# CareMatrix AI

Where Vision Meets Vigilance.

An NVIDIA  and Dell-optimized Physical AI based vision & agentic reasoning with continuous knowledge-graph updating system for autonomous elderly fall and health-surveillance.

“My goal is to reimagine elder care with autonomous vision and agentic intelligence - delivering fall prediction, posture monitoring, and real-time health insights that make caregiving proactive, precise, and scalable. The mission is a global AI platform that safeguards elders through continuous, intelligent health surveillance, enabling longer, safer, independent living.”

Kanchan Bhale

Ex Boeing
MS in Data Science @Columbia University

# Elderly Falls - A GLOBAL EMERGENCY

## ~6,46,000

Worldwide deaths

## 37 Million

Critical Injuries

annually (across all age groups, older data)

## ~44,000

Deaths across USA

## 9 Million

Critical Injuries

From 2003 to 2023, the rate increased more than 70% for adults ages 65 to 74, and more than 75% for those aged 75 to 84. It more than doubled for seniors 85 and older.

## ~1,66,518

Deaths across India

## 1.5–2 Million

Critical Injuries

Around 12.5% of older adults in India experience falls, with rates increasing with age, peaking in those 80+ (8.84%).

Over 65% of fallers suffer injuries, with fractures (12.5%), dislocations/sprains (14.31%), and head/neck injuries (7.55%) common.

## ~93,378

Deaths across China

## 9.76 Million

Critical Injuries

Define how you'll generate income from this source. Identify relevant pricing or channels.

## 2nd

leading cause of accidental injury deaths worldwide, with an estimated 646,000 individuals dying from falls each year, majorly among adults over 65 age.

https://www.cbsnews.com/news/americans-fall-deaths-prevention/#:~:text=Sara%20Moniuszko%20is%20a%20health,news%20for%20CBS%20News'%20HealthWatch.&text=More%20older%20adults%20in%20the,prevent%20falls%20as%20you%20age.

# “If deployed at global scale, our Dell + NVIDIA agentic computer-vision system could prevent up to 3,00,000 deaths and over 15 million severe injuries every year, making it one of the most impactful elder-safety innovations of this decade.

## Why is CareMatrix AI critical in the current market?

### 1. TAM - Total Addressable Impact (Global Scale)

| Metric | 25% Prevention | 40% Prevention |
|---|---|---|
| **Lives Saved** | **1,70,000–200,000** | **270,000–320,000** |
| **Injuries Prevented** | **9–10 million** | **15 million+** |

### 2. SAM - Serviceable Available Market

US, China, EU, Japan, South Korea, Urban India ≈ 300 million elders

Lives Saved per Year

- 75,000–1,10,000 lives (at 25–40% prevention range)

Injuries Prevented per Year

- 4–6 million severe injuries

### 3. SOM - Serviceable Obtainable Market (First 3 Years)

-US assisted living facilities
-Indian metro hospitals
-China urban elder-care programs
-Corporate elder-care insurers
-Pilot deployments in 50–100 facilities

**Realistically reachable elders in 3 years:**
**5–10 million elders monitored**

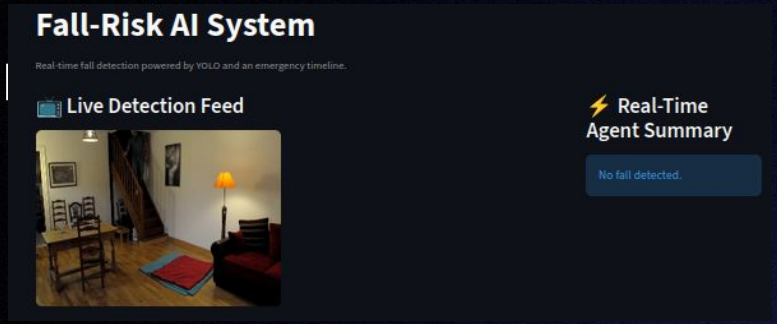
# Nvidia & Dell Usage

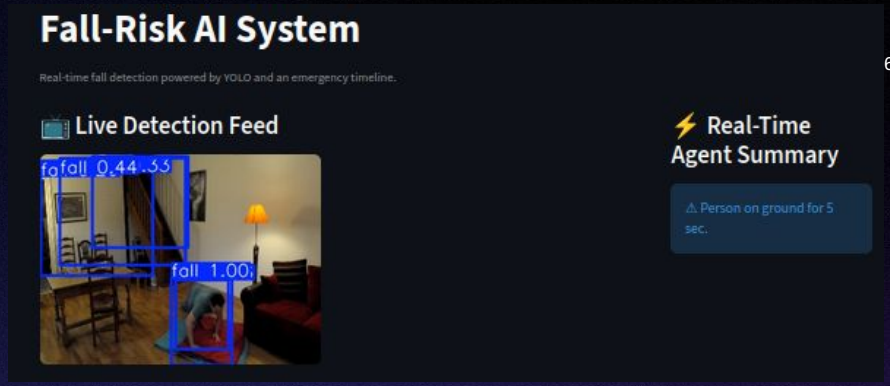
## Dell/Nvidia Advantage

- Reliable edge compute for hospitals/elder homes
- Multi-stream video pipelines with high throughput
- Scalable deployment: room -> floor ->  building -> city
- Enterprise agreements with healthcare systems

## Startup USP Advantage

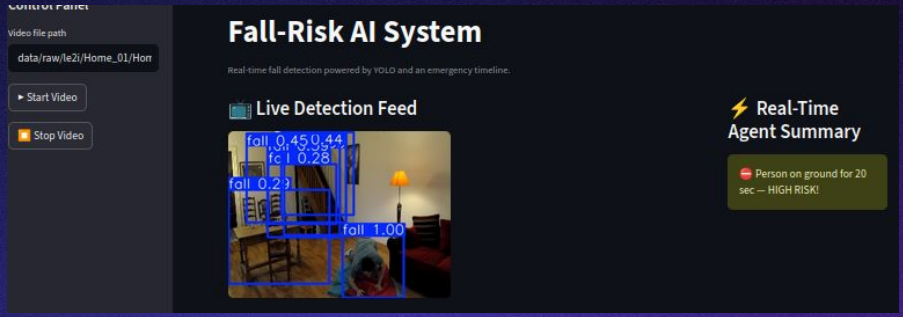
- Physical AI + vision + agentic reasoning + knowledge-graph updating
- Continuous summaries + alerts - saves caregiver time & lives
- Modular -> can launch as SaaS, hardware bundle, or API layer
- Clinical validation possible in 6–12 months



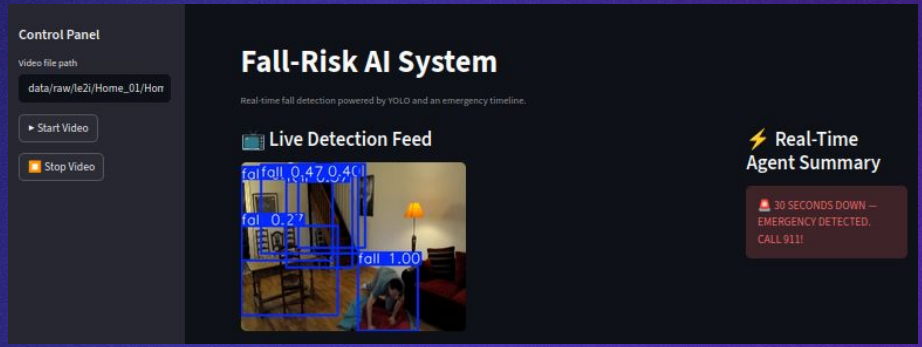

- We don't just provide the cure, we PREVENT!

  Before the accidents happen, the real time monitoring system will provide continuous updates including prediction of fall, detection of obstacles, close proximity of fall.




- **During the Fall**

  The system gives warning of family SOS, and confirms the fall




- **After the Fall - Emergency and 911 service integrations**

  After locking the fall confirmation, our system continuously provides observer the option to connect family SOS, call 911 and other emergency actions based on the time and posture of fall duration.

# 1. Dataset

I used a **multi-dataset fusion strategy** to maximize robustness and reduce model bias:

## Datasets :

**1) Kaggle Fall Detection Dataset (Le2i subset)**
Used for supervised training of fall vs. non-fall classification and temporal fall sequence modeling.

**2) Daily-Living Human Activity Dataset**
Used to teach the model normal motion patterns - helps reduce false positives for bending, sitting, picking objects.

**3) UR Fall Detection Dataset (URFD)**
Used for high-acceleration fall events, strong frontal/side-view falls - increases sensitivity for fast incidents.

**4) FDD Dataset**
Used for environmental diversity: bedrooms, corridors, assisted-living homes - generalizes model to different camera angles.

## Combining them :

- Preprocessed all datasets into a **unified 30 FPS - 8 FPS pipeline**
- Extracted **pose keypoints, bounding box tracks, and optical flow vectors**
- Created a **3-stream input representation**:

  `RGB frame + Motion flow + Skeleton keypoints`

- Trained using **weighted sampling** to avoid dataset imbalance (fall events are rare)

# 1. COMPUTER VISION PIPELINE + OUTPUTS

**I implemented a hybrid CV architecture:**

| Component | Model | Purpose |
|---|---|---|
| **Person Detection** | YOLOv8-nano (real-time optimized) | Detect humans in frame |
| **Pose Estimation** | Ultralytics RTMPose | Track body joints & orientation |
| **Motion Analysis** | RAFT Lite (optical flow) | Detect fast downward motion |
| **Sequence Fall Classifier** | Temporal CNN / LSTM | Determine if trajectory = fall |

```
{
  "posture": "lying/standing",
  "confidence": 0.9-1,
  "time_on_ground": 12.4,
  "fall_detected": true/false
}
```

# 3. Agentic Layer

**Domain specific rule based agent -**

YOLO model detects whether a person is in *fall* class (class 0).

The detection signal becomes the agent's "observation".

| Condition | Agent Action |
|---|---|
| No fall | Reset memory, "No fall detected" |
| Fall detected | Start timer + "Fall Confirmed - Call Family?" |
| 5 seconds | "Person on ground for 5 sec" |
| 10 seconds | "Person on ground for 10 sec" |
| 20 seconds | High-risk warning |
| 30 seconds | Emergency → "CALL 911!" |

## Output (Agent Actions)

- Updates real-time alerts
- Issues escalating emergency warnings
- Chooses UI severity (info, warning, error)
- Automatically governs safety escalation

# 4. Physical AI

How CareMatrix AI **perceives** physical human activity and converts it into **safety decisions**.

| Component | Function | Your System Implementation |
|---|---|---|
| **Perception** | Understand physical posture from video | YOLO detects fall class and converts pixels -> signals |
| **Temporal Understanding** | Measure how long a person stays down | Timer starts on fall; session state tracks duration |
| **Safety Intelligence** | Judge risk level | Classifies states: harmless -> risky -> critical |
| **Human-Centered Emergency Logic** | Trigger appropriate actions | Escalates alerts (family -> high risk -> call 911) |

# Customer segments

## Places Where CareMatrix AI can be  Implemented Specifically for Elderly Care

### At-Home Elder Care

Seniors living alone

Remote caregiving setups

Home nursing services

### Assisted Living Facilities

Senior living communities

Rehabilitation homes

Memory care units

### Nursing Homes

High-risk patients

Dementia/Alzheimer's monitoring

Bed-fall detection in shared rooms

### Hospitals With Elderly Wards

Geriatric wards

Emergency rooms

Post-surgery fall-risk patients

### Elder Transportation & Mobility Services

Wheelchair transport monitoring

Shuttle services inside senior communities

# Industry segments

## Other Industries / Use-Cases where CareMatrix AI Systems Could be Implemented (Non-Elderly)

### Workplace Safety & Industrial Environments

Construction sites - fall-from-height detection

Manufacturing plants - worker collapse, unsafe posture detection

Mining - worker fatigue, collapse, gas exposure incidents

Oil & gas rigs - slipping, unconsciousness detection

### Hospitals & Healthcare (Non-elderly patients)

ICU patient fall & motion monitoring

Post-operative fall risk prediction

Rehabilitation movement tracking

### Sports & Athletics

Concussion detection

Collision impacts in football, hockey, rugby

Real-time pose analytics for injury prevention

### Transportation & Public Infrastructure

Subway/rail platforms - detecting person falling onto tracks

Airport walkway - motion abnormalities, fainting

Traffic cameras - biker/motorcyclist fall detection

### Defence & Military

Soldier down detection in training grounds

Unconscious/immobilized personnel alerts

# Technical Future

**“Today we detect falls. Tomorrow we predict, prevent, and autonomously respond to them using agentic multimodal intelligence.”**

## Current Technology

| | |
|---|---|
| Computer Vision | Agentic AI |
| Knowledge Graph | UI Application |

## Goals

- Utilize more powerful LLMs
- Move from Single-Camera CV to Multimodal Fall Understanding
- Integrate privacy and personal database access (Family SOS, 911 SOS)

| | |
|---|---|
| **Depth sensors** | Thud Sounds |
| **Wearables** | heart-rate |
| **Audio Cues** | Gasp, call for help |
| **Thermal Cameras** | Night Detection |
| **Location** | Which room riskier |
| **Floor/Object Mapping** | Water, Objects, etc. |

## Pose Detection

Hip-Knee Angle

Sudden Loss of Vertical key points

Hip-shoulder angle

## Partnerships/Outsourcing

- ISmart lights turn on automatically during fall
- Alexa/Google Home integration
- Door unlocks for emergency responders
- Public Safety Organizations
- City Police Department

# Keep in touch.
# Thankyou!

**Contact**
Kanchan Bhale
MS in Data Science Columbia University
kvb2117@columbia.edu
https://www.linkedin.com/in/kvb2117/

“Together, we care for those who once cared for us.”