALOG2), STAIotCraft etc.

AIoT Application development Cycle



- Data retrieved from MEMS acc/gyro sensors like LSM6DSL is consumed by training and inference phase of an AI application
- Data collection is time consuming and sometimes cumbersome phase of AIoT (Artificial Intelligence of Things) application development.
- A human subject must wear sensors correctly at right place (e.g. wrist, waist etc.)
- Large amount of data is required for training and testing AI model

Need for Generative AI based solution

- Generative AI has made it possible to generate artificial videos, images and audio samples
- We can leverage generative AI models to create sensor data for specific activities like running, walking, sitting etc.
- Such a system can be integrated with tools present in ST Edge AI suite (e.g. ST AIoT Craft) for rapid application development by researchers without requiring a hardware board
- Result: Enhanced customer experience and engagement with ST software ecosystem

Synthetic Data Generator For Human Activities of Daily Living

- Create a Generative AI model and helper scripts for generating 3D MEMS accelerometer data for Human Activities Recognition UC
  - Sensor: LSM6DSL
  - 3D accelerometer full scale range ±2/±4/±8/±16g meter per second square
  - Sample duration: specified using input configuration, 1-5 seconds
- Activities to be covered:
  - walking,
  - running,
  - stationary
  - cycling,
  - Nordic walking,
  - Ascending stairs,
  - descending stairs,
  - ironing,
  - house cleaning,
  - playing soccer,
  - rope jumping

I/O Constraints on Synthetic Data Generator

- Input format: system to be configured using a JSON input file

sample_configuration.json

```
{
  "activities": [
    "walking",
    "running",
    "stationary"
  ],
  "samples_per_activity": 100,
  "sample_duration_in_ms": 1000,
  "acc_mg_range": {
    "min": -4000,
    "max": 4000
  }
}
```

- Output data should be compatible with this dataset: [stm32ai-wiki/AI_resources/HAR/dataset at master · STMicroelectronics/stm32ai-wiki · GitHub]
  - Each generated sample should be saved to a CSV file, in a directory named as <activity_name>
  - Variable duration (1-5 seconds), 3 columns (along X, Y, Z directions)
  - Acceleration range: -4000 mg to +4000 mg
  - Sensor: LSM6DSL
  - Sampling rate: 26 Hz
- Publicly available datasets can be used for training AI model (e.g. WISDM, PAMAP2 etc.)

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Acceptance Criterion

- Acceptance criterion:
  - Accuracy: A discriminative AI model will be used to classify the generated data.
    - At least 99.5% classification accuracy is required on generated samples
  - Originality: Use of existing AI models is not allowed
- Artifacts to be submitted
  - ML model in Keras compatible format (.keras, .h5)
  - Source code:
    - Model training/testing scripts
    - Supporting script for generating N synthetic samples saved to CSV files in given directory, using following command line
      - `python <script_name> --config <configuration.json> --out output_dir_name`

Sample Input Configuration File

```
{
    "activities": ["walking", "running", "stationary"],
    "sample_count_per_activity": 100,
    "sample_duration_in_ms": 1000,
    "acc_mg_range": {
        "min": -4000,
        "max": 4000
    }
}
```

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