Automatic Seat Adjustment using Face Recognition

- H.M.I.S. HERATH - E/20/135
- H.M.R.D. HERATH - E/20/140
- L.D.N.S. KARUNARATHNE - E/20/190
- M.V.J. JAYASANKA - E/20/167

1. Motivation

In modern vehicles, adjusting the driver's seat manually can be a repetitive and uncomfortable task, especially for the elderly, differently abled, or overweight individuals. Drivers often spend precious time realigning their seats according to their comfort and body type. This not only causes inconvenience but also delays departure and can create ergonomic issues over long-term usage. With the rising focus on smart automation and personalization in automobiles, our motivation stems from designing an intelligent system that recognizes the driver’s face and automatically adjusts the seat based on pre-stored preferences—minimizing effort, saving time, and enhancing comfort and driving safety.

2. Overview

2.1 Significance of the Project

This project bridges the gap between driver personalization and intelligent automation. It introduces a smart, touchless system that improves driver ergonomics, reduces manual intervention, and aligns with current trends in AI-integrated smart cars. It has a practical use case in daily life, especially beneficial to carpool drivers, family-shared vehicles, and mobility-impaired individuals. Academically, it combines key learnings from machine learning, image processing, and embedded systems, making it a multidisciplinary project with real-world value. If successful, this solution could be integrated into commercial vehicles or aftermarket car systems.

2.2 Description of the Project

The system uses face recognition to identify the driver and adjusts the seat automatically by controlling motors that regulate seat distance, height, and recline angle. Once the driver's face is matched with a database profile, the system retrieves the corresponding seat settings and sends commands to a microcontroller interfaced with motor actuators. The scope involves:

- Real-time face detection and recognition
- Profile management system for multiple drivers
- Microcontroller-based seat control system
- Data storage for predefined seat positions
- Safety override mechanisms

2.3 Background of the Project

Research in facial recognition for user-specific adjustments is gaining traction. Automotive giants like Tesla and BMW are experimenting with personalization features. Face detection algorithms such as Haar Cascades and DNNs are already used in various industries. Intelligent driver recognition can drastically reduce the chance of ergonomic injuries and increase comfort. Existing car memory seat systems use manual buttons; however, they lack automatic identification.

---

3. Methodology

3.1 Design Phase

The solution is designed using the ESP32/ Raspberry Pi as the main processing and control unit, capable of handling both facial recognition and motor control. A camera module interfaced with the ESP32 captures the driver's face, and facial recognition is performed using OpenCV or MediaPipe. Once the driver is identified, the system fetches their pre-saved seat profile (position, height, and recline angle), and adjusts the seat using motors controlled by the ESP32/ Raspberry Pi
This compact architecture will be cost-effective, power-efficient, and suitable for embedded automotive applications.

3.2 Implementation Phase

- Facial dataset collection for registered users
- Face recognition model training and validation
- Development of user interface for registration
- Motor calibration for seat control
- Integration of face recognition with seat motor system
- Safety interlock to ensure seat adjustment only occurs while the car is stationary

3.3 Testing Phase

Due to limited access to actual car seats and motors, testing will be done on a prototype model of seat mechanisms. Each seat parameter (height, distance, tilt) will be tested individually and in sequence after face recognition. Accuracy, latency, and misidentification scenarios will be tested using datasets with varied lighting and angles.

3.4 Evaluation Phase

Performance metrics include:

- Recognition accuracy
- Time to complete adjustment cycle
- User satisfaction (via surveys)
- Comparison with manual adjustment time
- Evaluation via real-time simulation and demo hardware

---

4. Features

- Automatic Driver Identification via face recognition
- Personalized Seat Adjustments based on driver profile
- Multi-user Support with profile management
- Touchless Operation — hygienic and accessible
- Safety Lock Mechanism to avoid adjustment while driving
- Cost-effective Prototype for research and further development
- Can be extended to adjust mirrors, steering wheel, or A/C based on profile

---

5. Project Planning

Table 1: Project Planning

Phase	Duration	Activities
Requirement Analysis	Week 1	Literature review, project scoping
Design Phase	Weeks 2–3	System architecture, dataset planning, motor selection
Implementation Phase	Weeks 4–6	Facial recognition, microcontroller coding, interfacing
Testing & Evaluation	Weeks 7–8	Prototype testing, result analysis, modifications
Finalization & Reporting	Week 9	Final documentation, proposal updates

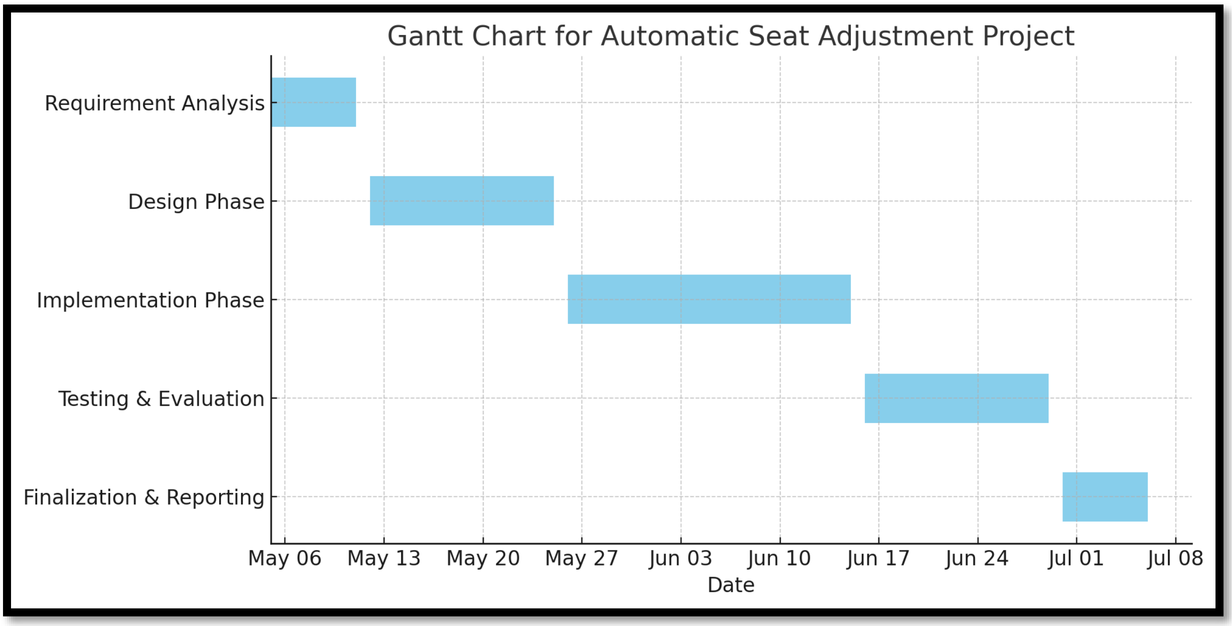

Figure 1: Gantt Chart

6. Hardware and Software Requirements

Hardware

- Raspberry Pi or ESP32
- Camera module
- Driving seat
- Motors (3x)
- LCD Display
- Breadboard, jumper wires, power supply

Software

- Python
- Vs Code
- Arduino IDE

---

7. Diagrammatic Representation

Camera → Face Recognition Module → Profile Database → Motor Control Unit → Seat Mechanism (height, distance, recline)

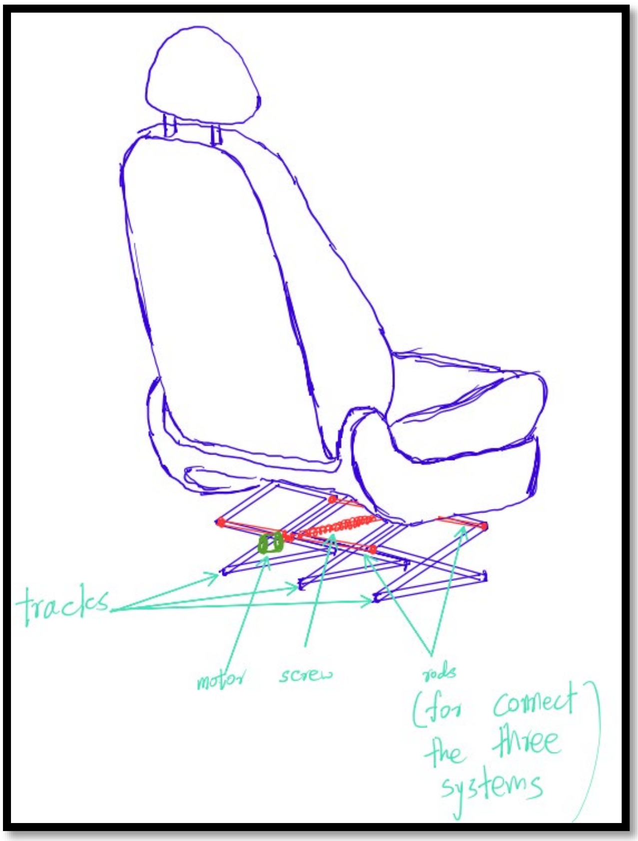

Figure 2: Mechanism For the Vertical Linear Motion

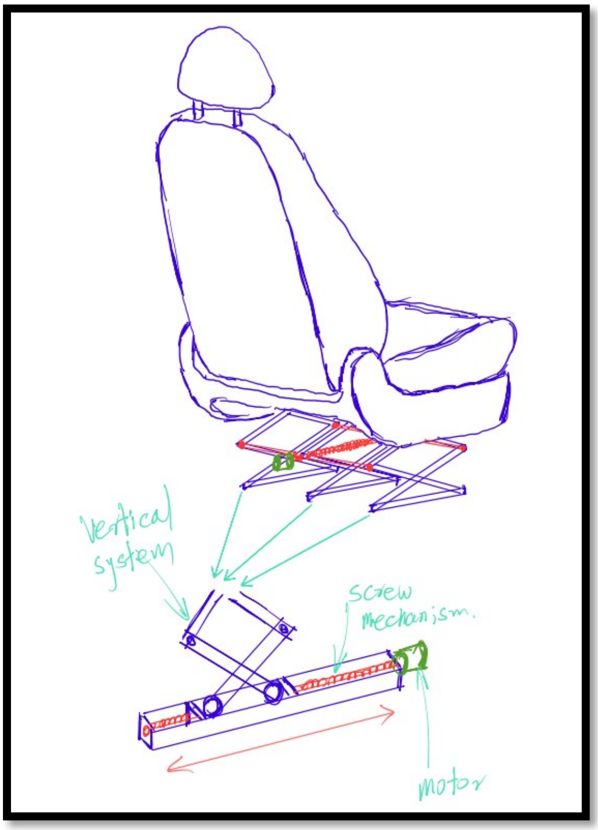

Figure 3: Mechanism For the Horizontal Linear Motion

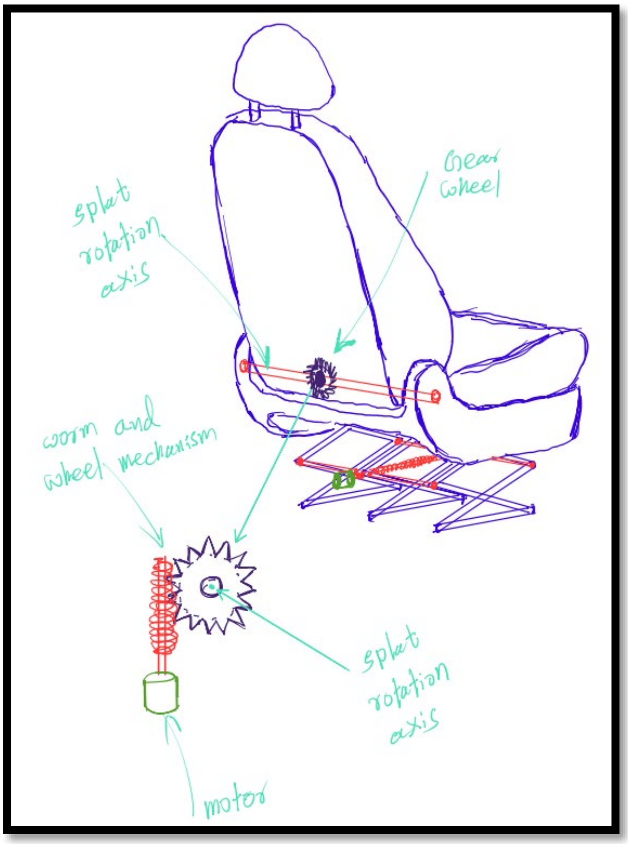

Figure 4: Splat Rotation Mechanism

8. References

[1] OpenCV Documentation, https://docs.opencv.org/
[2] MediaPipe Face Detection, Google Developers, https://google.github.io/mediapipe/
[3] Vamsi, M., Soman, K. P., & Guruvayurappan, K. (2020, February). Automatic seat adjustment using face recognition. In 2020 International Conference on Inventive Computation Technologies (ICICT) (pp. 449-453). IEEE.