Phase 1 Proposal: AI-Powered Chronic Disease Risk Screener Using Non-Invasive Signals

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1. Industry Context and Problem Definition

Industry: Healthcare / Digital Health / Preventive Medicine

Chronic diseases such as diabetes, hypertension, and kidney disease are silent but costly threats. Globally, the WHO (2023) reports that 74% of all deaths are caused by chronic diseases. In the U.S., the CDC (2023) estimates that 6 in 10 adults live with at least one chronic condition, and 4 in 10 live with two or more.

The financial burden is immense: the U.S. spends $4.1 trillion annually on chronic disease management. Diabetes alone affects 38.4 million Americans (11.6% of the population), with nearly 1 in 5 undiagnosed. Chronic kidney disease impacts 37 million adults, yet 90% are unaware they have it.

In California, and particularly Long Beach, disparities are stark. Nearly 20% of Long Beach residents live below the poverty line, and uninsured or underinsured patients face barriers to lab-based screening. Clinics here often operate with limited staff and resources, making early, affordable detection critical.

Customer Pain Points:

- Patients: Lab tests are costly and inconvenient; lack of early detection leads to severe complications like dialysis, blindness, and heart failure.
- Clinics: Limited staff and budgets make it hard to identify high-risk patients efficiently.
- Insurers: Late-stage treatment (e.g., dialysis costing ~$90,000 annually per patient) drives high claims and reduces profitability.

Business Importance:
Early detection prevents severe complications, improving outcomes while lowering costs. By flagging high-risk individuals early, clinics can prioritize scarce resources, patients can avoid life-altering complications, and insurers reduce long-term claims.

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2. Proposed AI Solution

We propose an AI-powered risk screener that predicts the likelihood of diabetes, hypertension, and kidney disease using non-invasive signals, providing actionable insights without requiring lab tests.

Inputs:

- Images (Primary): Retinal or nailbed images captured via smartphones, showing early biomarkers of disease. *(Available now and feasible to use.)*
- Demographics & Lifestyle (Optional): Age, gender, BMI, smoking status, alcohol consumption, diet, activity levels.
- Wearables (Optional): Heart rate, sleep patterns, daily step counts.

AI Model:

- Lightweight CNN: Extracts biomarkers from images.
- Tabular Transformer / MLP (Optional): Handles structured lifestyle and wearable inputs.
- Fusion Layer (Optional): Combines image + tabular embeddings into a unified, interpretable risk score.

Key Features:

- Personalized risk scores for diabetes, hypertension, and kidney disease.
- Prioritization for care, directing limited lab resources to highest-risk patients.
- Explainable AI: SHAP values and heatmaps reveal what features drive predictions.

Data Availability:

- Primary: Public retinal datasets (e.g., EyePACS) and nailbed images.

- Optional: NHANES tabular datasets, open-source wearable data repositories.

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3. Prototype Feasibility

The project is feasible in 9 weeks and can yield both a Proof of Concept (PoC) and a Minimum Viable Product (MVP).

Plan:

1. Fine-tune a lightweight CNN on retinal/nailbed images.
2. (Optional) Train a transformer/MLP on tabular lifestyle data.
3. Fuse models to output a risk score with interpretability.
4. Build a web/mobile demo app showing risk scoring on sample inputs.

Deliverable:
An app that demonstrates how clinics can rapidly screen patients using images, reducing undetected cases and optimizing lab referrals.

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4. Teamwork & Collaboration

- Data Acquisition & Preprocessing – Collect, clean, and annotate datasets.
- Model Development – Train CNNs and optional tabular models.
- Integration & Interface – Build fusion layer and web app interface.
- Documentation & Presentation – Reports, slides, and final demo video.

We will conduct weekly meetings and use GitHub for version control, ensuring accountability, coordination, and presentation readiness.

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5. Conclusion

Chronic diseases account for 74% of global deaths and cost the U.S. over $4.1 trillion annually. Millions remain undiagnosed due to the high costs and invasiveness of lab-based testing.

Our project addresses this with a non-invasive, AI-powered screener using retinal/nailbed images, expandable to lifestyle and wearable data. It is technically feasible, clinically impactful, and financially beneficial—empowering patients, clinics, and insurers.

This solution not only aligns with CECS 551 objectives but also holds potential for real-world scalability in preventive medicine.

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