



TEAM DERP'S MONOTRONIC

*“SAFETY WITH COMFORT,
ANYWHERE AND EVERYWHERE”*

PROBLEM STATEMENT

Imagine enhancements to the vehicle Infrastructure to address safety and convenience needs of the passengers in the car. In order to cater to these needs, what are the solutions that can be added/modified to the car.

- A way to find out the oxygen content and temperature present inside the car to take right precautions.

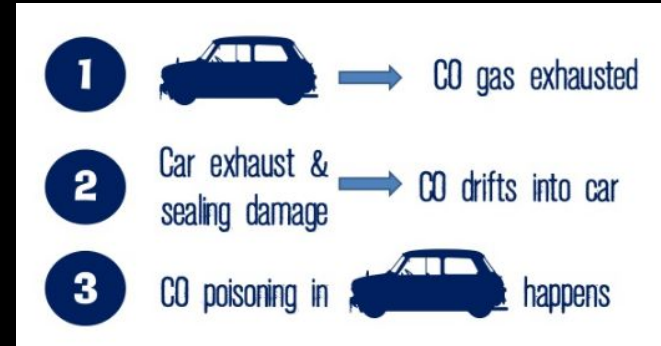


TARGET ISSUES

SUFFOCATION IN CAR



- Exhaust fumes contain CO & CO₂ which can enter the car.
- Exposure to high content of CO can cause headache, nausea, dizziness etc and prolonged exposure can cause death.
- People exhale CO₂ and accumulation of it can lead to suffocation due to oxygen deprivation.



Sleeping in the cool comfort of your car can kill you

Experts say that in less than an hour one can die of carbon monoxide poisoning



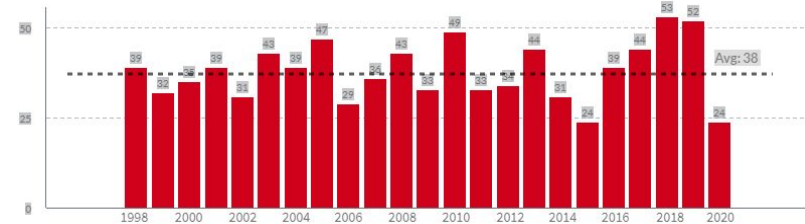
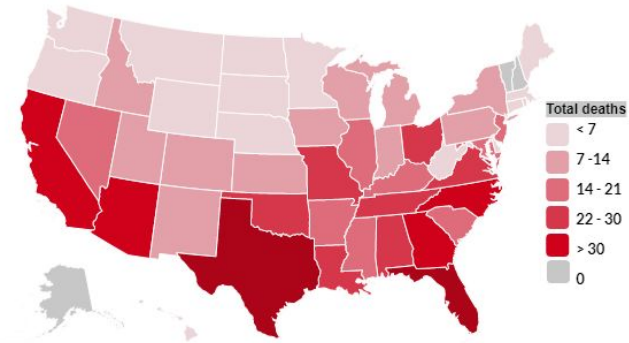
Sleeping in your car with the AC on and the engine running could be deadly. Picture for illustrative purposes only.

HEATSTROKE IN CAR

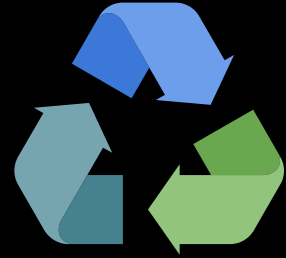


- Temperature inside a car can rise up by 20°F in 10 minutes due to greenhouse effect even when car has been parked in shade with windows down.
- Between 1998 and August 2019, **849 children have died** from vehicular heatstroke, and many more have been put in a life-threatening state in USA.
- In less extreme cases, shopping items and electronics kept in car can get damaged/spoiled due to the rise in temperature inside cabin.

Child heatstroke deaths in vehicles, United States, 1998 - current

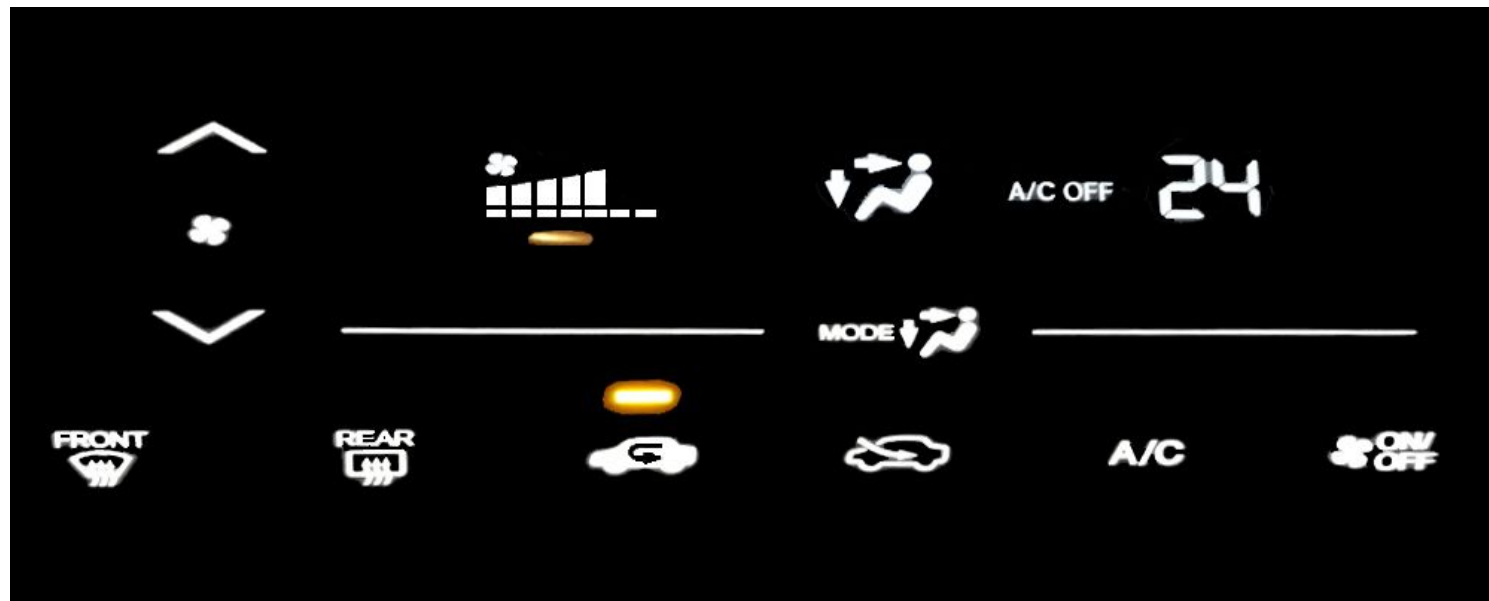


[source for image](#)



EXISTING
TECHNOLOGY

AUTOMATIC CLIMATE CONTROL

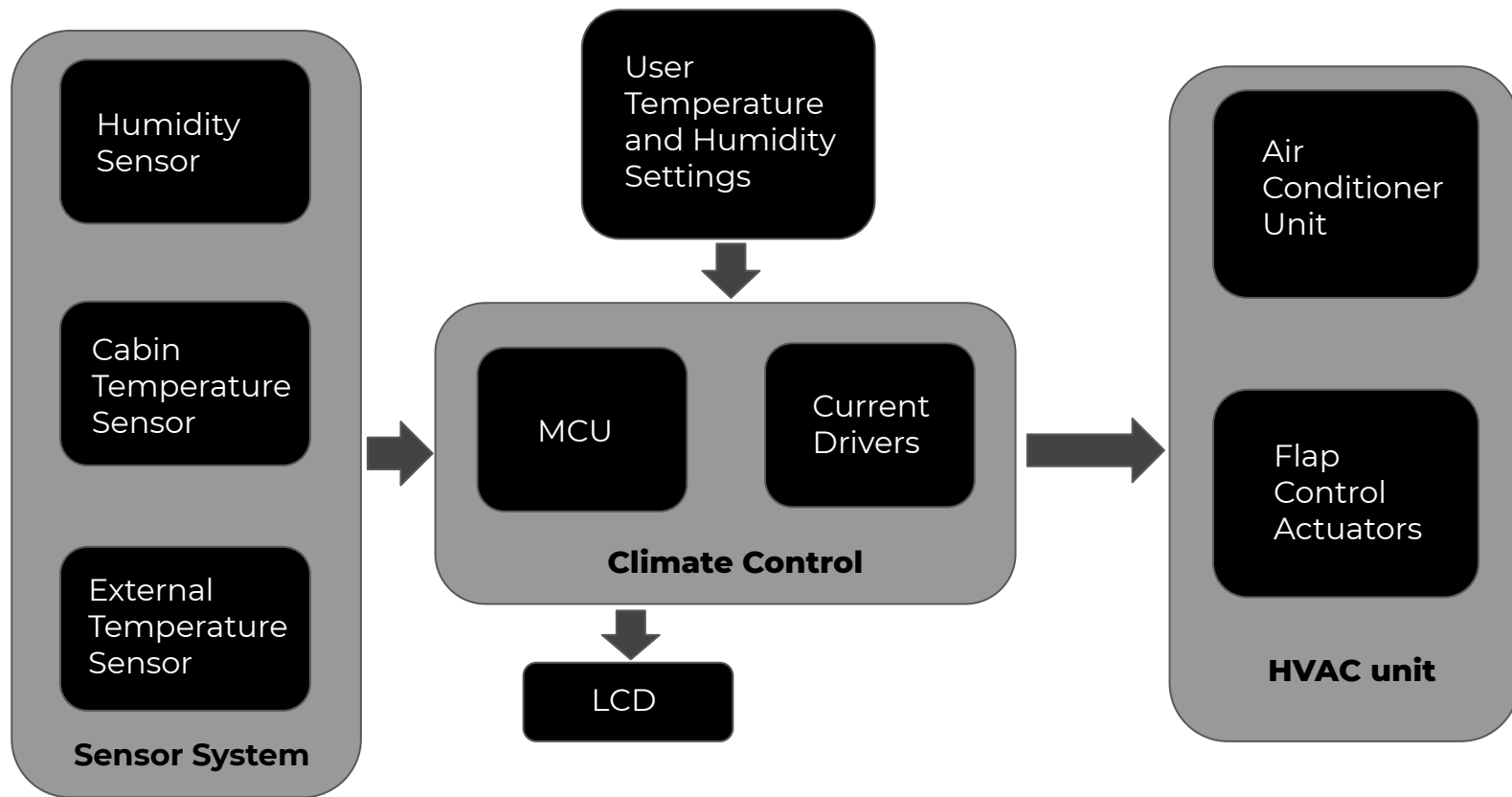


Automatic Climate Control is designed to automatically adjust the vehicle's climate system to heat or cool the vehicle to the temperature set by owner.

This eliminates the human effort to regulate the cabin temperature by switching on/off the AC or by sliding warmer or cooler control.

This system provides the user with the desired comfort they need for their ride with minimal to no effort by user.





Automatic Climate Control System

One of the major issues with most automatic climate control system found in commercial cars is that it does not incorporate the detection of toxicity in the cabin air to take necessary actions.

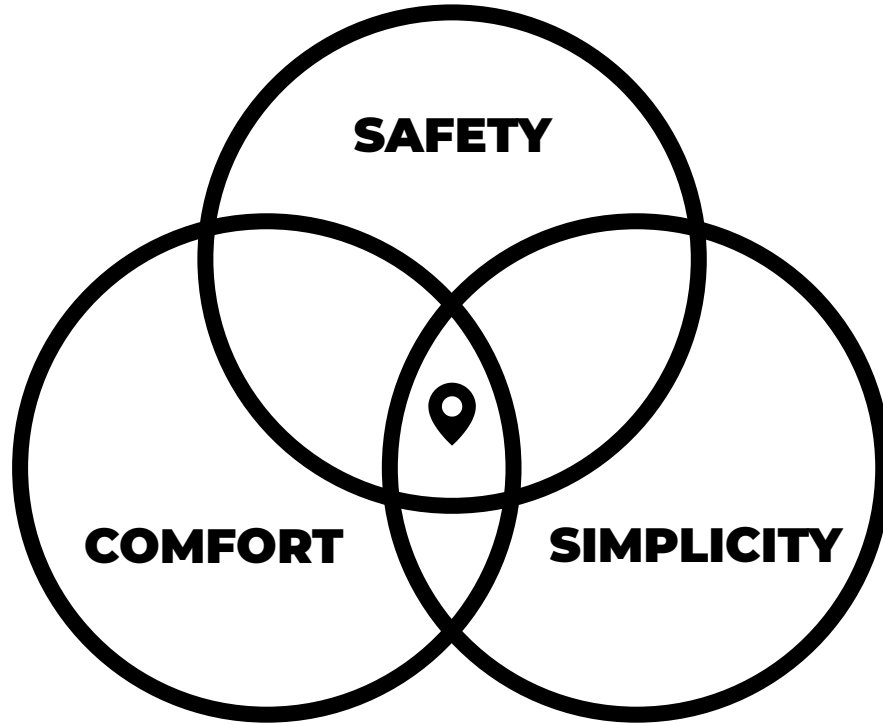
People generally prefer setting AC to recirculation mode which hastens the process of cooling/warming the cabin air with less burden on engine.

Unregulated recirculation can increase toxicity inside cabin and suffocate passengers.

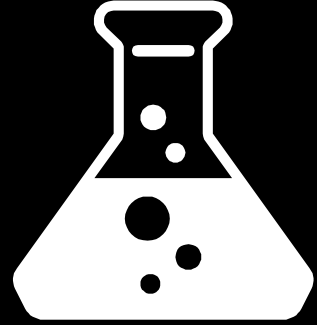




OUR APPROACH



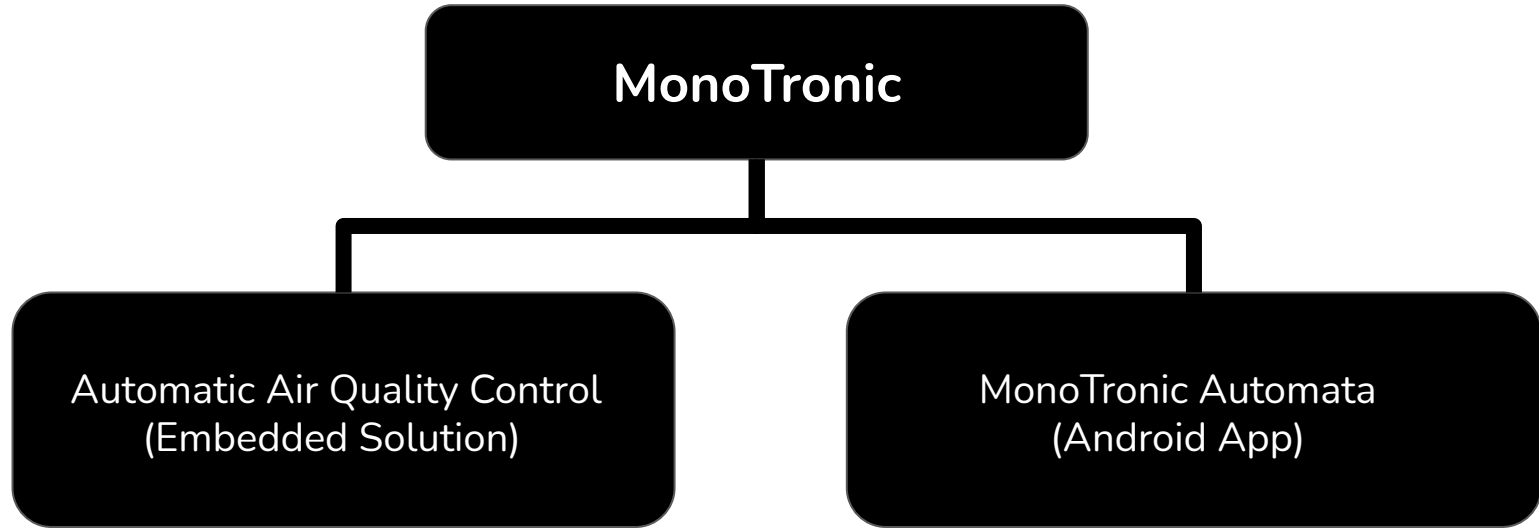
Our idea :
MonoTronic keeps in mind the **safety** of the passengers while they enjoy the optimum **comfort** provided by automatic climate control system and provides them with a **simple** to use android app.



OUR SOLUTION

Our solution comprises of essentially two components:-

- An embedded solution
- An android app





**AUTOMATIC
AIR QUALITY
CONTROL**

**MONOTRONIC
AUTOMATA**

Automatic climate control systems found in most commercial vehicles is capable of maintaining a desired temperature and humidity inside the car by controlling the Heating, ventilation, and air conditioning (HVAC) system of the car.

Our solution aims to exploit the HVAC of the car and expand existing automatic climate control technology by adding an automatic air quality control system which will attempt to maintain a safe concentration of gases like carbon monoxide and carbon dioxide inside the car cabin.

Sensors to measure CO and CO₂ concentration inside and outside car cabin are used and the control unit (MCU) will control the modes of car AC to maintain the desired concentration.

MODES OF OPERATION OF CAR AC

Almost all modern vehicles with air conditioning unit comes with two modes of operation, even if it doesn't have an automatic climate control system.

Recirculation Mode

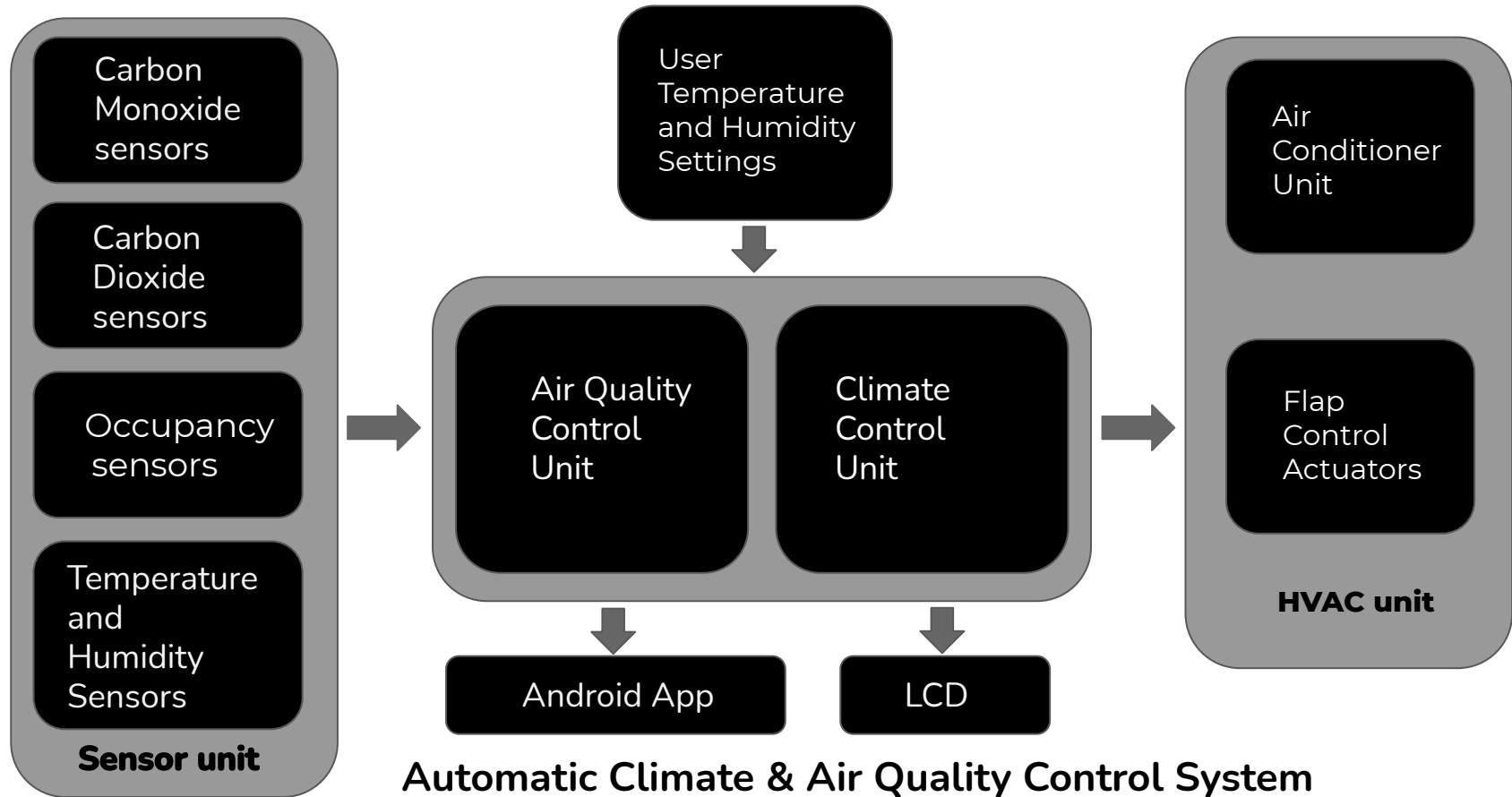
The car recirculates the same air inside the cabin to cool/warm the cabin quickly.



Fresh Air Mode

This opens the air duct present in front of car to use fresh air from outside to cool/warm the cabin





What causes Carbon Monoxide poisoning in car?

- ❖ Internal combustion gasoline engines produce extremely high carbon monoxide concentrations. Even a properly tuned gasoline engine, will produce more than 30,000 parts per million (ppm) of CO in the exhaust stream.
- ❖ Catalytic converters found in most vehicles combine oxygen with carbon monoxide to form non poisonous carbon dioxide bringing carbon monoxide emissions below 1000 ppm.
- ❖ Defective exhaust system can leak CO in high concentration before it passes through the catalytic converter or the catalytic converter might be malfunctioning.
- ❖ CO can enter the car cabin through holes in car body or open air ducts used by AC.

What can Carbon Monoxide do to us?

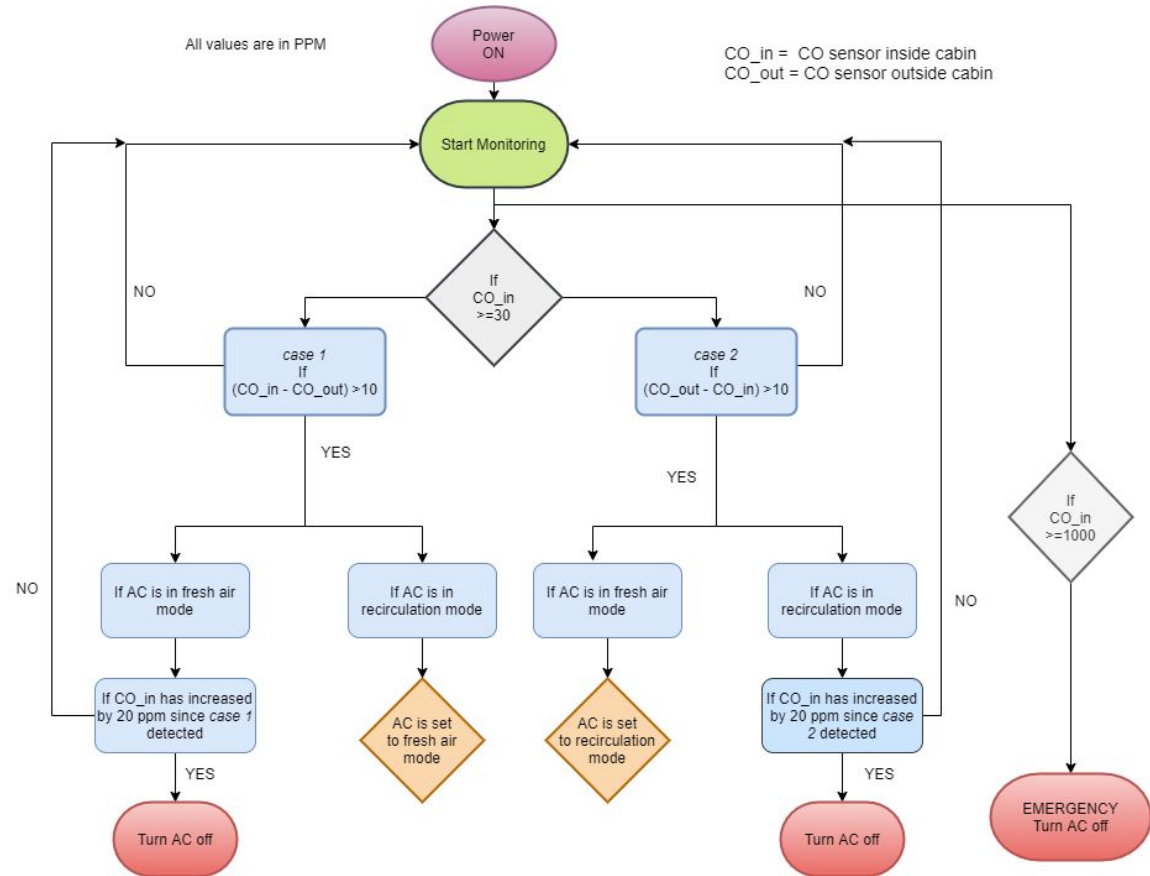
Concentration(ppm)	Effect on Health
0	No effect, fresh air
30	Symptoms on long exposure
200	Dizziness, nausea, fatigue, headache
400	Headache & nausea within 1-2 hours
1000	Lost of consciousness after 1 hour
1600	Unconsciousness, Death within 1-2 hours
6400	Death within 30 minutes
12800	Death within 1-3 minutes

How does MonoTronic protect the passengers?

- ❖ The air quality control unit i.e the MCU is programmed to control the modes of operation of AC (recirculation and fresh air) based on the concentration of CO detected by the sensors placed both inside and outside cabin.
- ❖ As gases diffuse from higher concentration to low concentration, controlling the AC duct and ventilation is a cheap and effective method to maintain a healthy concentration inside the cabin.
- ❖ The explanation of the algorithm is portrayed through a flow chart.



Operation of Carbon Monoxide monitoring and control system



Explanation with practical scenario

When the CO concentration inside cabin exceeds 30 ppm, there are two cases:

Case 1

- CO conc. inside cabin exceeds outside by the amount of 10 ppm or above.
- If AC was in recirculation mode then automatically set it to fresh air mode to flush out the higher concentration CO present inside cabin.
- If AC was in fresh air mode, chances are either AC is malfunctioning and unable to effectively clear out the cabin air or there might be a hole in the car floor letting CO from exhaust pipe leak in.
- Check if CO conc. inside cabin has increased by further 20 ppm in fresh air mode, turn AC off if it did and alarm the user (via app).

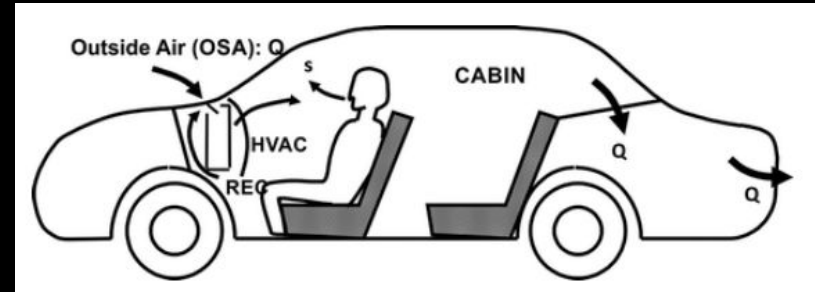
Case 2

- CO conc. outside cabin exceeds inside by 10 ppm or above.
- If AC was in fresh air mode then set it to recirculation mode to prevent further CO entering the cabin via AC air duct.
- If AC was in recirculation mode, chances are CO is leaking in from a hole in vehicle body or AC air duct is not functioning properly (not getting closed).
- If CO conc. inside cabin increases further by 20 ppm then AC is turned off and user is alarmed (via app).

If CO concentration Inside cabin exceeds 1000 ppm then it is a state of emergency, AC is turned off and instructions are provided to user via app.

How does Carbon Dioxide enter car cabin?

- Just like carbon monoxide, exhaust fumes contain carbon dioxide.
- Carbon dioxide is also naturally present in atmosphere.
- It enters car cabin through air ducts and other openings.
- Unlike CO, humans naturally produce CO₂ by exhaling which increases its concentration inside car cabin.
- On recirculation mode, CO₂ exhaled by passengers mixes with the recirculated air increasing its concentration.
- CO₂ is not toxic but increased concentrations can lead to suffocation, headache, nausea and even death.

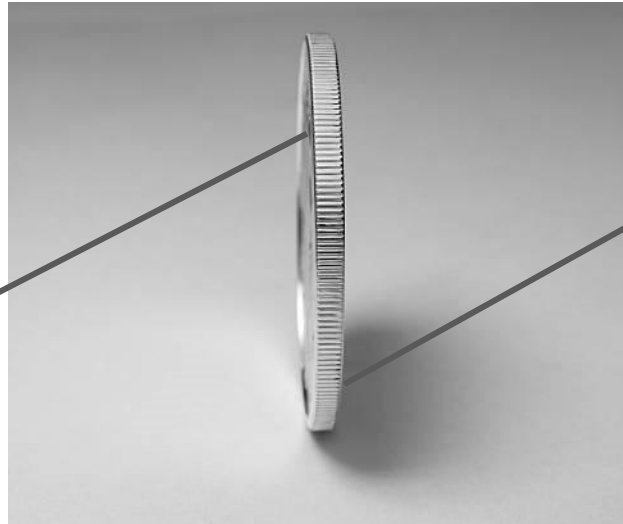


How does increased Carbon Dioxide suffocate?

In a confined space, increase in carbon dioxide indicates decrease in oxygen

The depletion rate of oxygen in the car's cabin is directly proportional the number of people seated in the car.

OXYGEN



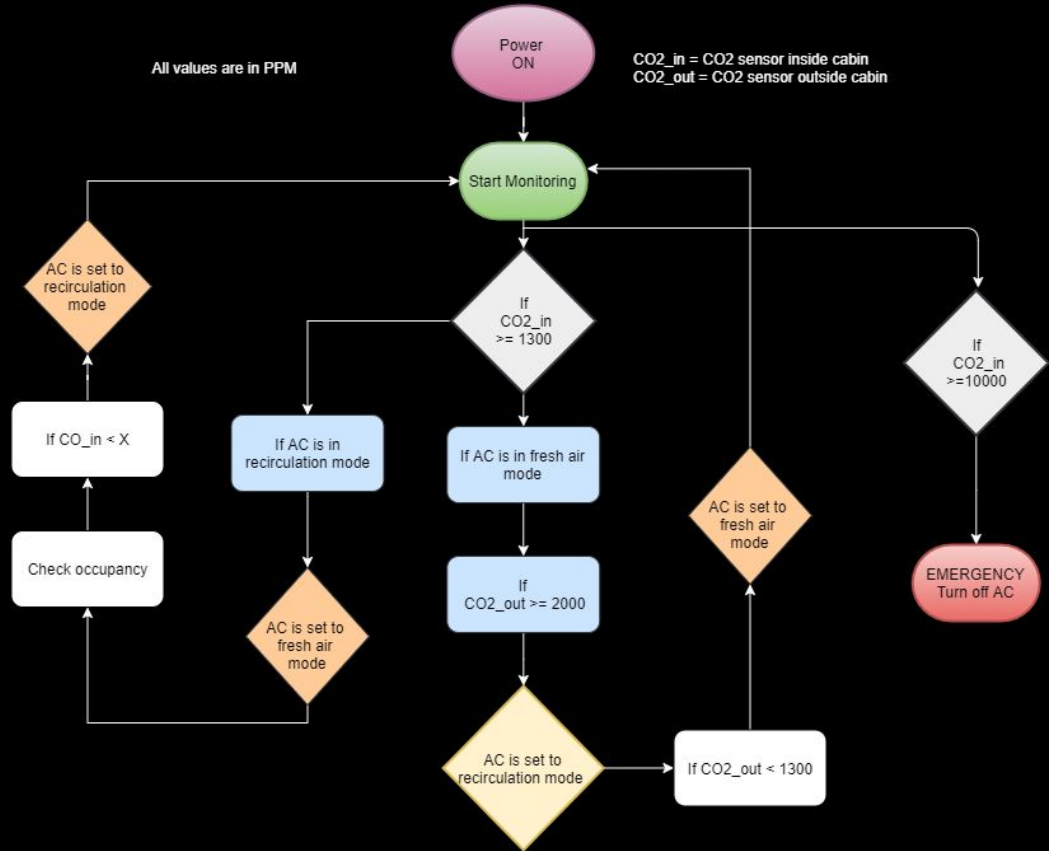
**CARBON
DIOXIDE**

The depleted oxygen is replaced by the carbon dioxide exhaled. The rate of increase depends on the number of people in a car.

O₂ and CO₂ are two sides of same coin

Operation of Carbon Dioxide monitoring and control system

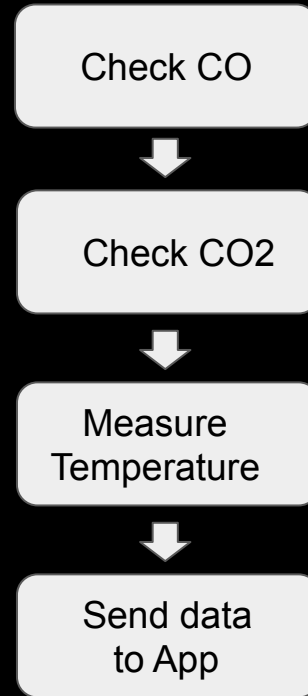
Occupancy	X
1	550
2	700
3	850
4	1000
5	1150



Explanation with practical scenario

- Just like carbon monoxide, the control unit uses the modes of operation of car AC to maintain the carbon dioxide concentration inside cabin based on the values detected by sensors present inside and outside car cabin.
- People generally prefer keeping AC on recirculation mode but that can be dangerous in long journeys if fresh air is not allowed to enter the cabin.
- When the interior CO₂ sensor detects conc. over 1300 ppm, the control unit will switch the AC to fresh air mode to refresh the air inside.
- Once the conc. goes below occupancy dependent threshold, it will switch it back to recirculation mode.
- This will make sure there is regular refreshment of air inside cabin during long journeys without hindering the passenger's comfort.
- If the AC is in fresh air mode and the car momentarily enters areas with high CO₂ conc., for example, traffic area, then the control unit will switch AC to recirculation mode till conc. of CO₂ outside car cabin reaches below 1300 ppm.
- If CO₂ conc. inside cabin crosses 10000 then AC is turned off and user is alarmed by the app to take appropriate precautions

Since CO can be more lethal at low concentration, resolving issues related to CO is prioritised over CO2 in case there is a conflict (both in dangerous levels).



**AUTOMATIC
AIR QUALITY
CONTROL**

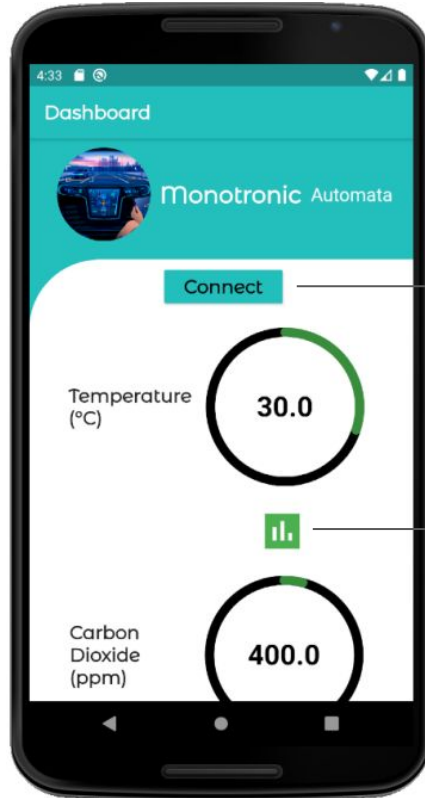


**MONOTRONIC
AUTOMATA**

Automation has its limits and its job is to reduce need of human efforts as much as possible. But when automation fails, nothing can replace the need of human efforts and awareness.

With that in mind, the android app i.e MonoTronic Automata has been designed. It provides the user with a simple to understand user interface to monitor the state of their vehicle. During danger levels of various parameters(temperature and gas concentration) detected, the app will provide users with suggestive measures to guide them to safety.

Dashboard



Connect

Temperature
(°C)

30.0



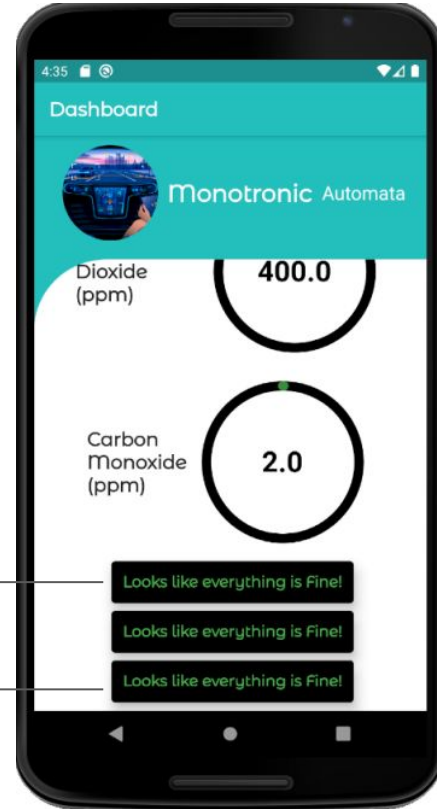
Carbon
Dioxide
(ppm)

400.0

Open Bluetooth connection page

Open temperature prediction chart

Display status



Dashboard

Monotronic Automata

Dioxide
(ppm)

400.0

Carbon
Monoxide
(ppm)

2.0

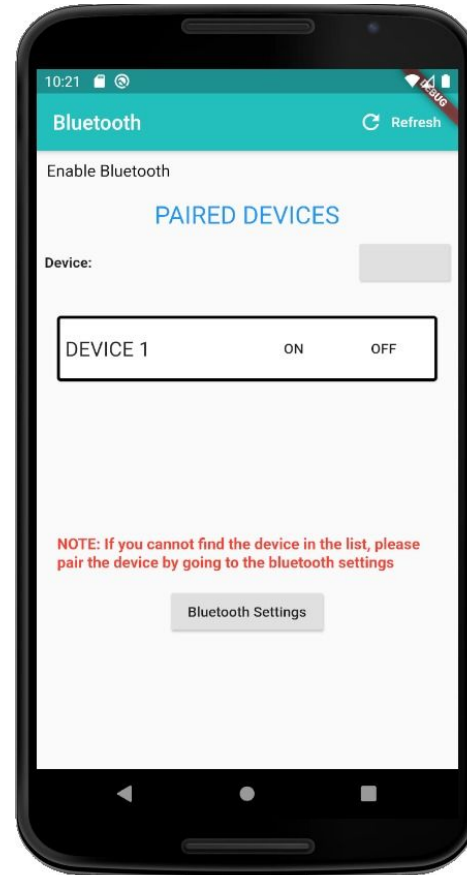
Looks like everything is Fine!

Looks like everything is Fine!

Looks like everything is Fine!

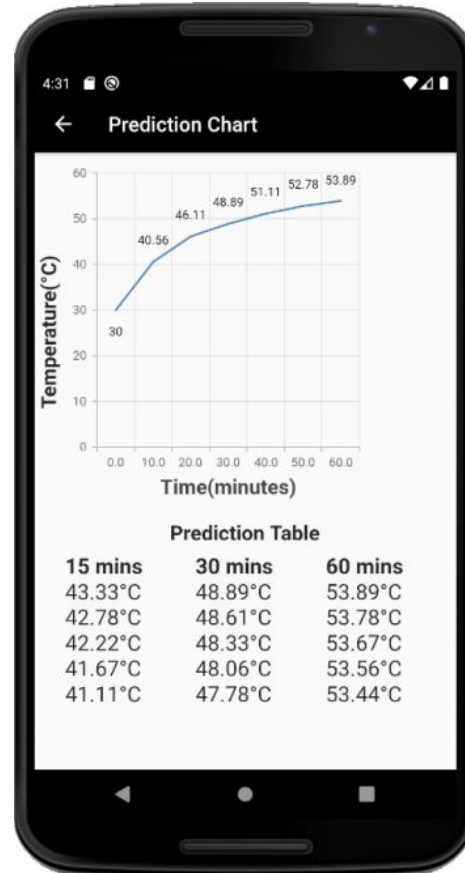
Bluetooth

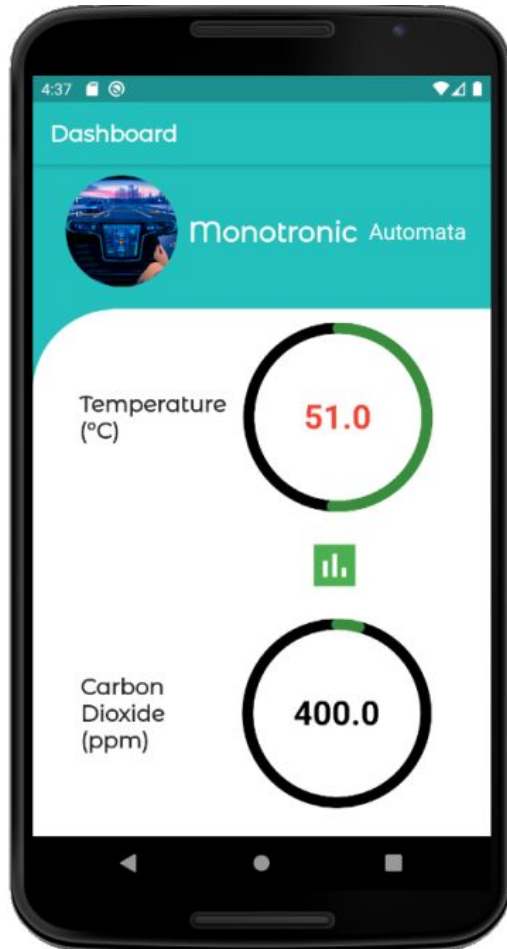
This page will be used to connect the app to the bluetooth module of the air quality control system of the car



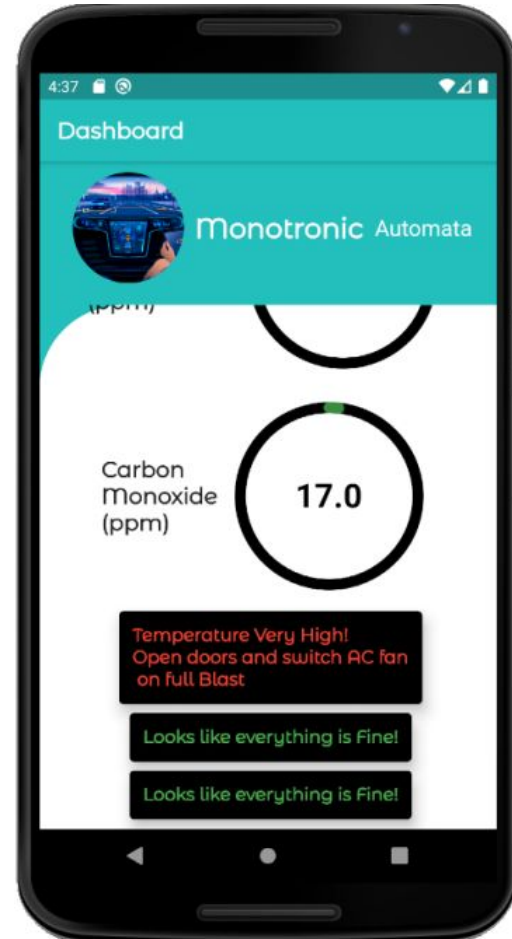
Prediction Chart

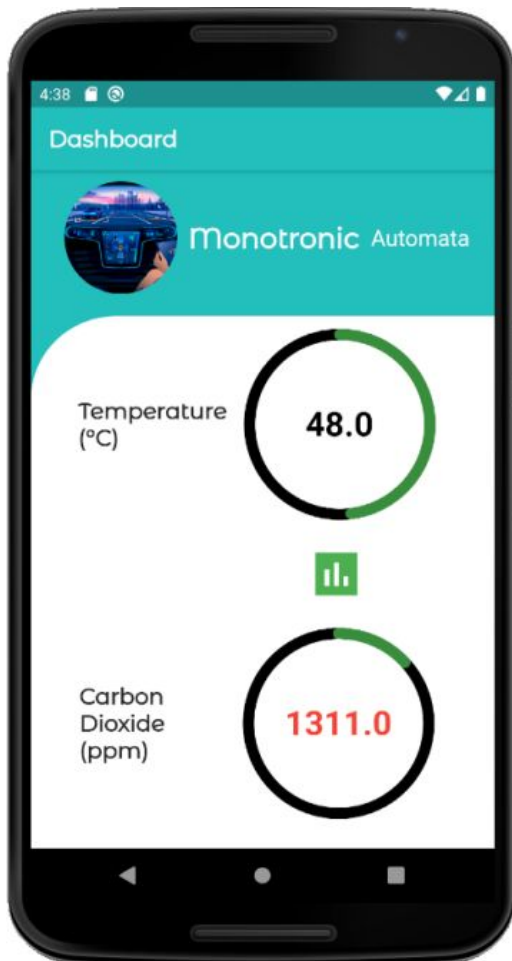
Concerning to increased cases of vehicular heatstroke, most of which being caused by unawareness of people, the temperature prediction chart provides a useful way to protect the user's health and belongings. It uses an [Inside Car Temperature Calculator](#) to estimate the interior cabin temperature upto 1 hour in future based on current interior temperature value. The predicted values may not be precise but will help the user to decide whether to park the car at a certain spot and leave their belongings inside.



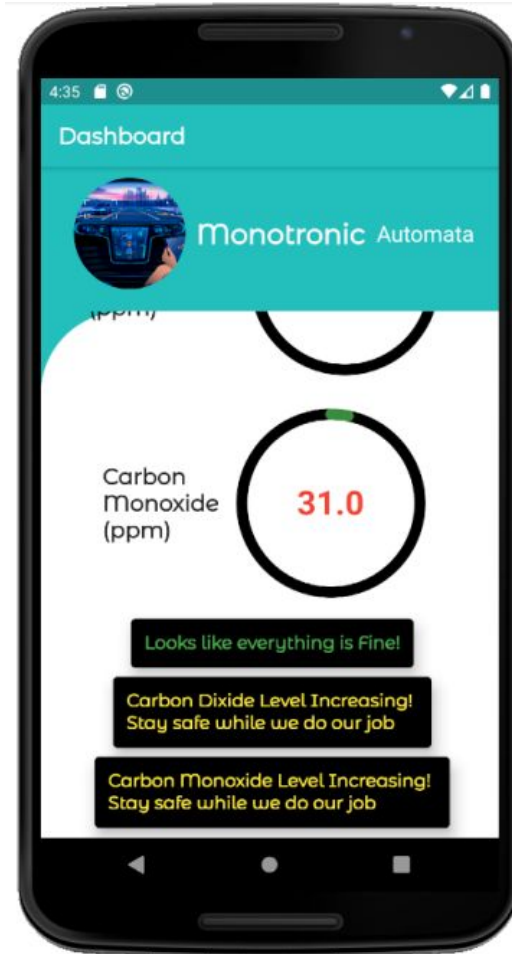


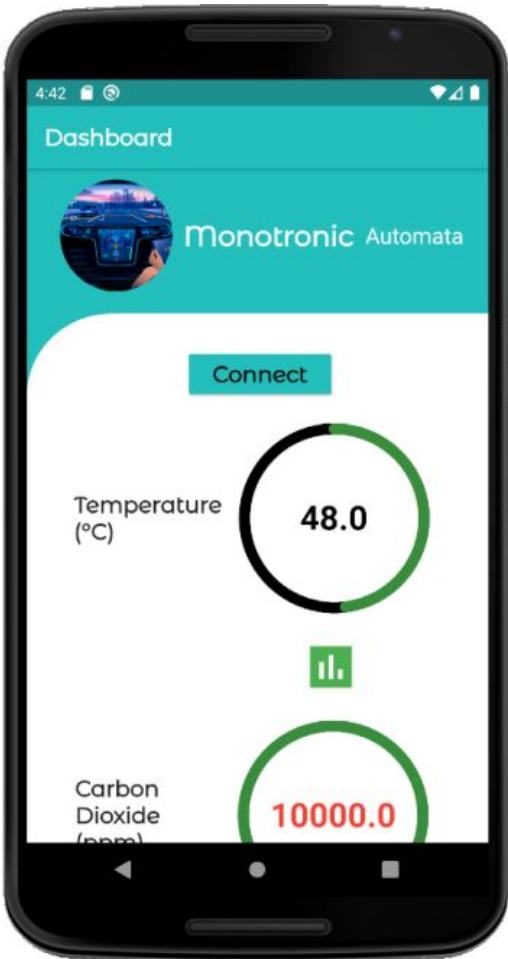
When the temperature reaches 50 and above, the status box of the app will suggest the user to open the doors and switch on the AC fan to flush the hot air out .



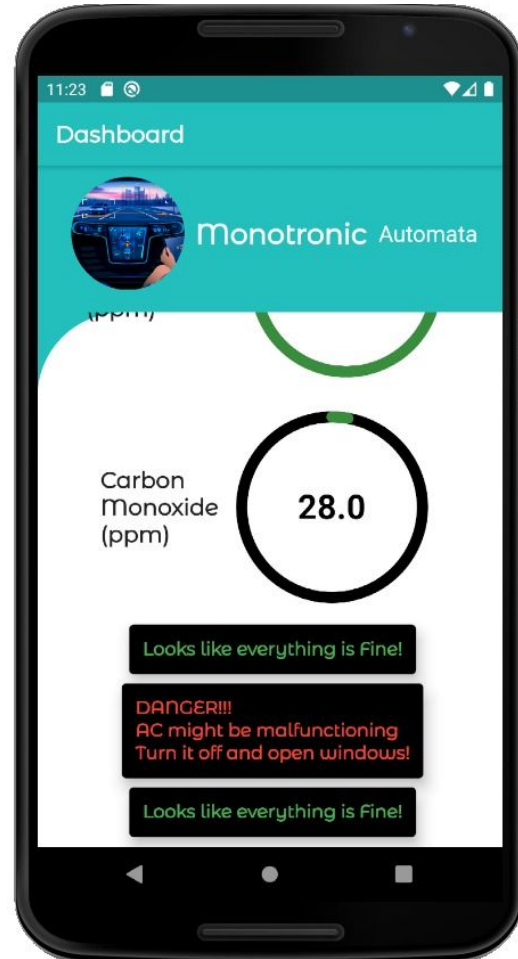


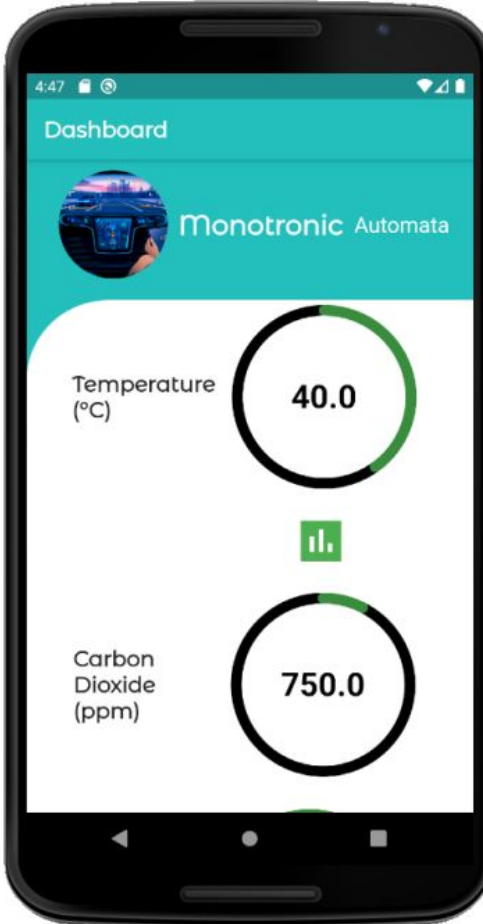
When the level of carbon dioxide exceeds 1300 ppm or when carbon monoxide exceeds 30 ppm, our solution starts working according to the situation.



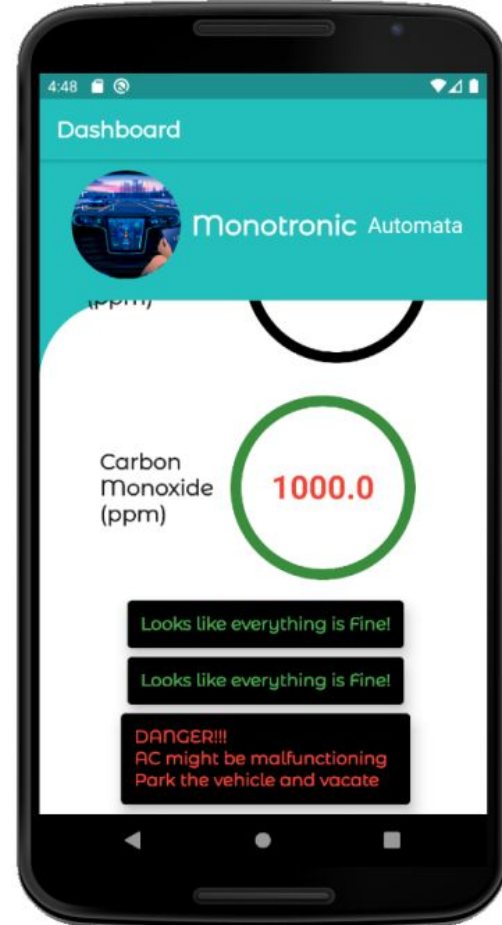


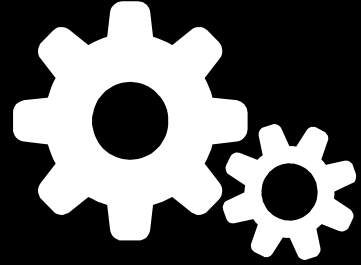
When the carbon dioxide level reaches 10000 ppm, the app notifies you with a danger warning and suggests the user to turn AC off and open windows for proper ventilation.





When the level of carbon monoxide goes above 1000 ppm, the app suggests the user to park the car and leave the car as it can be lethally dangerous.





HARDWARE

HARDWARE COMPONENTS

1. Temperature Sensor : **LM35**
2. Microcontroller : **ATMEGA16M1**
3. Carbon Dioxide Sensor : **CM1106SH**
4. Carbon Monoxide Sensor : **110-102**
5. Ultrasonic sensor / IR sensor
6. Bluetooth module

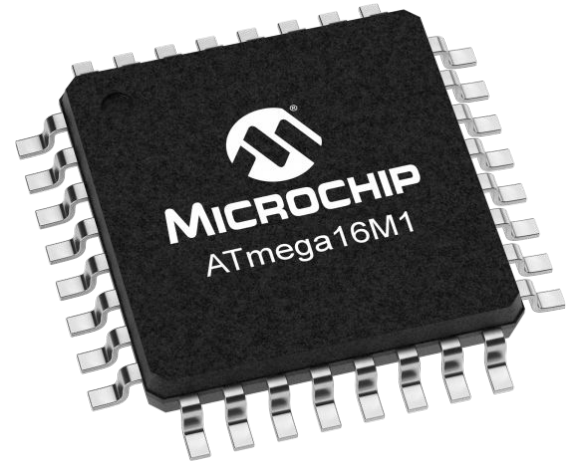
TEMPERATURE SENSOR : LM35

- LM35 is used to measure the temperature inside the car cabin. This is also used in HVAC systems.
- The sensor can measure temperature in the range of -55°C to 150°C .
- It has an accuracy of 0.5°C (at 25°C) and is calibrated in centigrade.
- With the help of an algorithm the change in temperature inside the car cabin is predicted and a graph plotted with respect to time.



MICROCONTROLLER : ATMEGA16M1

- ATMEGA16M1 is the microcontroller used in our solution. It is a 8-bit AVR Microcontroller with 16 KB Flash Program Memory.
- The CAN (Controlled Area Network) protocol feature of the chip enables us to communicate with the other microcontroller without an operating system which is very useful in automotive.
- Inexpensive, fast and accurate.

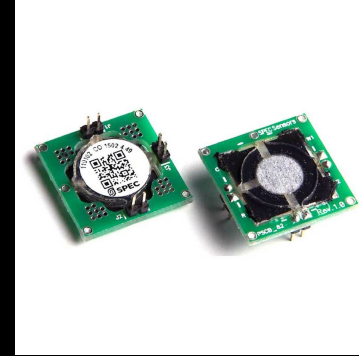


CARBON DIOXIDE SENSOR CM1106SH



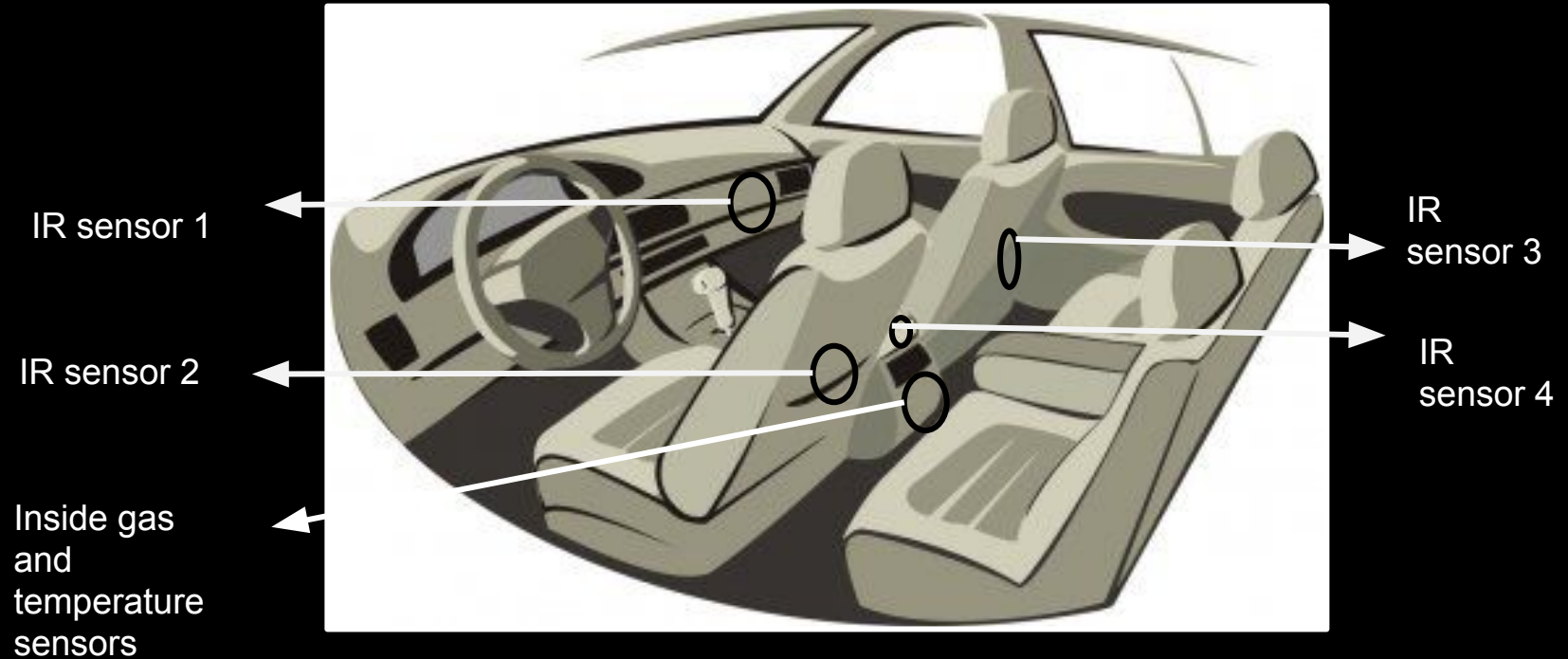
- The range of CO₂ that can be sensed by the sensor is between 1 - 10,000 ppm.
- It is a single beam NDIR (non-dispersive infrared) CO₂ sensor module with an accuracy of 3%

CARBON MONOXIDE SENSOR 110-102



- The range of carbon monoxide sensed by the sensor is 1 to 1,000 ppm.
- Accuracy of the sensor is 2%.

IN CABIN PLACEMENT



OUTSIDE CABIN PLACEMENT

The outside gas sensors are placed near the AC inlet.



ADVANTAGES OF MONOTRONIC

- Air quality control using in-built AC mechanisms, no need of costly air purifiers.
- Aims to make existing automatic climate control features more safer for the passengers.
- As most commercial non luxury vehicles comes with 2 modes of AC, easy to integrate even if automatic climate control feature is not available.
- App provides a cost free and simple way of monitoring your car cabin's condition instead of buying CO2 meters.
- The temperature prediction feature of app will create awareness among users to prevent future unfortunate incidents due to heat strokes, as most people underestimate the rise in temperature of parked vehicles.
- Along with monitoring, app provides users with warnings and safety tips to help them take calm decisions.

FUTURE PROSPECTS

- App is still under development due to bugs in bluetooth package, appropriate fix or alternatives needs to be decided.
- Add more features to app like connecting with google maps to show nearby hospitals and fire stations.
- Use of controllers like PID to increase efficiency and accuracy of air quality control inside cabin.

THANK YOU

- TEAM DERP