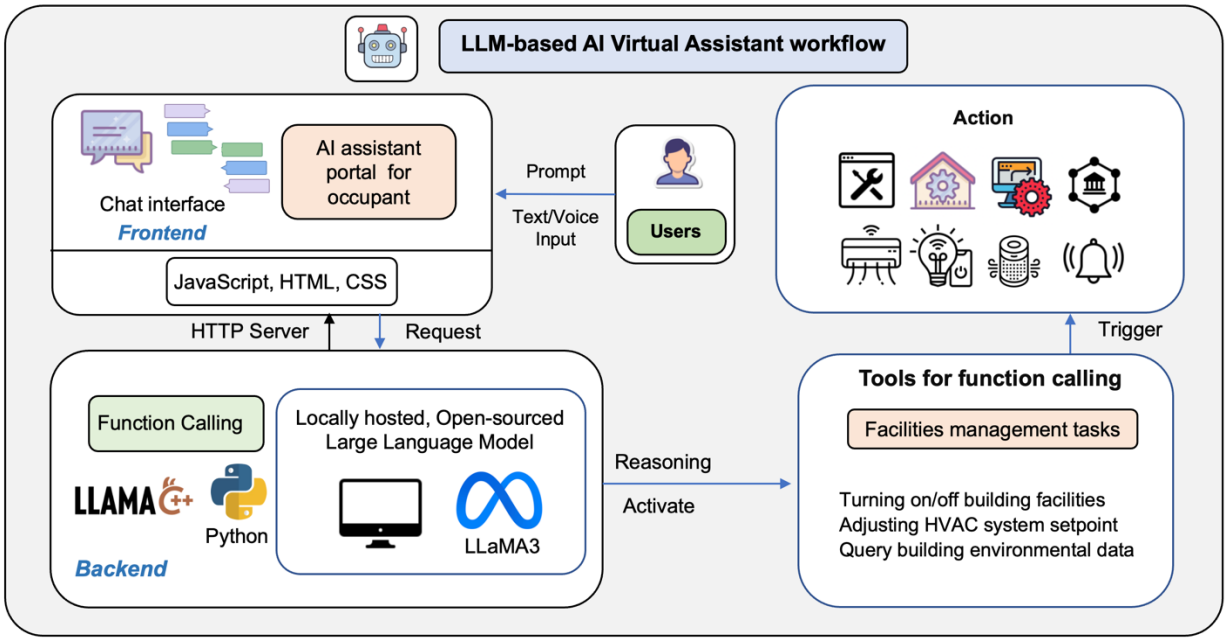
Project List

1. AI assistant for smart building using Large Language Models

Project description: The Project aims to facilitate the human-building interaction within smart buildings using open-sourced LLM such as LLaMA 3. This AI assistant provides smart and personalized assistance to occupants through web apps. Users can communicate with the AI virtual assistant through text and voice input to control various building facilities, adjust setpoints for the specific building smart facilities, or turn systems on or off as needed. The assistant also provides real-time information on indoor environmental conditions by accessing live sensor data from the IoT device. The Text-to-Speech (TTS) and Speech-to-Text (STT) models are powered by open-source tools and models such as Whisper and Piper.

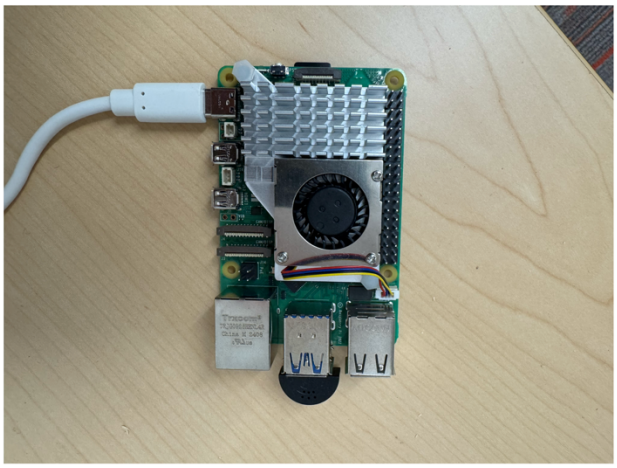
Link: GitHub Page (Description, Code, Video demo)



2. Small Language Model-Based Smart Home Devices for Human-Building Interaction

Project description: This project explores the integration of small language models (SLMs) with smart home environments by deploying the Phi-3 Mini model and Llama 3.2 onto a Raspberry Pi 5 to enable natural language interaction with building systems. The primary objective is to enhance human-building interaction through accessible, cost-effective, and localized AI-powered solutions. This project seeks to revolutionize human-building interaction by embedding generative AI within the built environment. By enabling localized AI-driven decision-making, the research contributes to the development of more responsive, secure, and sustainable smart home ecosystems, forming the backbone for future smart cities.

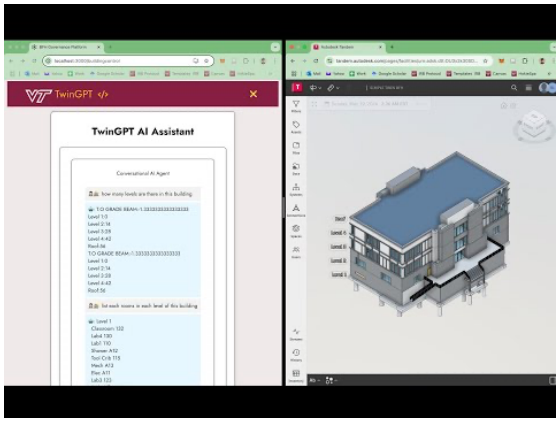
Link: GitHub Page (Description, Code, Video demo)



3. TwinGPT: Large Language Model-based AI assistant for Digital twin query

Project description: TwinGPT is an AI-powered digital twin query system designed for facility managers to interact with and extract insights from building data using a large language model (LLM). This system integrates static data, such as BIM (Building Information Modeling) details such as Rooms, Levels, and building assets, with dynamic data from sensors, environmental inputs, and occupancy information. It provides an intuitive interface for querying both historical and real-time building data. The platform offers an interactive AI chatbot, enabling facility managers to ask questions or communicate with the AI assistant to retrieve relevant building information quickly and efficiently. TwinGPT supports queries that span static BIM data and dynamic inputs, such as sensor readings, environmental conditions, and occupancy metrics. This platform is powered by the open-source AI system Llama 3.2, powered by the llama.cpp framework.

Link: GitHub Page (Description, Code, Video demo)



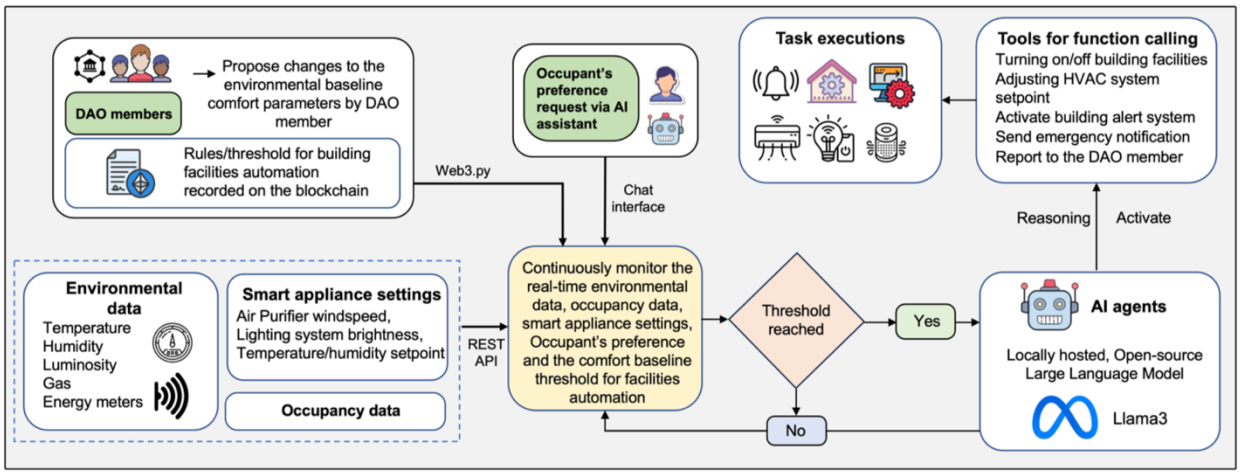
4. AI agent for Autonomous Building operation using Large Language Models

Project description: This project introduces an advanced AI agent designed to oversee autonomous building operation and facilities management. The proposed LLM-based autonomous building operation framework combines IoT devices, smart building facilities, LLMs, and blockchain technologies to create an automated system for managing building systems.

Threshold-Based Automation System: The threshold-based automation system utilizes the AI agent to continuously monitor real-time sensor data and compare it with these predefined thresholds. If the environmental conditions exceed these thresholds, the AI agent uses its function-calling capabilities to take action, such as adjusting HVAC setpoints, modifying lighting intensity, or triggering alerts to maintain optimal building conditions. These threshold values are the baseline comfort parameters for ensuring optimal comfort and indoor environmental quality.

Occupancy-Based Automation System The proposed AI agent will adjust the performance of building systems (e.g., HVAC performance or lighting intensity) based on occupancy level to dynamically optimize energy consumption. For example, during low occupancy periods, the AI agent may reduce HVAC intensity or dim the lighting to conserve energy. Conversely, during high occupancy, the agent ensures that environmental conditions are optimal for occupants. The system also accommodates user preferences and feedback through natural language processing, enabling users to provide specific requests or adjust system behaviors dynamically.

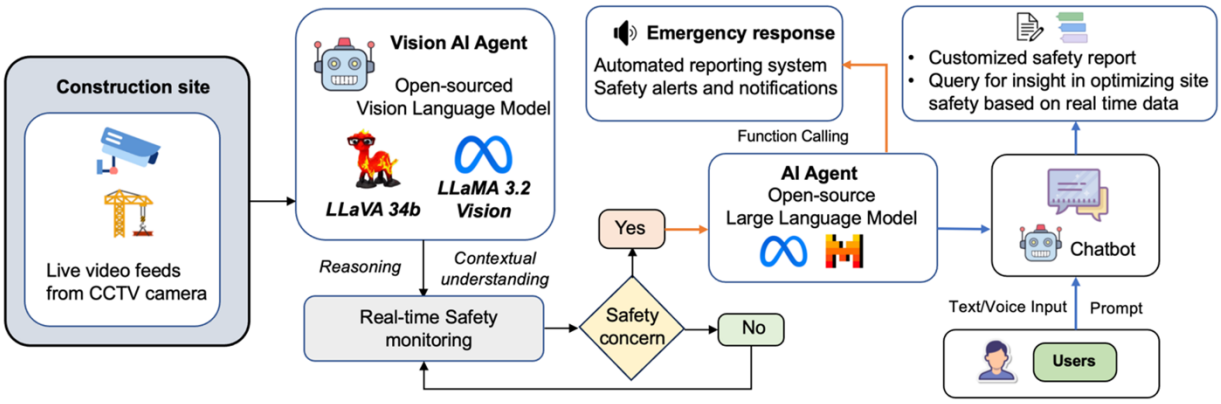
Link: GitHub Page (Description, Code)



5. Vision Language Model-based AI agent for Construction Site Progress and Safety Monitoring

Project description: This project involves developing a vision-language model (VLM)-based autonomous system to monitor construction site progress and safety conditions, thereby providing a comprehensive analysis of construction sites to ensure ongoing progress and adherence to safety protocols.

Link: GitHub Page (Description, Code, Video demo)

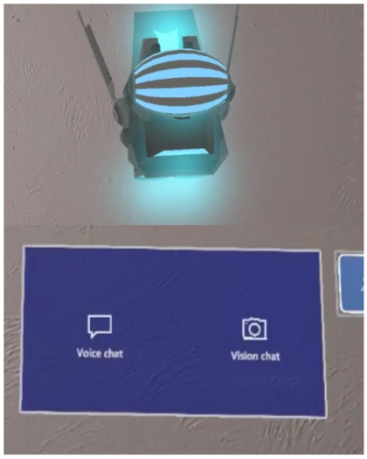


6. Vision Language Model-based AI assistant and AI agents and (XR) Extended Reality application

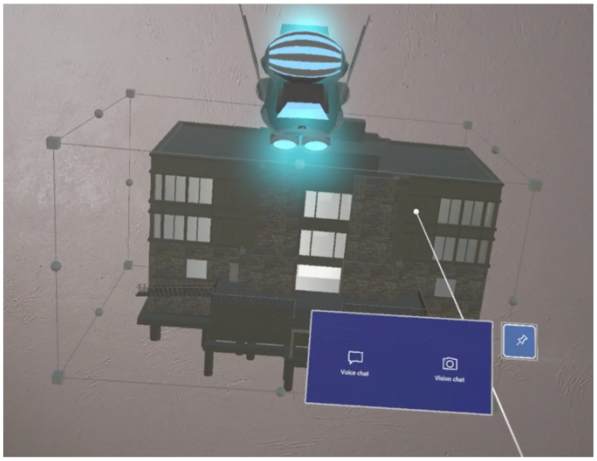
Project description: This project explores the integration of Vision Language Model (VLM), Large Language Model (LLM), and extended reality (XR) to create a Multimodal AI assistant with voice chat, Image understanding, and smart building control in immersive environments. This project aims to create an innovative solution for remote facility management and urban infrastructure monitoring.

The developed system deploys an LLM-based AI assistant and a digital building twin into an XR environment using Microsoft HoloLens 2. Users can interact with the BIM models and communicate with the Multimodal AI chatbot. Users can also interact with the AI assistant through voice commands to control building facilities. This setup enhances the ability of facility managers and occupants to interact with and control smart buildings remotely. The approach also holds the potential for scaling to multiple buildings or urban infrastructure, enabling immersive, real-time monitoring and management for smart city applications.

Link: GitHub Page (Description, Code, Video demo)



(a) AI Virtual Assistant

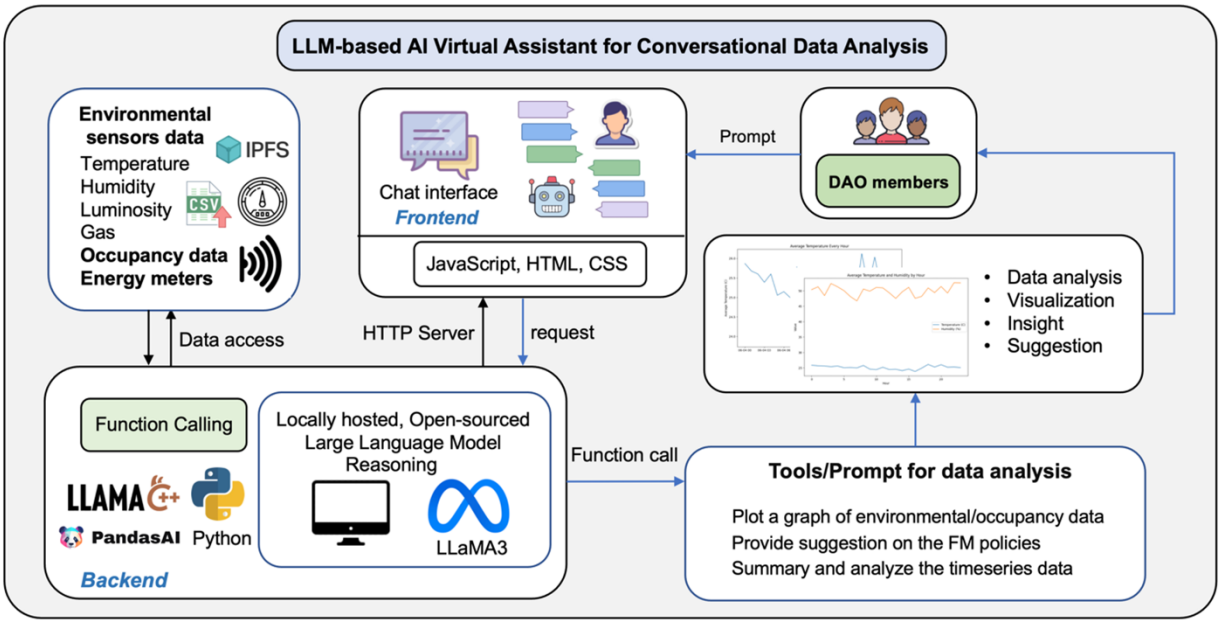


(b) Augmented digital building twin with AI assistant

7. **Data-driven Smart Building Facilities Management using AI Assistant and Digital Twin**

Project description: This project focuses on implementing an AI and Digital twin-driven decision support system for smart building facilities management using digital twins, and large language models (LLMs). The aim is to enhance facility management through AI-driven insights and digital twin visualizations.

Link: GitHub Page (Description, Code, Video demo)



8. **Retrieval-Augmented Generation (RAG) Chatbot for Construction Safety using LLM**

Project Description: This project developed a RAG chatbot using LLaMA 3, Llamaindex, and a vector database to provide construction personnel with instant access to safety protocols and building codes. The AI-powered chatbot offers accurate and contextually relevant information from a construction safety standards database. This system enhances safety awareness and promotes a safer construction environment through efficient knowledge retrieval.

Link: GitHub Page (Description, Code, Video demo)

9. **A GenAI-Powered Prototype for Detecting Defects and Vulnerabilities in Smart Home Automation Systems**

Project description: To address this challenge, this project will develop SmartHomeSecure, an intelligent software prototype leveraging advanced Generative AI, LLaMA, to enhance smart home security and reliability. Specifically, the prototype will (i) identify and correct errors in YAML-based automation configurations through syntax and semantic analysis, (ii) detect vulnerabilities in smart home automations using control flow analysis, symbolic execution, and GenAI-powered insights, and (iii) simulate real-world scenarios to test automation performance under diverse conditions.

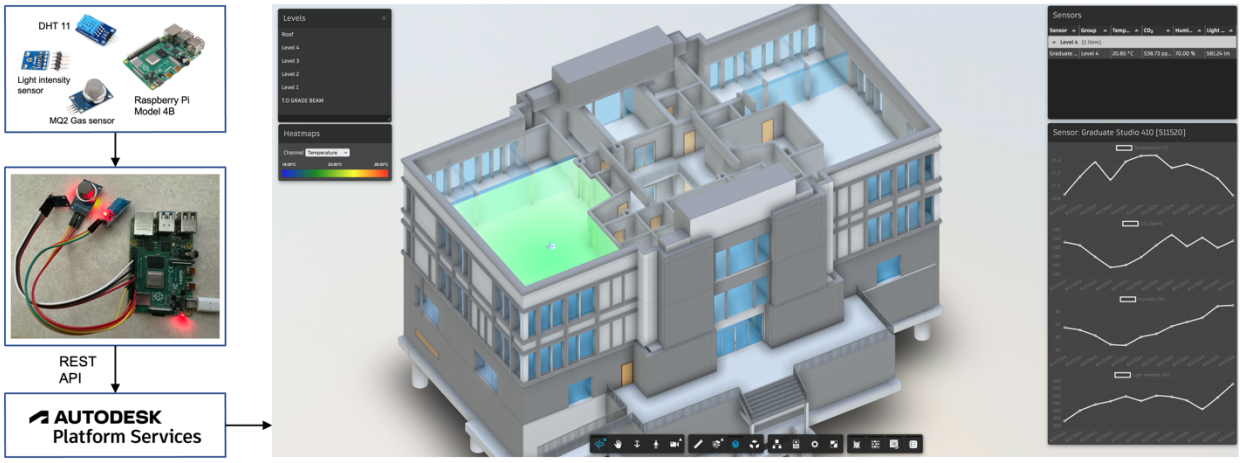
Link: GitHub Page (Description, Code, Video demo)

10. Digital building twin

Project description:

This project focuses on developing digital twins for visualization of environmental conditions within a physical building. The framework is demonstrated using a case study of Bishop-Favrao Hall, the home of the Department of Building Construction at Virginia Tech. This digital twin provides real-time visualization of environmental conditions, including temperature, humidity, lighting levels, and air quality, within the building.

Link: GitHub Page (Description, Code, Video demo)



11. Decentralized Digital building twin using Public and Private Blockchain network

Project description: This project focuses on developing a blockchain-based IoT framework and digital twin model to automate and optimize building facilities operations. The project leverages Hyperledger Fabric, Ethereum blockchain, digital twin technologies, and various IoT sensors and devices.

Link: GitHub Page (Description, Code, Video demo)