**PCET’s**

***Pimpri Chinchwad College of Engineering,***

**Nigdi, Pune-44**



**Department of Electronics & Telecommunications**

**Model-Based Design Mini-Project Synopsis**

**T.Y BTech, Sem-V**

**A.Y. 2025 – 2026**

**Project Title: -  
Assistant-based Knowledge Distillation on Differentiable Filters with Adaptive Filtering of MEMS-IMU for Real-time Applications**

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| **PRN** | **Name of Student** |
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**Name of Guide:** Mrs. Mrunalini Bhandarkar

**Project Synopsis**

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| **1. Title: Assistant-based Knowledge Distillation on Differentiable Filters with Adaptive Filtering of MEMS-IMU for Real-time Applications** |

**2. Group Details: -**

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| **PRN No.** | **Class &**  **Division** | **Name of Student** | **Mobile Number** | **Email Id** |
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| **3. Project Overview / Background: -** |
| * **Motivation:** -   In real-time systems such as self-driving vehicles, drones, etc. IMUs play a critical role in data acquisition through accelerometer (accel), gyroscope (gyro), and magnetometer (mag), to give precise trajectory mapping. However, the data acquired must be digitally filtered to cancel out internal and externally induced noise. This filtering process needs to be accurate and fast, plus account for multi-modal efficiency. Hence, it is crucial to design a filter architecture that is accurate, fast, and works on partial modalities in real-life scenarios.   * **Objectives: -**   **1.** To design a compute-efficient ANN-based filter by compressing relatively large fine-tuned models using knowledge distillation.  **2.** To perform distillation-based partial modality deep learning of the edge ANN-based filter.  **3.** To design an Adaptive FIR filter based on LMS algorithm and perform Continuous Learning through Knowledge Distillation (CL-KD).     * **Problem Statement: -**   To implement an advanced filter architecture capable of real-time accurate filtering of the digital data acquired from the trimodal 9-DoF IMU, MPU-92/65, accounting for missing modality estimation, for downstream trajectory mapping tasks. |

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| **4. Methodology: -** |
| * **Flowchart/ Algorithm with explanation**:      * The edge consists of the IMU sensor feeding discrete-time digital data to the MCU, on which the filters are programmed in the L1 block. * The ANN-based Differentiable filter and the Adaptive FIR filters are placed in cascade and are updated using micro-Stochastic Gradient Descent and Least Mean Squares algorithms, respectively. * The local server consists of a model trained on IMU datasets, L3. And a Low-Rank Adaptor neural network, L2, serving the purpose of bridging the gap between the number of parameters of L1 and L3, and fine-tuning itself to new data. * Knowledge flows as L3 🡪 L2 🡪 L1, thus increasing accuracy for smaller and smaller models. The backpropagation algorithms are made possible by the inter-model Distillation Losses; also serving as the desired signal for the Adaptive FIR filter. * Training L2 on full modality, i.e. accel, gyro, and mag, and distilling its knowledge into L1, allows L1 to accurately filter the IMU data on partial modality, ex: accel, and gyro only, as mag dysfunctions due to interference. |

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| **5. Timeline: -** |
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| **6. References: -** |
| Include Details of the IEEE / Research Journal Papers, Book / Magazine / Manual information, Websites etc. Hard-copy of IEEE / Research Journal Papers is required to attach. |

**Signature of Guide:**