

SHELL ECO-MARATHON 2022

PITCH THE FUTURE

Smart Car Seat : Boost Passenger Comfort

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INTRODUCTION

Autonomous Vehicle is one of the recent breakthroughs in the automotive industry. In an Autonomous Vehicle, passengers can simply enjoy the ride without having to control the vehicle, creating easier mobility. However, Autonomous Vehicle technology is still focusing on safe navigation and has not considered the ergonomic aspect and the comfort for the passenger, where these two aspects can improve the experience of using Autonomous Vehicles to be more seamless.

In 2016, around 30.8 million days of work were lost to musculoskeletal problems, according to government figures [1]. This is caused by sitting for long periods, sitting in the wrong position, and a poor posture. In addition, this can lead to the risk of back pain, cramps, stiffness, and spinal problems. This risk can increase if you sit in the car more than 20 hours per week.

Other than the uncomfortable sitting position, a less-than-optimal body temperature will also cause discomfort while in the vehicle. The most common thing that happens from the AC circulation is that the AC could not reach the back of the passenger's body even though the AC setting is quite cold. However, if the AC is set too cold, it will dry out the passenger's skin and eyes, causing excessive fatigue [2]. Therefore, just using an air conditioner is not enough to maintain the optimal temperature in the car.

Sleep is a critical component of healthy development and overall health. Lack of sleep can affect overall health and lead to severe medical conditions, such as obesity, heart disease, high blood pressure (hypertension), and diabetes [3]. The most common contributor to sleep deprivation is work obligations. Moreover, people tend to get stuck in traffic jams while going to work. For example, people in Jakarta spend an average of 68 minutes in traffic per day [4]. The time people spend in traffic can be used for resting or sleeping if the car is comfortable enough.



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Based on all the problems above, a smart car seat is needed to solve all these problems related to the ergonomic aspect and comfort for the passenger. Therefore, it can improve the user experience in using Autonomous Vehicles to be more seamless.

SMART CAR SEAT

A car seat plays an essential role in determining a person's comfort while driving. Therefore, a Smart Car Seat is needed to create an ideal driving experience. The machine learning technology in this Smart Car Seat is aided by sensors placed around the seat. These sensors support the Smart Car Seat's functionalities, allowing them to work automatically and providing passengers with a more seamless experience while driving an autonomous vehicle. These features are:

- Human Pose Recognition

The posture feature uses the camera sensor to identify the user's pose and body form, allowing the seat position to adjust to the user's needs. In this seat, a pressure transducer is also employed to calculate the ideal pressure for the user to feel comfortable in various postures. When a pressure transducer is used, the seat will automatically adjust until the sensor detects the amount of pressure is fit for the passenger. This feature allows seat to be adjust to a variety of positions, including seat side (moving the seat back and forth to create an appropriate angle between the thighs and calves), reclining (moving the backrest front and back to create an optimal angle between the back and thighs), seat lifter or rear vertical (changing the overall height of the seat to generate an appropriate angle between the thigh and tailbone) and front upright (adjusting the front seat height to form an optimal angle between the thigh and tailbone).

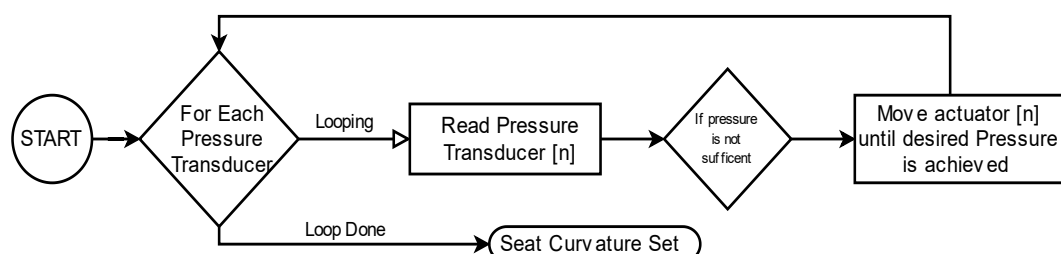


Fig. 1. Seat Curvature by Pressure Transducer Block Diagram

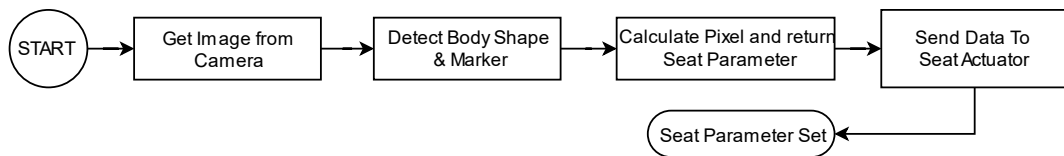


Fig. 2. Block Diagram of Seat Parameter Using Body Shape Detection from Camera

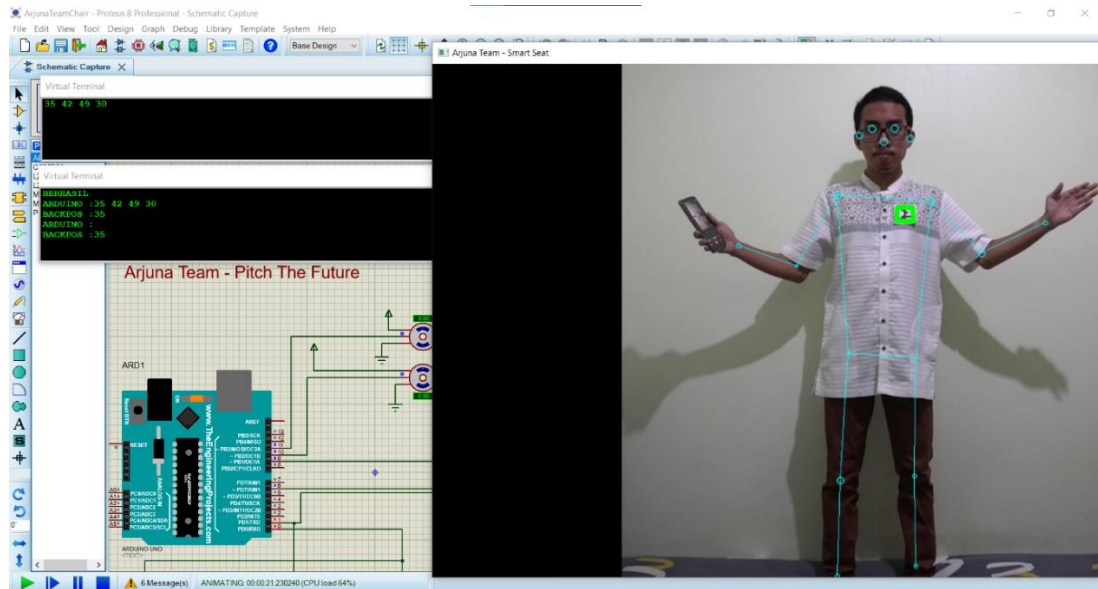


Fig. 3. Simulation Using Camera and Proteus

The system to detect seat curvature uses two primary sensors: the camera and the pressure transducer. The camera is used with an image recognition algorithm to detect basic human features such as shoulder, wrist, knee, and ankle. The algorithm then uses these relative positions of human features on an image to calculate the actual size by comparing it with the custom-made marker positioned near the user. This parameter is used for seat size configuration. Then, the pressure transducer is used to detect the curvature of the user by detecting pressure in each strategically placed sensor so that we can deduct how fit the seat is to the user. If the detected pressure value is not suitable, the actuator in the seat is moved so that the position is suitable and comfortable as standard.

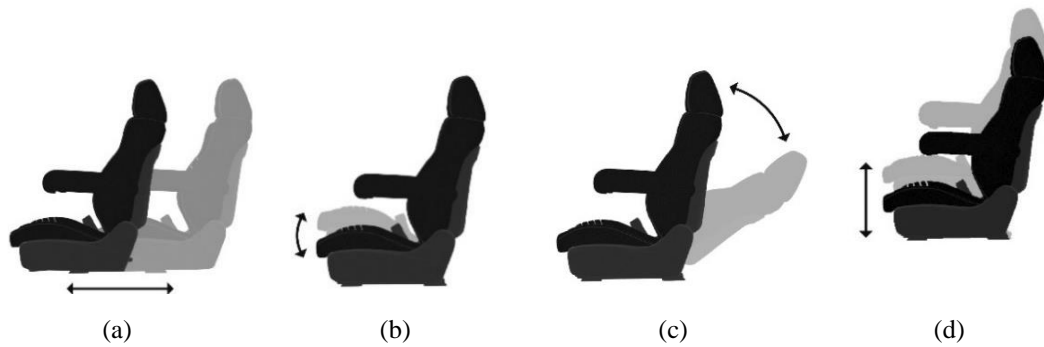


Fig. 4. Seat Position Adjustment. (a) Seat Side (b) Front Upright (c) Reclining (d) Seat Lifter.

- Drowsiness Detection

Smart Car Seat has a drowsiness detection feature that uses a camera sensor to identify tiredness based on the user's facial expression. When the sensor detects that the user is tired, the seat adjusts to a more comfortable resting position.

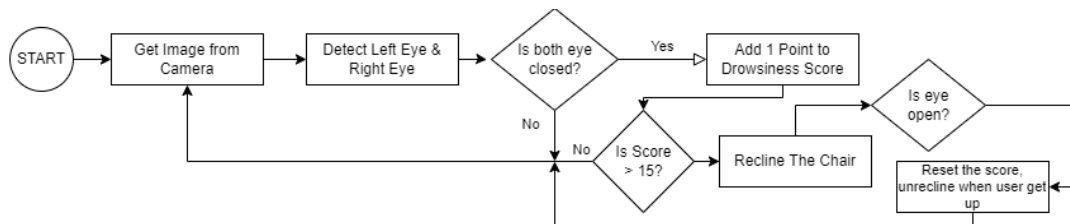


Fig. 5. Drowsiness Detection Block Diagram

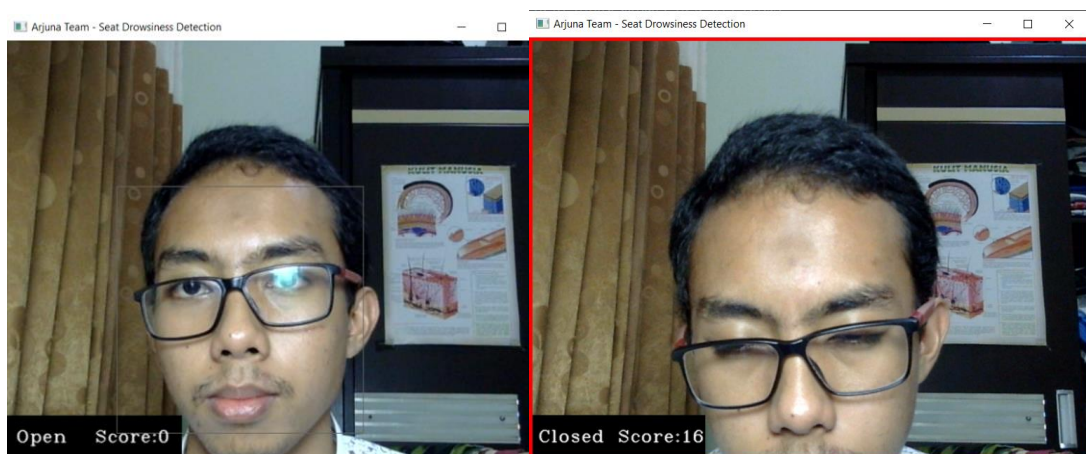


Fig. 6. Drowsiness Detection Using Camera when Wide Awake (left) and Drowsy (right)

The system to detect drowsiness uses the camera as input. The right and left eyes of the person on the camera are then detected using an image recognition algorithm. The Haar Cascade Classifier algorithm then classifies the detected eyes into closed or open

categories. If both eyes are closed, one point is added to the Drowsiness Score. The Drowsiness Score is used to count how many frames that detect closed eyes in succession. If the Drowsiness Score is greater than 15, the actuator in the seat then will move so that the chair is reclined. If both eyes are open, the Drowsiness Score will be reset.

- **Seat Temperature Control**

The seat temperature control is a feature that keeps the body of the Smart Car Seat's user at a comfortable temperature. This function makes use of a temperature sensor to monitor the temperature of every portion of the user's body in direct contact with the seat. Furthermore, this feature also uses an automated heating/cooling element that keeps the body part at its ideal temperature at all times.

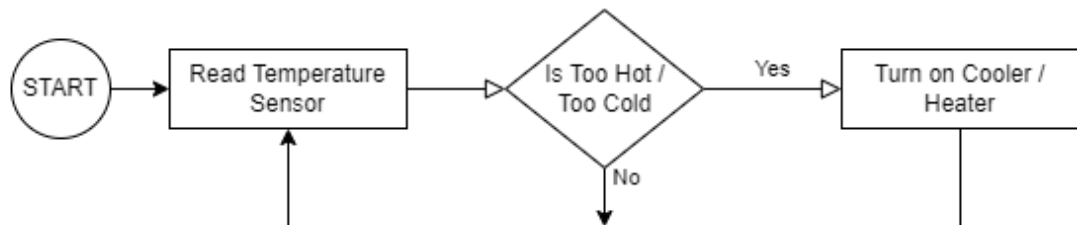


Fig 7. Seat Temperature Control Block Diagram

The seat can also detect body temperature in a strategically placed temperature sensor. By probing each of the temperature sensor, we can get an accurate reading of body temperature and using it to set the chair temperature conditioning system to a suitable value.

All of the repository for Smart Car Seat is in the link below: https://github.com/hnsImp/UISMV_PitchTheFuture2022. The Repository also contain links to the demo video.

SEAT'S MATERIAL

The design of this seat also needs to be eco-friendly from the consideration of low carbon emissions. This seat is made from recycled materials to help reduce greenhouse gas emissions by reducing energy consumption. Manufacturing from recycled materials requires less energy than making products from virgin materials. The less energy used to produce, the fewer

greenhouse gases are emitted [5]. More recycling means less extraction; this also means less pollution. For this reason, the frame of the seat is made from recycled aluminum. Recycled aluminum uses approximately 90% less energy than mining for pure aluminum [6].

This emission problem also applies to the upholstery of the car seats. Some cars, mostly the luxury ones, reportedly still use animal-based materials like leather for upholstery and car interiors. While such materials are of high quality, they were also quite damaging to the environment. According to the United Nations' Food and Agriculture Organisation (FAO), animal agriculture is responsible for 14.5% of global greenhouse gas emissions [7]. Therefore it would be better to avoid using animal-based materials with alternatives such as vinyl or other recycled materials.

Furthermore, the seat foam is also made from recycled plants. Using a more environmentally friendly foam cushion will help reduce the use of petroleum. The less non-renewable resources used like petroleum, the better off our planet will be. Two excellent alternatives for synthetic latex foam are 100% natural latex and soy-based foam [8].

SEAT'S POWER SOURCE

For the seat to be fully operated, it needs extra energy that could increase the vehicle's electricity consumption. To solve that problem, the seat will be powered using solar panels installed on the car roof to convert the solar energy into electricity. Solar panels are the most effective, sustainable and environmentally friendly power generation system in the world today. Compared to pure electric cars, the mileage of the solar-powered car is much further, and it may reach a level of zero carbon emission [9]. Modern solar panels are very efficient, with many capable of turning more than 60 percent of the sun's power into electricity [10].

CONCLUSION

Smart Car Seat is an advanced car seat that could solve the ergonomic problems and provide comfort for its user. Smart Car Seat has three excellent features that are Human Pose Recognition, Drowsiness Detection, and Seat Temperature Control, which works automatically by using sensors around the seat. The sensors transmit data to the Machine Learning to be processed; thus, the Smart Car Seat can adjust to fulfill the user's needs. Therefore, the Smart Car Seat can give a more seamless experience for the Autonomous Vehicle user.

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