AI-Driven Early Alzheimer’s Detection via Speech and Eye Movement

Problem Statement:

Alzheimer’s disease is usually diagnosed only after the brain is already damaged, which is too late for helpful treatment. In early stages, people show small changes in speech and eye movement, but these are often missed by regular checkups.

We want to use AI to catch these early changes using simple tools like a microphone and webcam to help identify Alzheimer’s earlier.

What Is Alzheimer’s?

* It’s a brain disease that slowly affects memory, thinking, and behavior.
* It gets worse over time. There is no cure yet, but early help can slow it down.
* It starts years before any major symptoms show.

How it progresses:

1. Preclinical: No clear symptoms, but changes are happening in the brain.
2. Mild Cognitive Impairment (MCI): Small memory slips and confusion.
3. Alzheimer’s Dementia: Clear memory loss, confusion, and personality changes.

Traditional Diagnosis Methods:

Here are the common ways Alzheimer’s is found and why they are not enough for early detection:

* Brain Scans (MRI/PET)
  + Shows shrinkage or damage
  + Problem: Expensive and only useful in later stages
* Biomarker Tests (from spinal fluid)
  + Checks for special proteins in the brain
  + Problem: Invasive and painful
* Memory Tests (like MMSE or MoCA)
  + Ask questions to check thinking and memory
  + Problem: Can miss early signs, depends on the doctor
* Observations by Doctors or Family
  + Looking at behavior and daily ability
  + Problem: Late signs, not reliable

Why Use AI for This?

* Catches problems earlier, before big symptoms appear
* Non-invasive: Just needs a microphone and webcam
* Low cost, easy to use at home or in clinics
* Helps doctors make faster and better decisions

What the AI Model Should Do:

Speech Input

* Person speaks for 1–2 minutes (e.g., tell a story, describe a picture)
* AI listens for:
  + Pauses or stammering
  + Repeated words or forgetfulness
  + Simple vs. complex sentences
  + Voice tone and emotion

Eye Movement Input

* AI uses webcam to track:
  + How long a person looks at one thing (fixation)
  + Whether their eyes move smoothly or jump around
  + If they get distracted often

AI Processing

* Combines both types of input
* Uses machine learning to guess:
  + Healthy
  + Mild cognitive issues
  + Possible early Alzheimer’s

Output

* A simple risk score (e.g., “Low”, “Medium”, “High”)
* Show why the score was given (e.g., “frequent pauses and gaze drift”)

What We Expect from the AI Model:

* It should run on simple devices (like a browser or mobile)
* It should give results in 1–2 minutes
* It should be 70–80% accurate, even with simulated data
* It should be easy to understand for both doctors and families
* Optional: Let users test again over time to track changes

Background Research:

* DementiaBank: Audio recordings of people with Alzheimer’s
* GazeCapture (MIT): Eye-tracking data for testing models
* Helpful articles:
* "Using Speech to Detect Alzheimer’s" (Journal of AI in Medicine, 2023)

<https://link.springer.com/article/10.1007/s43621-024-00217-2>

* "Eye Movement Changes in Early Alzheimer’s" (Frontiers in Aging, 2021)

<https://www.nature.com/articles/nindia.2019.172>