Agentic AI in Search & Rescue

Exploring the use of LLM agents and Multimodal data integration in Search and Rescue
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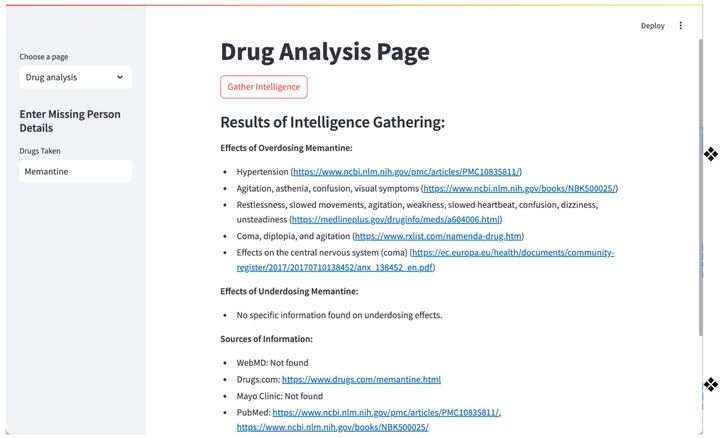
Abstract

This research presents a multi-agent system leveraging **Agentic AI** to aid in **Search and Rescue (SAR)** missions. The system integrates **Drug Analyst**, **Health Assessor**, and **Document Analyst** agents, each designed to provide real-time support in locating missing persons. By utilizing **Large Language Models (LLMs)**, **graph databases**, and **vector-based retrieval**, the system offers personalized recommendations based on health data, location history, and prior case studies. Initial results show significant improvement in SAR operations, with faster information retrieval and more accurate behavioral predictions for missing individuals.



Introduction

Search and Rescue missions often rely on timely and accurate information to locate missing individuals, especially when the individuals have health conditions that affect their behavior. This research explores the development of a multi-agent system designed to provide SAR teams with real-time support. The system integrates several AI techniques, such as **knowledge graphs**, **vector databases**, and **LLMs**, to assess health risks, predict behavior, and retrieve relevant documents during rescue missions. The agents specialize in different tasks: health assessments, drug analysis, and document retrieval.

REFERENCES

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Retrieved from https://groq.com/docs
2 LangChain Documentation. (2023).
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3 Neo4j Knowledge Graph. (2023).
Retrieved from https://neo4j.com
4 Vosk Speech Recognition API. (2023).
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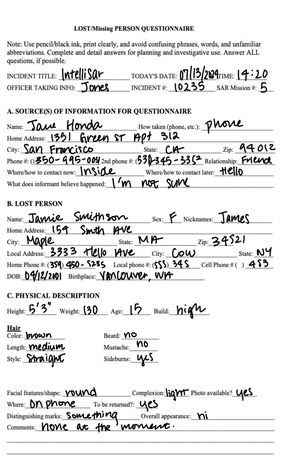
Methods

- **Drug Analyst Agent**
  - **Objective**: Analyzes the effects of drugs the missing person may be taking, identifying risks of underdosing and overdosing.
  - **Method**: Uses web scraping tools and vector databases to search through trusted medical sources (e.g., PubMed, WebMD).
  - **Output**: Bullet-point summaries of risks, provided to the SAR team to assess potential health complications.
- **Health Assessor Agent**
  - **Objective**: Analyzes medical history and behavioral patterns to predict the missing person's movements.
  - **Method**: Utilizes **Neo4j** knowledge graphs and LLMs to process health data and generate location recommendations.
  - **Output**: Personalized recommendations based on the person's health condition and last known location.
- **Document Analyst Agent**
  - **Objective**: Retrieves relevant documents from the vector database to assist the SAR team.
  - **Method**: Uses a **Retrieval-Augmented Generation (RAG)** system to access case studies, SAR protocols, and other relevant information.
  - **Output**: Retrieved documents provided to the SAR team to support their operations.
- **Voice Recognition Integration** (Postponed)
  - **Objective**: Enable real-time, hands-free data input for SAR teams during field operations.
  - **Challenges**: Implementation of this feature faced cost and accuracy challenges, especially with tools like **Deepgram** (high cost) and **OpenAI Whisper** (accuracy issues in real-time). The open-source tool **Vosk** was deemed the most suitable, but implementation has been paused due to project goals focusing on prototyping rather than production-level software.
  - **Next Steps**: Future work will resume development of real-time transcription using **Vosk**, combined with **LLM calls** via **LangChain** or **Kor** to automate form filling.
- **Handwritten Form Scanning**
  - **Objective**: Automate the extraction of information from physical forms commonly used in SAR operations.
  - **Method**: Uses image processing (via **PIL**) and LLMs to recognize and autofill form fields.
  - **Output**: Automatically populated digital forms that SAR teams can verify, significantly reducing the time spent on manual data entry.

Results

- **Drug Analyst Agent**
  - The agent successfully retrieved drug-related information in under 10 minutes, providing essential details on the risks of underdosing and overdosing for medications like insulin and beta-blockers.
- **Health Assessor Agent**
  - Analyzed health data and predicted the behavioral patterns of missing individuals with high accuracy. For example, it correctly suggested urban areas for locating a person with dementia.
- **Document Analyst Agent**
  - Provided relevant SAR protocols and case studies within minutes, enabling the SAR team to adjust their strategies based on historical data.
- **Voice Recognition System** (Postponed)
  - The voice recognition system, which was initially planned to integrate **real-time transcription** for automatic form filling, faced challenges with implementation. **Vosk** proved to be the best free and open-source tool, but real-time performance issues and complexity in integrating with **LLMs** led to postponing the feature.
  - **Future Steps**: Full implementation of the voice form-filling system using **Vosk** and **LLMs** will be explored in future iterations.
- **Handwritten Form Scanning**
  - Handwritten forms were successfully scanned and converted into digital formats, allowing SAR teams to quickly input details like **lost person descriptions** and **contact information**. The system auto-populated key fields, reducing the time spent on manual data entry by 50%.


LOST/Missing PERSON QUESTIONNAIRE

Note: Use pencil/black ink, print clearly, and avoid confusing phrases, words, and unfamiliar abbreviations. Complete and detail answers for planning and investigative use. Answer ALL questions, if possible.

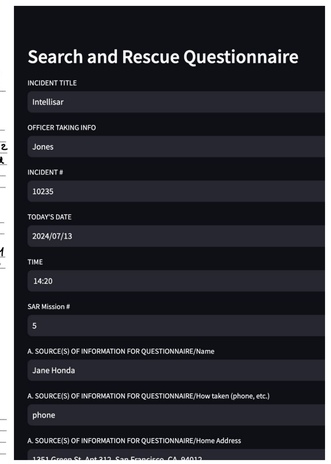
INCIDENT TITLE: Intellisar TODAY'S DATE: 07/13/2024 TIME: 14:20
OFFICER TAKING INFO.: Jones INCIDENT #: 10235 SAR Mission #: 5

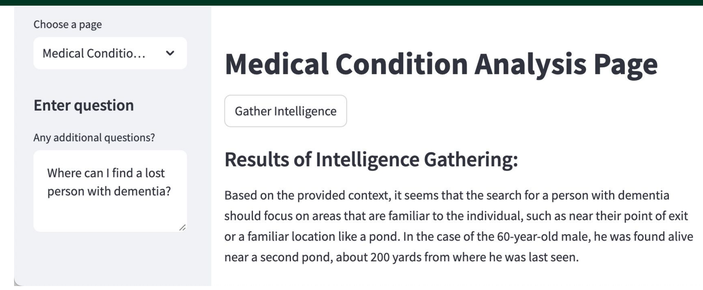
A. SOURCE(S) OF INFORMATION FOR QUESTIONNAIRE
Name: Jane Honda How taken (phone, etc.): phone
Home Address: 1351 Green St Apt 312
City: San Francisco State: CAL Zip: 94012
Phone # (850-499-2004 2nd phone #: 638-365-3328 Relationship: Friend
Where/how to contact now: Inside Where/how to contact later: Hello
What does informant believe happened: I'm not sure

B. LOST PERSON
Name: Jamie Smithson Sex: F Nickname: James
Home Address: 159 Smith Ave
City: Maple State: MA Zip: 34521
Local Address: 3333 Hello Ave City: COW State: NY
Home Phone # (559) 480-5295 Local phone #: (551) 395 Cell Phone # ( ) 493
DOB: 04/12/2001 Birthplace: Vancouver, WA

C. PHYSICAL DESCRIPTION
Height: 5'3" Weight: 130 Age: 15 Build: high
Hair
Color: brown Beard: no
Length: medium Mustache: no
Style: straight Sideburns: yes

Facial features/shape: round Complexion: light Photo available? yes
Where: On phone To be returned?: yes
Distinguishing marks: Something Overall appearance: tri
Comments: none as the moment:





Conclusion

This research demonstrates the potential of AI in improving **Search and Rescue** operations. By combining different AI agents that specialize in health analysis, drug safety, and document retrieval, the system offers faster and more accurate insights for SAR teams. The integration of **voice recognition** and **handwritten form scanning** further streamlines the data entry process. However, the voice form-filling feature was postponed due to technical and cost-related challenges. **Future work** includes the full implementation of this feature and the development of a **Clue Master agent** to enhance the system's ability to manage and analyze clues in SAR operations.

Future Work

1. **Voice Form Filling**:
   The voice form-filling feature will be revisited as part of future work. Using **Vosk** for real-time transcription, combined with **LLM-powered** data extraction via **LangChain** or **Kor**, will automate filling form fields based on spoken input. This will help SAR teams save time during in-person interviews.
2. **Clue Master Agent**:
   In Fall quarter, we plan to develop an **AI-based Clue Master agent**, responsible for managing and analyzing clues during SAR operations. This agent will:
   - **Collect and analyze clues** such as witness reports, physical evidence, and geographical data.
   - **Generate hypotheses** on the missing person's movements and location.
   - **Coordinate SAR efforts** by communicating updates and findings to the SAR team.
   - Operate as part of a **multi-agent system**, collaborating with specialized agents for data ingestion, behavioral profiling, and environmental analysis.

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