Decoder-Only Transformer Methods for Indoor Localization

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BACKGROUND

WiFi-based indoor positioning has been a widely researched area for the past five years, with systems traditionally relying on signal telemetry data including Received Signal Strength Indicator (RSSI), Channel State Information (CSI), and Fine Timing Measurement (FTM). However, adoption in practice has remained limited due to environmental challenges including signal fading, multipath effects, and interference that significantly impact positioning accuracy. Existing machine learning approaches typically require extensive manual feature engineering, preprocessing steps like filtering and data scaling, and struggle with missing or incomplete telemetry data while lacking flexibility across heterogeneous environments. Furthermore, there is currently no unified model capable of handling variations in telemetry data formats from different WiFi device vendors, use-case requirements, and environmental conditions, forcing practitioners to develop separate models for each specific deployment scenario.

TECHNOLOGY DESCRIPTION

To help address these challenges in wireless sensing applications, and in particular WiFi-based indoor positioning, researchers at UC Santa Cruz (UCSC) have explored transformer architectures for their potential for sequence modeling and pattern recognition in wireless telemetry data. The UCSC system, WiFiGPT, moves beyond current state-of-the-art by being the first to repurpose decoder-only Large Language Models (LLMs) specifically for indoor localization tasks, treating WiFi telemetry as sequential data that can be processed through next-token prediction mechanisms. The system demonstrates a novel approach by directly processing raw telemetry data without requiring manual feature engineering, preprocessing, or data scaling, while achieving sub-meter accuracy for RSSI and FTM measurements and centimeter-level precision for CSI data across multiple environments. Unlike traditional approaches that require separate models for different telemetry types or environments, WiFiGPT provides a unified, schema-less framework that can handle missing features through implicit data imputation and adapt to various WiFi device vendors and environmental conditions through its generalization capabilities.

APPLICATIONS

- indoor localization - smart buildings/IoT
- indoor localization - emergency response and safety
- indoor localization - retail, warehouse automation
- indoor localization - retail advertising

FEATURES/BENEFITS

- decoder-only and language-based transformer
- unifying approach to heterogeneous WiFi telemetry data
- few-shot learning significantly reduces data needs for machine training/learning
- achieves sub-meter accuracy for RSSI and FTM, centimeter-level precision for CSI

RELATED MATERIALS

- Transforming Decoder-Only Transformers for Accurate WiFi-Telemetry Based Indoor Localization - 05/16/2025

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- A Novel Iot Protocol Architecture; Efficiency Through Data And Functionality Sharing Across Layers

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OTHER INFORMATION

KEYWORDS

WiFi, indoor positioning, indoor localization, decoder-only, transformer, LLM, RSSI, CSI, FTM, unified, unifying, language model, telemetry, WiFi telemetry, schema-less, LLaMA, GPT, heterogeneity

CATEGORIZED AS

- **Communications**
  - Internet
  - Wireless
- **Computer**
  - Software
- **Environment**
  - Sensing
- **Sensors & Instrumentation**
  - Position sensors
- **Engineering**
  - Other

RELATED CASES

2026-577-0

- Patient Pressure Injury Prevention Methods and Software
- Platooning System and Methods
- Cross-Layer Device Fingerprinting System and Methods
- Smart Deployment of Nodes in a Network

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