COMP-SCI 5588
Data Science Capstone

Professor: Dr Yugyung Lee
Term name: Bug Killers
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Github Link: https://github.com/nanxuanhui/DSCapstone.git
Presentation Link:
https://drive.google.com/file/d/1vxbZOIQn8D5JdoHxGMYjN1K0V6VIrSLB/view?usp=sharing

Content

Team Information

1. Team Name

Bug Killer

2. Team Members

Name	Role
Saniya Pandita	UI Developer
Jayadithya Nalajala	Full Stack Developer
Sai Jahnavi Devabhakthuni	ML and Data Engineer
Hui Jin	AI Developer

3. Individual Responsibilities

Name	Responsibility
Saniya Pandita	Wireframing and Prototyping, Visual Design
Jayadithya Nalajala	Backend API Calls, AI Model Integration
Sai Jahnavi Devabhakthuni	Data Preprocessing & Feature Engineering Model Training & Optimization
Hui Jin	YOLOv5 Implementation, OpenPose Integration, Pipeline Construction

4. Skill sets

Name	Skill
Saniya Pandita	React.js, HTML, CSS, JavaScript
Jayadithya Nalajala	Python, Node.js, REST API's
Sai Jahnavi Devabhakthuni	Python, HTML, pandas, numpy, matplot lib, Mongo DB,YOLOv5
Hui Jin	YOLOv5, OpenPose, Python, MLX

Significance & Motivation

1. **Importance**
   Elderly people, especially those living alone, face significant health risks due to falls and mental health concerns. Falls are a leading cause of injury-related hospitalizations, while social isolation and cognitive decline are growing concerns among the aging population. An AI-driven system that detects falls and provides mental health companionship can significantly improve elderly care.
2. **Problem**
   Fall Detection: Real-time identification and alerting of falls using AI vision models.
   Mental Health Companion: AI-driven chatbot to provide emotional support and cognitive engagement.
3. **Benefits**
   Elderly individuals living alone
   Family members & caregivers
   Healthcare providers
   Assisted living facilities

Objective & Innovation

1. **Main goal**
   Develop a real-time fall detection system using AI vision models.
   Integrate an AI-powered mental health chatbot to provide cognitive support.
   Develop an intuitive web UI for caregivers and users to monitor and interact with the system.
   Ensure seamless API integration between the AI models, chatbot, and database
2. **Difference from existing solutions**
   Our system uniquely integrates AI-powered fall detection with a mental health chatbot, ensuring both safety and emotional support. Unlike wearable-dependent solutions, our vision-based YOLOv5 model provides accurate, real-time detection without extra devices. The chatbot, tailored for elderly users, enhances engagement and mental well-being. Real-time alerts enable immediate caregiver intervention, making our solution more accessible and scalable than traditional alternatives.
3. **New**
   Combination of vision-based fall detection and natural language processing (NLP) chatbot in one system.
   Use of YOLOv5 for real-time object detection in fall identification.
   Chatbot powered by Transformer-based models trained for elderly support.
   Cloud-based MongoDB for efficient data storage and retrieval.

Related Work

1. **Key findings**

The fall detection system using OpenPose and YOLO achieved 100% precision, recall, F1 score, and mAP, demonstrating exceptional performance in detecting falls among the elderly. The integration of OpenPose improved accuracy in low-light conditions, achieving a fall detection accuracy of 99.75%.[1]
The EBER chatbot significantly improved user satisfaction among elderly participants, with 80% rating the system a score of 4 out of 5, indicating its effectiveness as an "intelligent radio" for entertainment and companionship. The system demonstrated the ability to adapt to users' moods through Sentiment Analysis (SA), which enhanced the conversational experience and engagement. The chatbot's design, which intersperses news reading with light dialogues, was well-received, as it aligned with the traditional media consumption habits of the elderly, thus reducing feelings of loneliness.[2]
The study presents a novel conversational system that effectively monitors cognitive impairment in elderly individuals through an entertainment chatbot. The system achieved a detection accuracy of cognitive impairment close to 90% using Machine Learning algorithms, demonstrating strong potential for user-friendly therapeutic monitoring. Additionally, the results indicated that users without cognitive impairment performed significantly better than those with mild or severe impairments, with a similarity metric ranging from 0.03 for stressed users to 0.36 for relaxed users.[3]

2. Methodologies

The study utilized a dataset of 430 images, divided into categories for training and testing, with a focus on comparing systems with and without OpenPose. YOLO was employed for real-time object detection, processing images through convolution and max pooling to generate bounding boxes.[1]
The EBER chatbot employs a combination of technologies, including Artificial Intelligence Markup Language (AIML), Natural Language Generation (NLG), and Sentiment Analysis (SA), to create coherent and contextually relevant dialogues. Experimental tests were conducted with 31 elderly users, assessing their interactions with the chatbot and measuring satisfaction, confusion, and stress levels through a structured feedback process.The system utilized facial recognition and voice commands for user interaction, making it accessible and user-friendly for the elderly population.[2]
The researchers employed a combination of Natural Language Processing (NLP) techniques and Machine Learning algorithms to create a chatbot that engages users with news content while assessing their cognitive capabilities. The system generates questions based on news items and evaluates user responses by comparing them to a gold standard derived from the same content. Field tests were conducted with 30 elderly participants under the supervision of gerontologists, focusing on the effects of stress and concentration on cognitive assessment.[3]

3. Gaps

The research indicates a need for more diverse datasets and the exploration of augmentation techniques, such as Generative Adversarial Networks (GAN). Future studies could benefit from using high-spec hardware to enhance training speed and model performance.[1]

Despite the positive feedback, the chatbot's ability to detect when a user has finished speaking needs improvement, as some users reported confusion due to interruptions. The current implementation does not fully mimic human-like empathy, which could further enhance user engagement and satisfaction. There is a need for further research to explore the long-term effects of using the chatbot on users' cognitive abilities and abstraction skills, particularly among those with varying levels of technological proficiency.[2]
Despite the advancements in AI and NLP, existing intelligent systems for cognitive assessment still rely heavily on predefined manual tests, which can be time-consuming and may induce stress in users, known as the "white-coat effect". The study highlights that while there are intelligent systems in telecare, they often lack the capability for autonomous communication with the elderly using natural language, indicating a significant gap in empathetic interaction. Furthermore, the research suggests that more work is needed to enhance the system's empathetic capabilities through user feedback, which is currently limited.[3]

Challenges

1. **Technical or conceptual challenges**
   Real-time processing of fall detection
   Ensuring chatbot adaptability for elderly users
   Data privacy and security
   Handling false positives in fall detection
2. **Plan to overcome**
   Real-time processing of fall detection
   Ensuring chatbot adaptability for elderly users
   Data privacy and security
   Handling false positives in fall detection

Potential Dataset

1. **Data sources, size, and format**
   The dataset is from kaggle and is based on a survey designed to study depression and mental health across various demographics.It includes information from a wide range of sources, including teenagers from Bangladesh, college students, housewives, professionals from businesses and corporations, and other people.
   The size of the dataset is 62.39 KB.
   The dataset is in csv format.
   https://www.kaggle.com/datasets/shashwatwork/depression-and-mental-health-data-analysis/data
   Data Sources: The dataset consists of 8,713 fall images collected from the internet, covering various environments and fall types to improve the model's generalization.

Size: A total of 8,713 images were collected and annotated for training and validation. The dataset was split into an 80:20 ratio for training and validation.
Format: The dataset was labeled using the YOLO format, with annotations created using LabelImg. The bounding boxes were manually drawn around fall-related instances and saved as .txt files corresponding to the images.

2. Data preprocessing

For data preprocessing, started by handling any missing values by either dropping or filling them. Ensure that each column has the correct data type, such as numeric for numerical values. Convert categorical data (like gender) into numerical format using encoding techniques. If necessary, scale numerical features to standardize their values. Remove any irrelevant or unnecessary columns that won't contribute to the analysis. Check for and eliminate duplicate rows to maintain unique data. Finally, split the dataset into training and testing sets if you plan to use it for machine learning.W

Potential Approach & Technologies

1. Technologies, frameworks, and models

Machine Learning & AI: YOLOv5 for fall detection, Transformer-Models, Tensorflow, Pytorch.
Frontend Development: React.js for an intuitive user interface.
Backend Development: Python with Flask/FastAPI for REST API development, Node.js for react server.
Database Management: MongoDB for efficient data storage and retrieval.

2. Programming languages, tools, and platforms

Languages: Python, JavaScript (React.js), CSS.
Tools: GitHub, Docker (for containerization).
Platforms: Web application.

3. APIs and external services

AI APIs: DeepSeek API, OpenAI API.
Twilio API: SMS alerts API.

Expected Deliverables

1. Final output

AI-based Fall Detection System (Integrated with real-time alerts).
Mental Health Chatbot (Conversational AI for elderly interaction).
Web Application (React.js UI) (User dashboard for caregivers & elderly users).
Fully Documented REST API (Python, Flask/FastAPI, MongoDB).
Project Documentation & Code Repository.

2. Key features or functionalities

AI-Powered Fall Detection: Uses YOLOv5 for real-time, device-free monitoring.

Mental Health Companion Chatbot: NLP-driven chatbot tailored for elderly engagement and emotional support.
Real-Time Alerts & Notifications: Twilio integration for immediate caregiver intervention.
Intuitive Web Dashboard: React.js UI for monitoring and user interaction.

Timeline & Milestones

1. Week-by-week breakdown of tasks

Week	Task
Week 3	Preprocess data for the selected idea.
Week 4	Train and refine the chosen AI model.
Week 5	Develop core functionalities (fall detection or chatbot).
Week 6	Build backend API integration.
Week 7	Develop React.js frontend.
Week 8	Integrate AI model with the system.
Week 9	Implement real-time alerts (if applicable).
Week 10	Conduct system testing and improvements.
Week 11	Optimize performance and finalize features.
Week 12	Scientific Paper Writing

Reference

[1] Hardiyanto, Ridho Adha, et al. "Empowering Elderly Care: Innovative Fall Detection with OpenPose and YOLO." 2023 6th International Seminar on Research of Information Technology and Intelligent Systems (ISRITI). IEEE, 2023.

[2] García-Méndez, Silvia, et al. "Entertainment chatbot for the digital inclusion of elderly people without abstraction capabilities." IEEE Access 9 (2021): 75878-75891.

[3] de Arriba-Pérez, Francisco, et al. "Automatic detection of cognitive impairment in elderly people using an entertainment chatbot with Natural Language Processing capabilities." Journal of ambient intelligence and humanized computing 14.12 (2023): 16283-16298.