REMONI

جامعة محمد بن زايد للذكاء الاصطناعي
MOHAMED BIN ZAYED UNIVERSITY OF ARTIFICIAL INTELLIGENCE

A Virtual Assistant Platform for ***Remote Health Monitoring*** *and* ***Medical Support***

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Problems in Healthcare

Discrepancy between the number of patients & healthcare professionals

Lack of assurance for **continuity** of care

Limited human-system interaction by **natural language**

Inadequate healthcare services in **suburban areas**

Proposed Solution

A Medical Virtual Assistant

Technology

Large Language Model

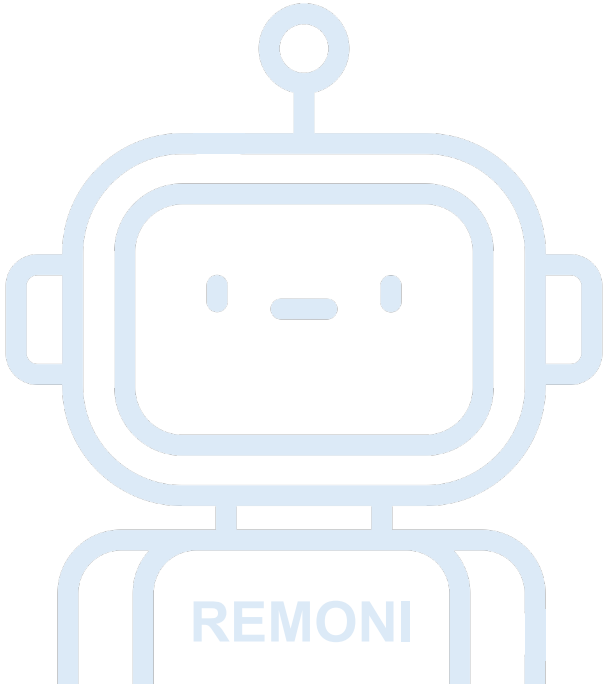
Vision Large Language Model

Internet of Things

Wearable Devices

Anomaly Detection Models

Federated Learning



Functionalities

Track Patient Health Remotely

Notify Emergency

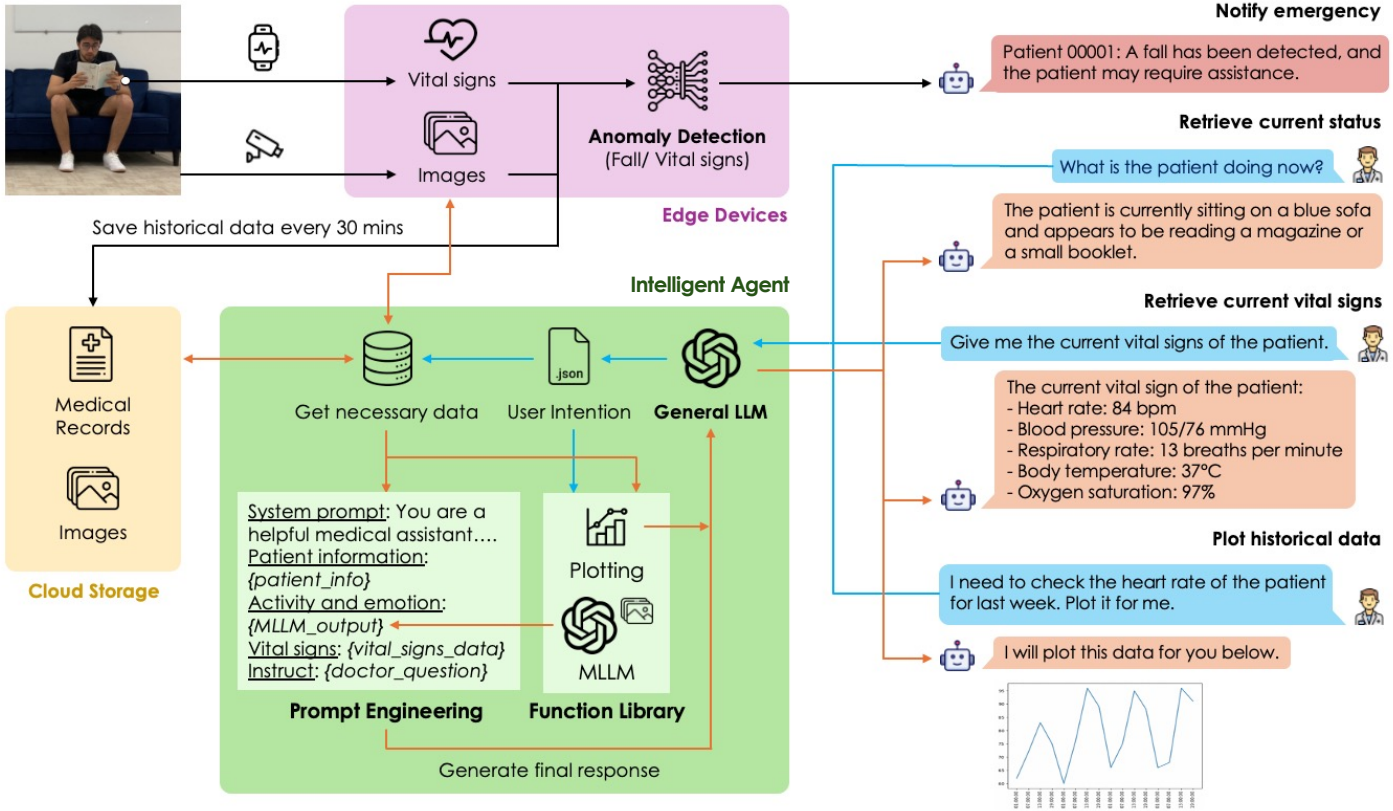
Retrieve Patient Data

Update Patient Status

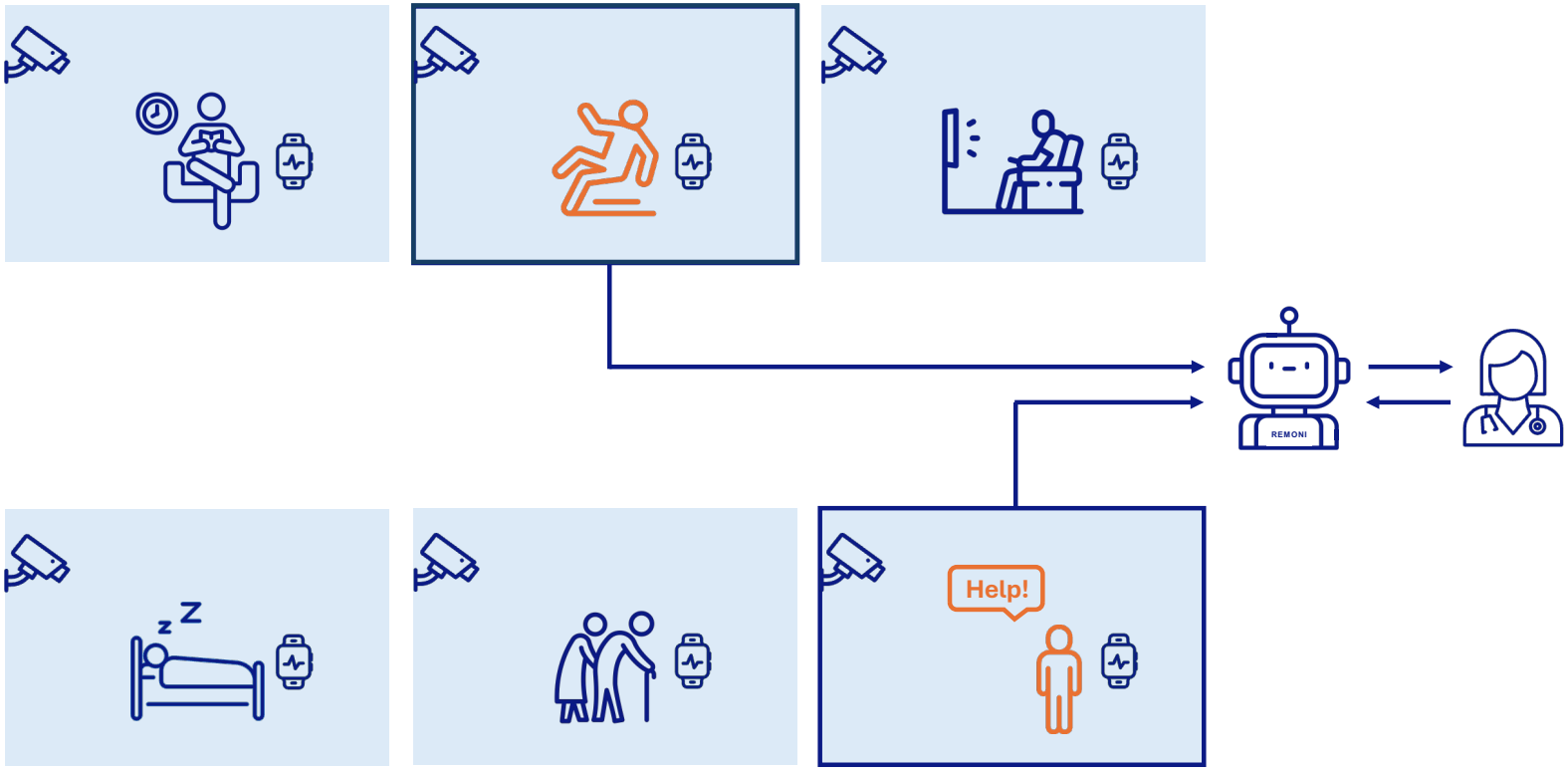
Ask for Medical Information

Request Assistance

Architecture Overview



When it is deployed in a hospital …



Three Research Areas

Enhancing Intelligent Interaction Capabilities

Information Fusion for Anomaly Detection

Security and Privacy Aspects

A. Enhancing Intelligent Interaction Capabilities

The Multimodal LLM in our intelligent agent is designed to serve **three main tasks**:

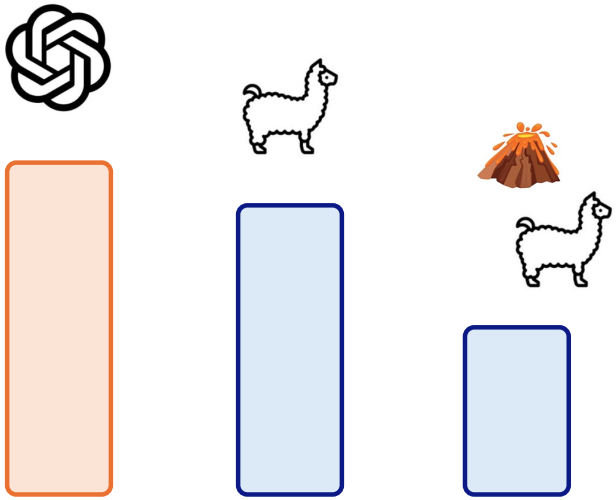
1. **Question Intention Detection**
2. **Human Activity Recognition**
3. **Generating the Final Response**

To evaluate the performance of MLMM, we are currently using **three evaluation methods**:

1. **Matching Keywords**
2. **Calculating BERTScore**
3. **Using LLM as a Judge**

A. Enhancing Intelligent Interaction Capabilities

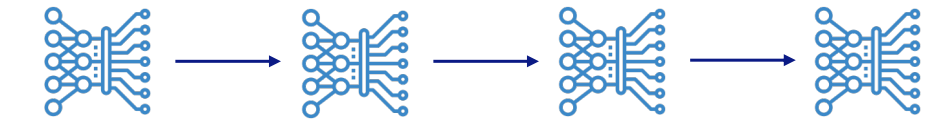
Overall, **GPT-4o** has shown the best performance. **LLaVA**, despite fine-tuning before evaluation, performed the worst. Interestingly, the original **LLaMA3.2** outperformed LLaVA. We are now exploring ways to *enhance LLaMA 3.2 to surpass GPT-4o for our specific use cases*.



A. Enhancing Intelligent Interaction Capabilities

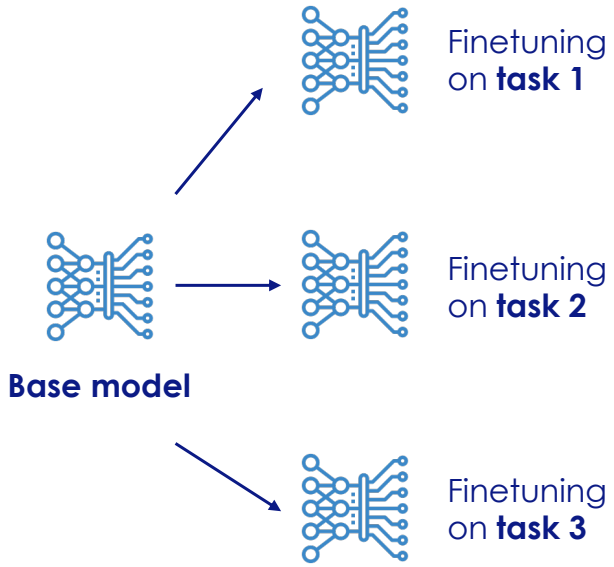
We are working on two improvement approaches.

Sequential Fine-tuning



Base model → Finetuning on **task 1** → Finetuning on **task 2** → Finetuning on **task 3**

Mixture of Experts-Based Fine-Tuning



B. Information Fusion for Anomaly Detection

There are two main sources of data that can be used to detect anomalies.

Accelerometer and Vision Data

These data sources can help detect *falls* & *abnormal behavior* of patients.

Vital Sign Data

This data can be used to identify *anomalies in vital signs* (such as abnormal values) & analyze patterns to *assess risks for various diseases*.

B. Information Fusion for Anomaly Detection

Our current fall detection model, which uses accelerometer data from the wrist (smartwatch), outperforms other off-the-shelf models.

Model	Sensor/Location	Accuracy	Precision	Recall	F1-Score
SVM	Acce + Gyro / Wrist	93%	N/A	87%	93%
LightGBM	Acce + Gyro / Wrist	95%	N/A	91%	91%
Coarse-fine CNN + GRU	Acce / Waist	98%	93%	96%	94%
Late AFVF	Acce / Waist + Wrist	N/A	N/A	N/A	96%
Proposed CNN-LSTM	**Acce / Wrist**	**98%**	**99%**	**98%**	**98%**

We are now working on enhancing fall detection capabilities by fusing accelerometer data with vision data processed through advanced techniques, including **CLIP, Vision Transformers for Time Series, Vision-Language Models (VLMs), ExtDM and MCVD Models**.

C. Security and Privacy Aspects

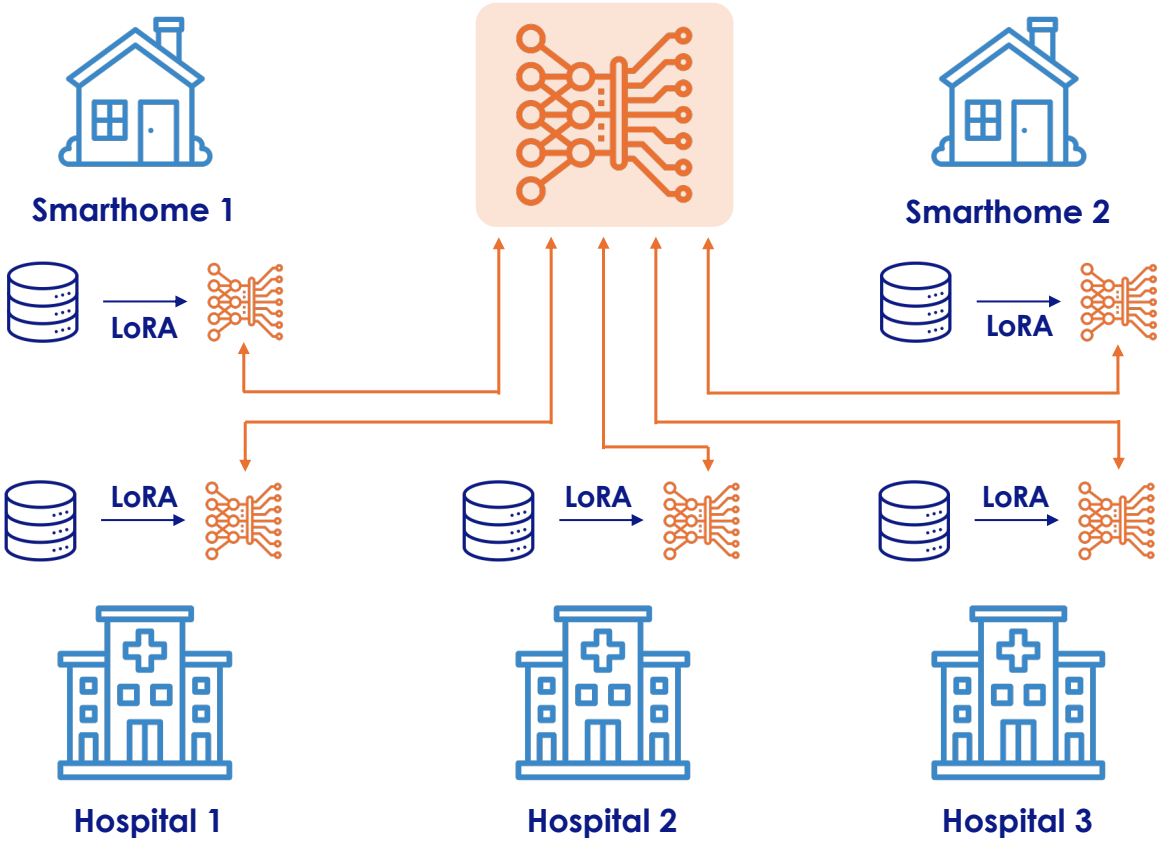
Federated Learning (FL) in REMONI:

- FL enables REMONI to **collaborate with diverse healthcare partners** to improve model accuracy and reliability.
- With FL, REMONI benefits from a **broader, richer dataset** drawn from multiple institutions while keeping patient data **private and secure**.

How FL Works in REMONI:

- Partners contribute **model updates** instead of raw data, allowing REMONI to leverage unique local data securely.
- This distributed training approach ensures REMONI learns from **real-world diversity** without compromising privacy.

C. Security and Privacy Aspects



C. Security and Privacy Aspects

Privacy in FL can be further strengthened through multiple complementary approaches:

Classical Privacy Enhancements:

- **Differential Privacy**:

Adding controlled noise to model updates

- **Secure Aggregation**:

Encrypting parameter exchanges

- **Homomorphic Encryption**:

Computing on encrypted updates

Architecture-Inherent Privacy:

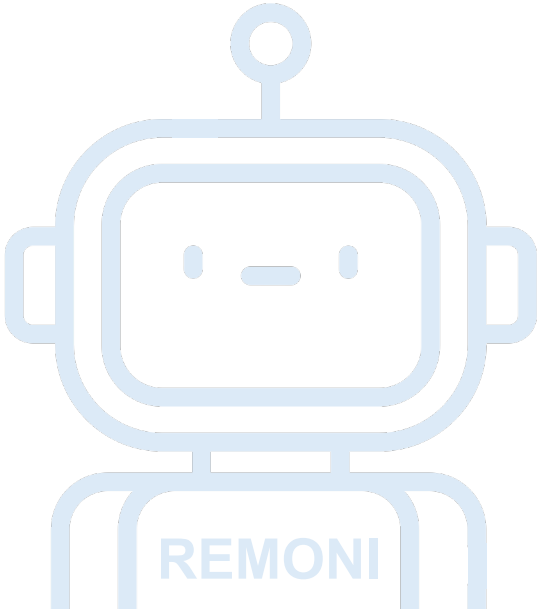
- **LoRA**: Transmitting rank decomposition matrices only (< 1% of parameters)
- **Split Learning**: Sharing only specific layers, making input reconstruction virtually impossible
- **Limited Parameter Exchange**:

Drastically reduced attack surface

These combined strategies ensure REMONI partners maintain *maximum privacy* while *preserving model effectiveness*.

Partnership

We are now collaborating with **United Nations Development Programme** to promote this technology on a global scale. We are also in discussions with **Cleveland Clinic Abu Dhabi** to test the system in a clinical setting.



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Thank you for reading

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We are actively seeking additional partnerships with hospitals and research teams to further refine and deploy REMONI in real-world applications. *If you are interested in collaborating, please reach out using the contact information below.*

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