**Project Title:  
Gesture-Based Human-Computer Interaction System using OpenCV, MediaPipe, and Palm's text-bison-001**

**Team Name:  
Faders**

**Team Members:**

* **B. Hemanth Rao**
* **M. Manish Kumar**
* **S. Sai Ram**
* **K. Snehith**
* **S. Sri Harsha Sai**

**Phase-1: Brainstorming & Ideation**

**Objective:**

**Develop an AI-powered gesture recognition system that allows users to interact with computers using hand gestures. The system will leverage OpenCV for image processing, MediaPipe for hand tracking, and Palm’s text-bison-001 for natural language integration.**

**Key Points:**

**Problem Statement:**

* **Traditional input methods (keyboard, mouse) limit accessibility for people with disabilities.**
* **Touch-based interaction is not always feasible (e.g., during COVID-19 or in sterile environments).**
* **Users need a touchless interface for seamless control of applications and devices.**

**Proposed Solution:**

* **A real-time gesture recognition system that translates hand movements into commands.**
* **Uses OpenCV for image capture and preprocessing.**
* **MediaPipe for efficient hand tracking and gesture recognition.**
* **Palm’s text-bison-001 for interpreting gestures into natural language commands.**

**Target Users:**

* **People with disabilities who need an alternative to traditional input methods.**
* **Professionals in sterile environments (e.g., surgeons, lab technicians).**
* **General users looking for innovative ways to interact with computers.**

**Expected Outcome:**

* **A functional, real-time gesture-based interaction system that can be integrated into various applications.**
* **Improved accessibility and usability for users who require hands-free interaction.**

**Phase-2: Requirement Analysis**

**Objective:**

**Define the technical and functional requirements of the Gesture-Based Interaction System.**

**Key Points:**

**Technical Requirements:**

* **Programming Language: Python**
* **Computer Vision Library: OpenCV**
* **Hand Tracking: MediaPipe**
* **AI Model for Natural Language Processing: Palm’s text-bison-001**
* **Hardware: Webcam (for real-time video capture)**
* **Frontend: Streamlit or Flask (for UI display)**

**Functional Requirements:**

* **Real-time hand tracking and gesture recognition.**
* **Mapping of gestures to predefined commands.**
* **Integration with NLP for command interpretation.**
* **Visual feedback on detected gestures.**

**Constraints & Challenges:**

* **Ensuring high accuracy in different lighting conditions.**
* **Reducing latency for real-time responsiveness.**
* **Handling multiple hand gestures simultaneously.**

**Phase-3: Project Design**

**Objective:**

**Design the system architecture and user interaction flow.**

**Key Points:**

**System Architecture:**

1. **Webcam captures real-time hand gestures.**
2. **OpenCV processes the video frames.**
3. **MediaPipe detects and tracks hand movements.**
4. **Recognized gestures are mapped to predefined commands.**
5. **Palm’s text-bison-001 translates gestures into natural language actions.**
6. **Output is displayed or executed in the UI.**

**User Flow:**

1. **User makes a hand gesture in front of the camera.**
2. **The system recognizes the gesture and maps it to a command.**
3. **The command is interpreted using Palm’s text-bison-001.**
4. **The result is displayed on the UI or executed in the application.**

**UI/UX Considerations:**

* **Simple interface with gesture feedback.**
* **Visual indicators for detected gestures.**
* **Option to customize gestures for specific commands.**

**Phase-4: Project Planning (Agile Methodologies)**

**Objective:**

**Break down development tasks for efficient completion.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sprint** | **Task** | **Priority** | **Duration** | **Deadline** | **Assigned To** | **Dependencies** | **Expected Outcome** |
| Sprint 1 | **Environment Setup & Library Installation** | 🔴 High | 6 hours (Day 1) | End of Day 1 | Harsha Sai | **Python, OpenCV, MediaPipe, Palm API** | **Working development environment** |
| Sprint 1 | **Hand Tracking Implementation** | 🔴 High | 4 hours (Day 1) | End of Day 1 | Hemanth | **OpenCV setup** | **Gesture detection in real time** |
| Sprint 2 | **Gesture Recognition Mapping** | 🔴 High | 5 hours (Day 2) | Mid-Day 2 | Snehith | **Hand tracking working** | **Mapping gestures to commands** |
| Sprint 2 | **NLP Integration** | 🔴 High | 4 hours (Day 2) | Mid-Day 2 | Manish | **Palm’s text-bison-001 API** | **Natural language command interpretation** |
| Sprint 3 | **UI Development & Feedback Display** | 🟡 Medium | 3 hours (Day 2) | **End of Day 2** | Sai Ram | **Processed commands** | **Visual feedback for gestures** |
| Sprint 3 | **Testing & Optimization** | 🟡 Medium | 3 hour (Day 2) | End of Day 2 | Entire Team | **Complete system** | **Smooth, responsive interaction** |

**Phase-5: Project Development**

**Objective:**

**Implement core features of the gesture-based interaction system.**

**Key Points:**

**Technology Stack Used:**

* **Frontend: Streamlit/Flask**
* **Backend: Python with OpenCV, MediaPipe, Palm API**

**Development Process:**

1. **Implement real-time hand tracking.**
2. **Develop gesture recognition and mapping.**
3. **Integrate NLP for command translation.**
4. **Optimize the model for performance.**

**Challenges & Fixes:**

* **Challenge: Variability in hand shapes and lighting.** 
  + **Fix: Implement adaptive brightness correction.**
* **Challenge: Latency in command processing.** 
  + **Fix: Optimize image preprocessing and reduce model complexity.**

**Phase-6: Functional & Performance Testing**

**Objective:**

**Ensure the system functions correctly and efficiently.**

| **Test Case ID** | **Category** | **Test Scenario** | **Expected Outcome** | **Status** | **Tester** |
| --- | --- | --- | --- | --- | --- |
| **TC-001** | **Functional** | **Perform basic hand gesture** | **Gesture recognized** | **✅ Passed** | **Tester 1** |
| **TC-002** | **Functional** | **Perform complex hand gesture** | **Correct command executed** | **✅ Passed** | **Tester 2** |
| **TC-003** | **Performance** | **Response time under 500ms** | **Fast response** | **⚠ Needs Optimization** | **Tester 3** |
| **TC-004** | **Bug Fix** | **Fix inaccurate gesture mapping** | **Accurate recognition** | **✅ Fixed** | **Developer** |
| **TC-005** | **UI Testing** | **Display correct feedback** | **UI updates correctly** | **✅ Passed** | **Tester 4** |

**Final Submission**

* **Project Report: Based on the templates.**
* **Demo Video: 3-5 Minutes.**
* **GitHub Repository: Source code and documentation.**
* **Final Presentation: To demonstrate working prototype.**