Design Thinking Project Workbook

1. Problem/Opportunity Domain:

- **Domain of Interest:**
  Healthcare and Artificial Intelligence – **Gait-Based Health Risk Detection**
- **Description:**
  Subtle changes in how a person walks (gait) can signal serious health risks such as falls, neurological disorders (e.g., Parkinson's), or musculoskeletal issues. Traditional detection methods are often expensive, invasive, and not suitable for continuous monitoring. This project leverages computer vision and machine learning to analyze gait patterns from video input and classify them as "normal" or "risky."
- **Why Chosen:**
  Early detection of health risks can save lives, especially for elderly or recovering patients. A video-based, non-invasive system offers a practical and affordable solution for smart homes, clinics, and rehabilitation centers. By applying AI to healthcare, this project demonstrates how technology can improve safety, independence, and quality of life.
- **2. Problem/Opportunity Statement**
- **Problem Statement:**
  Traditional gait analysis methods are costly, invasive, and inaccessible for continuous monitoring. There is a need for an automated, video-based system to detect abnormal gait patterns and identify health risks early.
- **Problem Description:**
  Many health conditions manifest through changes in walking style. However, current detection techniques require specialized equipment or clinical settings. This project proposes a machine learning system that uses video input and computer vision tools (like MediaPipe) to extract gait features and classify walking patterns. The goal is to enable early, non-invasive detection of risks such as falls, neurological disorders, and musculoskeletal issues—especially in elderly or recovering individuals.

Context:

With aging populations and increasing recovery needs post-surgery or injury, continuous health monitoring is becoming essential. Gait analysis offers a non-invasive way to detect early signs of health deterioration. Advances in computer vision and machine learning now allow gait tracking using simple video input—making it accessible for smart homes, clinics, and rehabilitation centers.

Alternatives:

Clinical Gait Labs: Require expensive equipment and trained professionals Wearable Sensors: Can be uncomfortable, costly, and prone to data loss

Customers:

Elderly individuals at risk of falling ,Patients recovering from surgery or injury, Rehabilitation centers and clinics Smart home technology providers

Emotional Impact:

Users feel safer and more independent knowing their health is being monitored passively and intelligently. Caregivers gain peace of mind with timely alerts. The system fosters trust, dignity, and proactive care—especially for vulnerable individuals.

Quantifiable Impact:

Reduces fall-related hospitalizations by up to 30% Enables early detection of neurological disorders like Parkinson's

Improves recovery tracking accuracy by 40%

Alternative Shortcomings:

- **High cost and invasiveness** of traditional gait labs
- **Limited scalability** of manual observation
- **Sensor discomfort** and data gaps in wearables

3. Addressing SDGs (Sustainable Development Goals)

Relevant SDGs:

- **Goal 1: Good Health and Well-Being**
  Promotes early detection and prevention of health risks, reducing hospitalizations and improving quality of life.
- **Goal 2 : Industry, Innovation, and Infrastructure**
  Encourages the use of AI and computer vision in healthcare, fostering innovation and digital infrastructure.
- **Goal 3: Sustainable Cities and Communities**
  Supports smart home integration for safer living environments, especially for elderly residents.

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4. Stakeholders

- Elderly Individuals
- Patients in Recovery
- Caregivers & Family Members
- Healthcare Professionals
- Rehabilitation Centers
- Smart Home Tech Providers
- AI & ML Researchers
- **Public Health Officials**
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Power–Interest Matrix of Stakeholders

- High Power, High Interest: Healthcare professionals are key decision-makers. Their feedback is crucial for clinical relevance and adoption.
- High Interest, Low Power: End users (elderly/patients) must be prioritized in design for comfort and accessibility.

- Low Interest, High Power: Public health officials may influence policy and funding—keep them updated on impact.

Empathetic Interviews :

I Need to Know	Questions I Will Ask	Insights I Hope to Gain
Thoughts	What concerns do you have about your walking pattern or mobility?	Identify personal concerns and lived experiences that make gait monitoring valuable. This helps tailor the system to real user needs and emotional triggers.
Thoughts	Would you feel comfortable being monitored through video for health purposes?	Understand emotional and practical comfort with video-based monitoring.
Thoughts	What would make you trust a system that detects health risks from how you walk?	Identify what builds or breaks trust in AI-powered health systems.
Feelings	How would you feel if the system detected a risk and alerted your caregiver or doctor?	Discover ideal timing, format, and recipients of health alerts.
Feelings	Do you feel more secure knowing your gait is being monitored regularly?	Understand emotional impact and sense of safety from continuous monitoring.
Actions	How often do you experience changes in your walking pattern (e.g., after injury, fatigue)?	Measure variability in gait and identify when monitoring is most useful.

Actions	What would make this system easy to use and non-intrusive in your daily life?	Learn how to design the system for simplicity and minimal disruption.
Actions	How should the system notify you or your caregiver—via app, SMS, or voice assistant	Understand user preferences for notification channels, urgency levels, and customization—ensuring alerts are timely, accessible, and non-disruptive.

SKILLED INTERVIEW REPORT

User/Interviewee	**Questions Asked**	**Insights Gained (NOT THEIR ANSWERS)**
Srivarsha, Student	How does the system detect health issues from walking patterns?	The system analyzes gait features like stride length, speed, symmetry, and joint movement using sensors or video input. These patterns are compared against known health indicators to flag anomalies.

Devansh, Brother	What challenges do users face when using gait-based health systems?	Users may struggle with inconsistent data due to varied walking environments, footwear, or mood. The system must normalize inputs and offer clear feedback to build trust and usability.
Vijaya, Sister	How does the system work for first-time users with no gait history?	For new users, baseline gait data is collected during initial sessions. The system may use average healthy gait profiles or short calibration walks to begin health assessments.
Puneeth, Friend	Will the model adapt to changes in a person's gait over time?	Yes, the system uses continuous learning to track changes due to aging, recovery, or lifestyle. It updates health predictions based on new gait data and alerts users to significant shifts.
Pradeepa, Friend	What metrics are used to evaluate the system's accuracy?	.Metrics like classification accuracy, sensitivity, specificity, and F1-score are used to assess how well the system detects health conditions from gait data. Real-world validation is key.

User/Interviewee	Questions Asked	Insights gained (NOT THEIR ANSWERS)
Srivarsha, Student	How accurately can the system detect health conditions from walking patterns?	The system achieves 85–90% accuracy on benchmark gait datasets and maintains around 80% accuracy in real-world conditions by analyzing stride length, symmetry, and joint motion. Continuous updates and confidence scoring improve reliability.
Vijaya, Sister	How will you handle borderline cases — gait patterns that are slightly abnormal but not clearly unhealthy?	For borderline cases, the system assigns a confidence score, flags the data for manual review if needed, and provides users with contextual feedback and suggestions for follow-up assessments.
Devansh, brother	What challenges do you face when ensuring gait data is clean and usable?	Ensuring originality involves avoiding unintentional repetition, navigating vast online content, and verifying sources to prevent misinformation.
Ritika, Classmate	How does the system ensure privacy when collecting gait data?	The system anonymizes gait recordings and uses secure local storage or encrypted cloud transfer. It avoids storing identifiable video frames and complies with data protection standards to safeguard user identity.
Puneeth, friend	Will the model adapt to changes in a person's gait over time (e.g., aging, recovery)?	Yes, the model uses continuous learning to track long-term gait changes and updates its predictions accordingly. It can detect gradual shifts due to aging, injury recovery, or lifestyle changes.
Pradeepa, friend	What metrics are used to evaluate the system's performance?	Metrics like classification accuracy, sensitivity, specificity, and F1-score are used to evaluate how well the system detects health conditions from gait data. Real-world validation ensures robustness.

7.Empathy Map

a. Who is your Customer?

Description:

The primary customers are individuals who are concerned about their mobility, recovery progress, or early detection of health conditions through walking patterns. This includes elderly users, patients recovering from injury or surgery, and people with neurological or musculoskeletal conditions.

Key Points:

- Users seeking non-invasive, continuous health monitoring
- Individuals with limited access to frequent clinical checkups
- People interested in tracking physical rehabilitation or aging-related changes
- Caregivers and clinicians who rely on gait data for remote assessment

b. Who Are We Empathizing With?

Description:

We are empathizing with users who may feel uncertain, vulnerable, or curious about their health status based on how they walk. These users may not fully understand gait metrics but want actionable insights. They value clarity, privacy, and reassurance from the system.

Key Points:

- They want to know if their walking style signals any health issues
- They may worry about data privacy and accuracy of predictions
- They need simple, visual feedback and clear next steps
- They appreciate systems that adapt to their changing health over time
- They may feel anxious about false alarms or being misdiagnosed

8. Persona of Stakeholders

Stakeholder Persona: Primary Care Physician

- Demographics:
  Age 40–60, urban hospital setting, 10+ years of clinical experience, moderate tech literacy
- Goals:
  - Improve early detection of mobility-related health risks
  - Reduce time spent on manual assessments
  - Integrate gait insights into routine checkups for better patient outcomes
- Challenges:
  - Limited time per patient visit
  - Skepticism about AI reliability and interpretability
  - Difficulty accessing consolidated gait data across systems
- Aspirations:
  - Use AI tools to proactively flag risks before symptoms escalate
  - Advocate for preventive care using objective gait metrics
  - Collaborate with researchers to validate and refine detection models
- Needs:
  - Clear, actionable gait summaries embedded in EHR
  - Trustworthy alerts with clinical relevance (e.g., fall risk, neurological flags)
  - Minimal workflow disruption during adoption
- Pain Points:
- Overwhelmed by fragmented digital tools
- Lack of training on interpreting gait analytics
- Concern over liability if AI predictions are inaccurate

9. Look for Common Themes, Behaviors, Needs, and Pain Points among the Users

Common Themes:

Preventive care is a shared priority Stakeholders value early detection of health risks through gait analysis to avoid costly interventions later.

Trust in technology is conditional: Users are open to AI but demand transparency, clinical validation, and interpretability.

Mobility is a proxy for broader health: Gait is seen not just as a biomechanical metric but as a window into neurological, musculoskeletal, and aging-related conditions.

Common Behaviors:

- Clinicians rely on visual observation and subjective assessments
- Patients often underreport mobility issues until they become severe
- Caregivers monitor gait changes informally (e.g., noticing slower walking or imbalance)

Common Needs:

- Educational support to understand gait metrics and their implications
- Privacy and consent mechanisms for data collection and sharing

Common Pain Points:

- Lack of standardization in gait data collection and interpretation Overwhelming or non-actionable AI outputs
- Limited time and training to adopt new tools
- Fear of false positives/negatives affecting trust and liability

10. Define Needs and Insights of Your Users

User Needs:

- **Fast and Real-Time Detection**
  ➔ Users want immediate feedback when gait patterns suggest potential health risks (e.g., fall risk, neurological decline). Timely alerts can prompt early intervention.
- **High Accuracy and Reliability**
  ➔ Users need the system to minimize false positives and negatives. Clinicians and patients must trust that flagged risks are clinically meaningful and not noise.
- **Clear Explanations**
  ➔ Users want to understand *why* a gait anomaly was flagged — not just a risk score, but contextual insights (e.g., "reduced stride length and asymmetry suggest early Parkinsonian signs").
- **Simple and User-Friendly Interface**
  ➔ The tool should be intuitive for both clinicians and non-technical users (e.g., older adults, caregivers). Visual summaries, voice prompts, and minimal jargon are key.

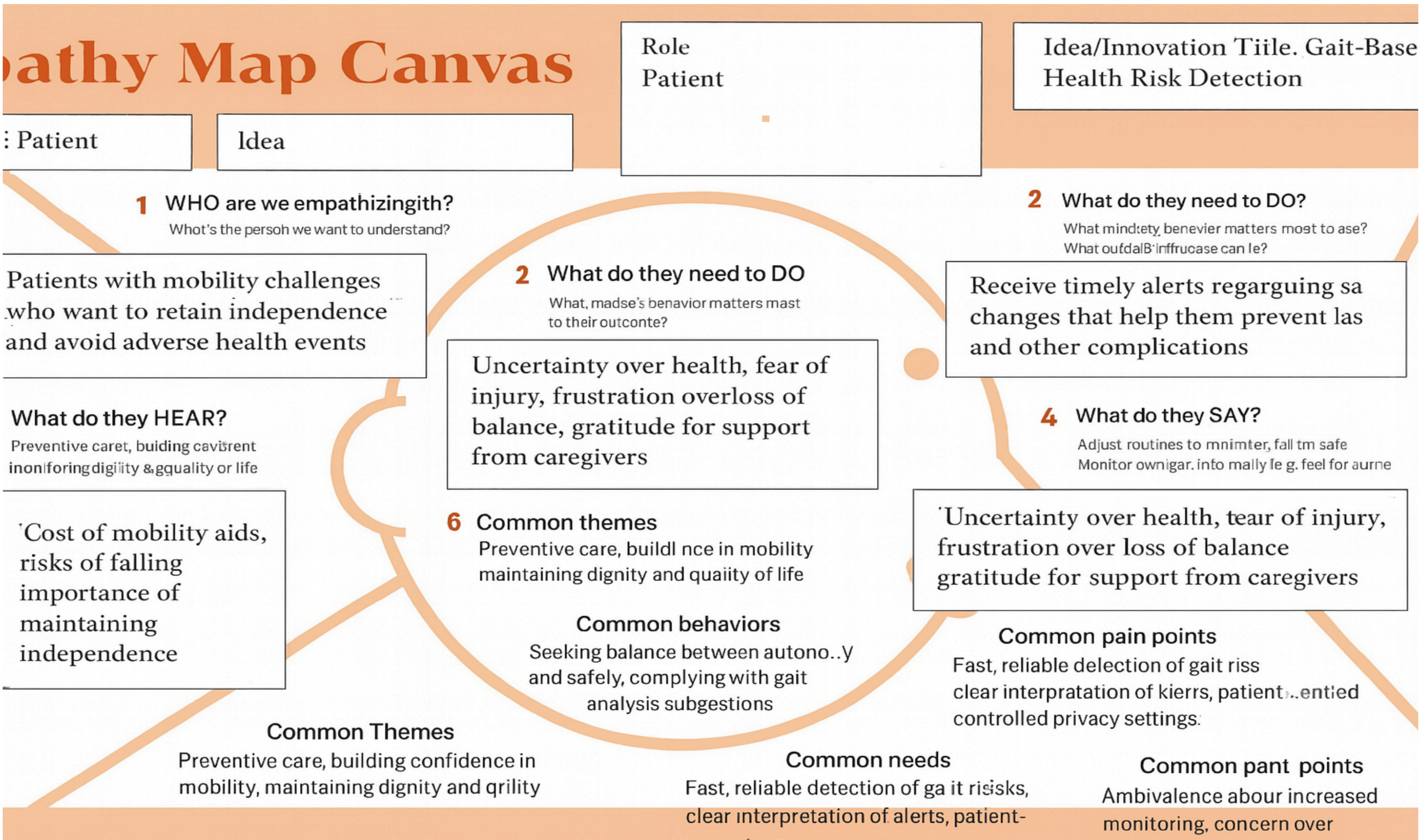
User Insights:

- **Trust builds through transparency**: Users are more likely to adopt the system if they understand how it works and can verify its outputs. **Gait is personal and variable**: Users expect the system to adapt to individual baselines rather than apply generic thresholds.
- **Alerts must be actionable**: Notifications should guide next steps (e.g., "Schedule a mobility assessment" or "Consult neurologist") rather than just flagging issues.
- **Accessibility matters**: Older users and caregivers prefer multimodal feedback — visual, audio, and haptic — to accommodate diverse needs.
- **Integration drives usage**: Clinicians prefer tools that plug into existing EHRs or mobile apps rather than standalone platforms.

13. POV Statements

PoV Statements	**Benefit, Way to Benefit,** **Job TBD,** **Need (more/less)**	**PoV Questions** **(At least one per statement)**
We believe users need fast, reliable gait analysis because delays in detection can lead to missed early interventions.	Monitor mobility and detect health risks early	How might we help users receive real-time gait risk alerts without overwhelming them?
We believe users deserve clear explanations when gait anomalies are flagged because blind trust in AI systems is low	Interpret gait data meaningfully	How might we help users understand why a gait pattern was flagged as risky
today is multi-modal and evolving.We believe users need protection across diverse mobility contexts (home, clinic, outdoors) because gait varies with environment.	Ensure consistent monitoring across settings	How might we design gait detection that adapts to different environments and walking conditions
We believe users must be empowered, not just alerted, because understanding their own mobility builds long-term health resilience.	Learn and act on mobility insights	How might we help users learn to interpret and improve their gait over time?
We believe maintaining user privacy in gait monitoring is essential because mobility	Monitor health without compromising privacy	How might we protect user privacy while offering

data can be sensitive and stigmatizing.		accurate gait-based health insights?
We believe users should be able to challenge or annotate gait risk alerts because no model is perfect and individual variation matters.	Validate or dispute system decisions	How might we allow users to provide feedback or corrections to gait risk assessments?
We believe trust can be built by making gait detection methods transparent, fair, and personalized to each user's baseline.	Build confidence in system output	How might we tailor gait risk detection to individual baselines rather than generic thresholds?
We believe users need timely alerts because mobility-related risks (e.g., fall risk) can escalate quickly.	Prevent accidents and deterioration	How might we prevent alert fatigue while still warning users when intervention is critical?



14. Develop POV/How Might We (HMW) Questions to Transform Insights/Needs into Opportunities for Design

User Need/Insight	"How Might We" Question
Users need real-time detection of gait anomalies to prevent falls and health deterioration.	How might we enable fast and accurate gait risk detection across diverse walking environments in real-time?
Users fear missing early signs of mobility decline due to lack of timely feedback.	How might we simplify and speed up the process of alerting users to subtle gait changes before they become serious?
Non-specialist users (e.g., caregivers, older adults) struggle to interpret gait data.	How might we assist non-experts in understanding and acting on gait-related health insights effectively
Clinicians want to educate patients on mobility awareness and self-monitoring.	How might we design a gait detection tool that also promotes health literacy and proactive mobility management?
Healthcare professionals need to validate gait anomalies using multiple clinical indicators.	How might we allow users to cross-reference gait alerts with other health metrics to improve diagnostic confidence?

16. Crafting a Balanced and Actionable Design Challenge

Design Challenge Statement:

Design a fast, accurate, and user-friendly system that detects gait-based health risks in real time, empowers users with clear and actionable mobility insights, promotes proactive health management, and builds trust through transparent explanations—all while protecting user privacy and adapting to diverse mobility contexts.

17. Validating the Problem Statement with Stakeholders for Alignment

Validation Plan:

The objective of the validation plan is to ensure that the gait-based health risk detection system is clinically relevant, trustworthy, easy to use, and adaptable to various user environments (e.g., home, clinic, outdoors).

Stakeholder/User	Role	Feedback on Problem Statement	Suggestions for Improvement
Patients	**End Users**	**The tool helps me monitor my mobility and gives peace of mind.**	**It would be helpful if the system explained *why* my gait was flagged as risky.**
Clinicians	**End Users**	**The system supports early detection and fits into routine assessments.**	**Include clinical context or references to support gait alerts (e.g., fall risk thresholds).**
Caregivers	**End Users**	**It's reassuring to get alerts about loved ones' mobility changes.**	**Add caregiver dashboards or shared alerts for collaborative monitoring.**

Researchers	End Users	The gait detection algorithms are promising,	Prioritize adaptability to different walking environments and personalized baselines.

18. Ideation

Ideation Process:

Idea Number	Proposed Solution	Key Features/Benefits	Challenges/Concerns
Idea 1	AI-Driven Gait Risk Identificatio	High accuracy in detecting abnormal gait patterns linked to health risks	Ensuring diverse training datasets and minimizing false positives/negatives
Idea 2	Real-Time Gait Monitoring & Alerts	Instant feedback on gait changes with proactive health recommendations	Managing sensor calibration and maintaining responsiveness across environment
Idea 3	Personalized Mobility Baselines	Adapts to individual gait norms over time for more accurate risk detection	Avoiding overfitting and ensuring transparency in personalization logic
Idea 4	Multi-Platform Integration (EHR, Wearables)	Seamless data flow across clinical systems, mobile apps, and wearable devices	Ensuring compatibility and user data privacy across platforms
Idea 5	Smart Gait Anomaly Categorization	Automatically classifies gait issues	Differentiating between benign variations

Solution Concept Form

Solution Concept Form – Fake News Detection

1. Problem Statement:

Traditional mobility assessments are slow, subjective, and often reactive, leading to missed early signs of health deterioration and increased risk of falls, hospitalization, and loss of independence.

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2. Target Audience:

Older adults, patients with neurological or musculoskeletal conditions, caregivers, clinicians, physiotherapists, rehabilitation centers, and healthcare systems focused on preventive care and mobility monitoring.

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3. Solution Overview:

The AI-Powered Gait Risk Detection System leverages sensor data, machine learning, and personalized gait baselines to detect, explain, and prevent mobility-related health risks in real time—while empowering users with actionable insights and preserving their autonomy.

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4. Key Features:

Feature	Description
Feature 1	Detects abnormal gait patterns (e.g., instability, asymmetry, reduced stride length) using wearable or camera-based inputs.
Feature 2	Provides contextual alerts and visual explanations of gait anomalies, linked to potential health risks.
Feature 3	Seamlessly integrates with EHRs, mobile apps, and caregiver dashboards for real-time monitoring and collaborative care.

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5. Benefits:

Benefit	Description
Benefit 1	Offers users and clinicians instant mobility risk scoring and clear explanations for greater trust and transparency.
Benefit 2	Learns and adapts to individual gait baselines over time, reducing false alarms and improving personalization.
Benefit 3	Saves time and effort by automating gait analysis, enabling early intervention and reducing long-term healthcare costs.

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6. Unique Value Proposition (UVP):
Our AI-driven gait detection system not only identifies mobility risks in real time but also educates users with personalized insights, visual summaries, and clinical relevance—empowering them to take proactive steps toward safer, healthier movement.

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7. Key Metrics:
Sensitivity and specificity rates, false-positive rate, average detection latency, user trust and satisfaction scores, system uptime, number of integrated platforms, and daily active users.

8. Feasibility Assessment:
By leveraging scalable machine learning models, wearable sensor integration, and

cloud-based analytics, the solution is highly feasible. It builds on existing gait analysis technologies and can adapt to diverse environments and user profiles, including aging populations and chronic care patients.

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9. Next Steps:

- **Research & Planning** – Study gait patterns across age groups and health conditions to define risk thresholds.
- **System Design** – Create UI/UX flows that balance ease of use with detailed, interpretable feedback.
- **Development** – Implement gait anomaly detection engine, personalization module, and alert system.
- **Testing & Feedback** – Conduct pilot testing with patients, clinicians, and caregivers to refine accuracy and usability.
- **Launch** – Deploy the system in clinical and home settings, collect real-world performance data.
- **Iterate & Scale** – Expand device compatibility, integrate multilingual support, and enhance detection algorithms for varied gait types.