Overview

The objective of this project is to create a mobile system to carry out a digital, wireless, and accurate wheel alignment on one axle of a car.

Sensors will be used the capture the toe and camber angles, which will be sent via a WiFi AP to a front end being run in the browser of a mobile device.

Sensors will be fitted to both the right and left side of the axle to be measured, along with a microcontroller (ESP32) on both sides.

The values of the left side will be sent via bluetooth to the right side, which will then transmit both the left and right side values to the front end via WiFi, making the system completely wireless.

Each side will also have a small OLED screen to display the repsective values, this is as a redundency for the case where a mobile device is not present, or there is a malfunction and the front end is not useable.

Construction

The values need to be taken while the suspension is in the compressed state at normal ride height, but the wheels must also be removed in order to gain access to the appropriate points of adjustment on the vehicle.

Therefore a plate (from here onwards referred to as “wheel plates”) for each side shall be built in such a way that it can replace the function of the wheel for the purpose of compressing the suspension to normal rideheight, while providing access the the adjustment points.

The wheel plates must be thick enough so that they do not bend under the weight of the car, and the must have some kind of wheels or rollers on the bottom, so that during adjustment they can move freely on the ground without binding up the suspension causing measurment errors.

Fig 1: an example of the above described plates, from Paco Motorsports

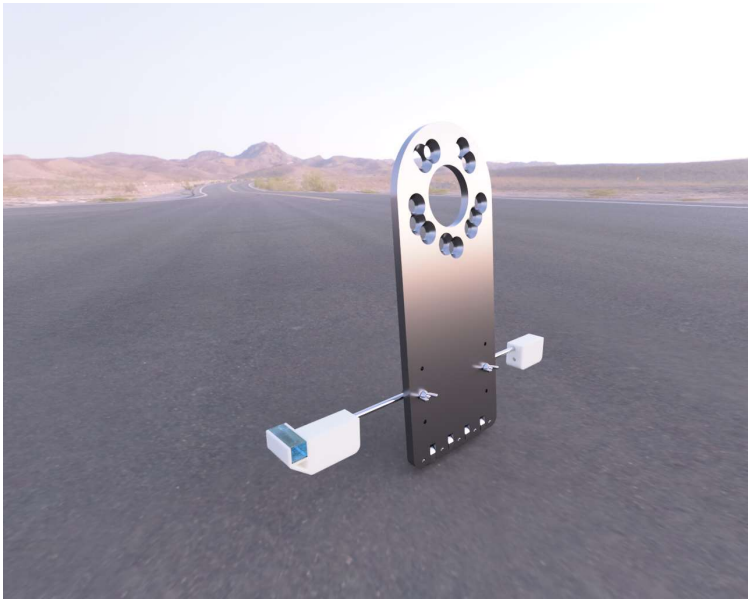


Fig 2: My proposed design

Capturing the camber values

Camber is the angle of the wheel when looking at the car from the front. If the top of the wheel is tilted inwards, this is negative camber, and tilted outwards is positive camber. The camber angle is measured perpendicular to the ground.

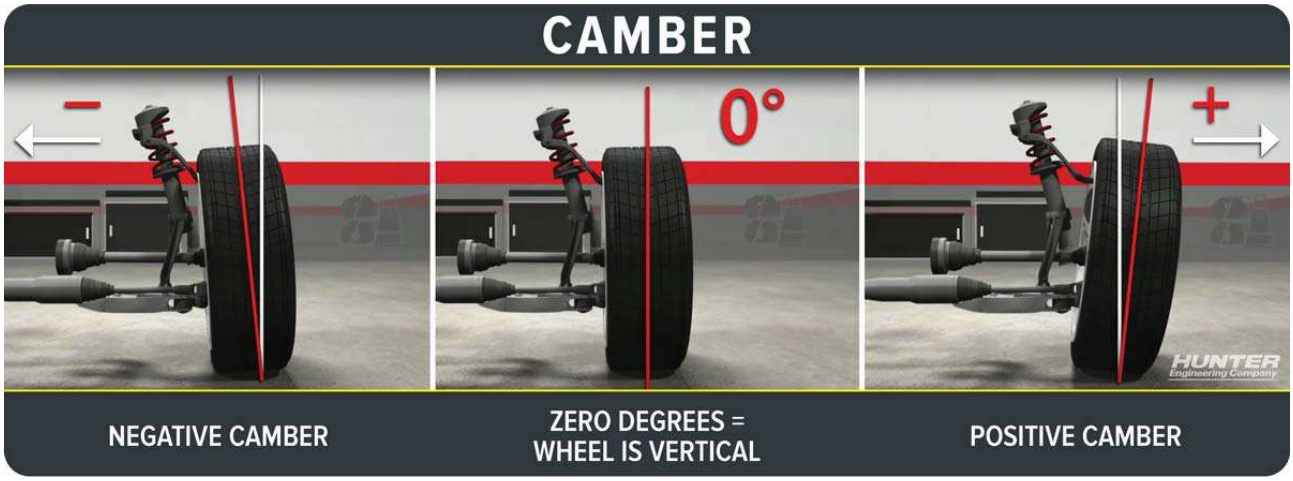


Fig 3: Explanation of camber angle

Therefore capturung the angle of the wheel plates will provide the camber angle. This can be achieved by mounting an accelerometer perpendicular to the wheel plate, and calculating angle from static acceleration.

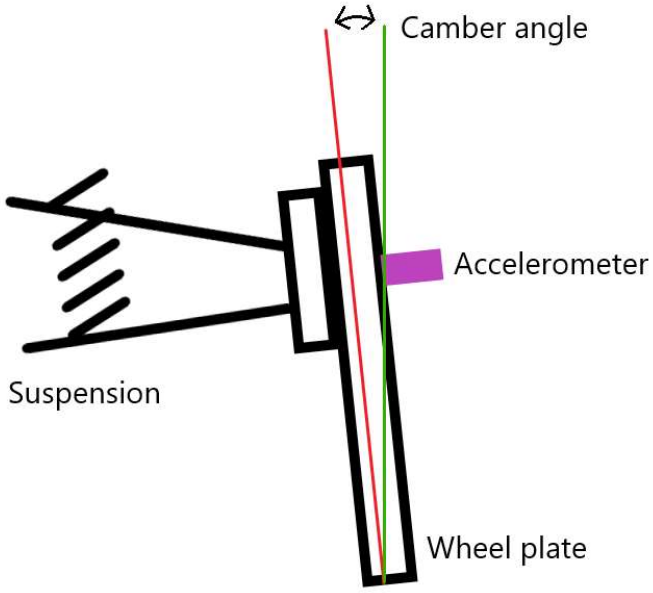


Fig 4: position of accelerometer and camber angle

Capturing the toe value

Toe is the angle of the the wheels when viewed from above. Positive toe, or toe-in, is when the front of the wheels are angled inwards, and negative toe, or toe-out is when the front of the wheels are angled outwards. Zero toe is when both wheels are parallel with each other.

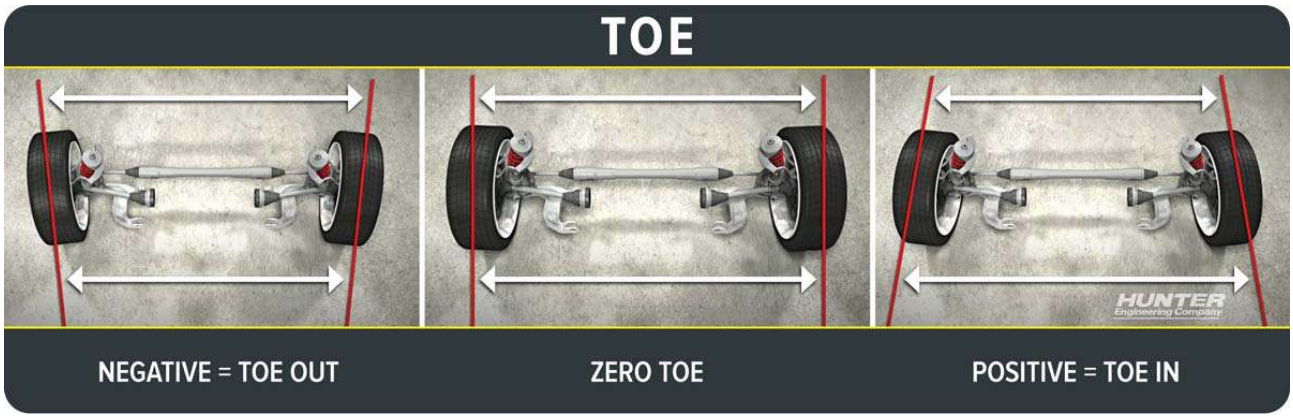


Fig 5: Explanation of toe angle

Toe ($\delta 0$) can be calculated if the distance between the front of the wheels (C) and the rear (B) of the wheels is taken, and the distance between the measurements (dF) is known .

$\delta 0 = (360° * c)/(2 * \pi * dF)$ $\quad$ $c = B-C$

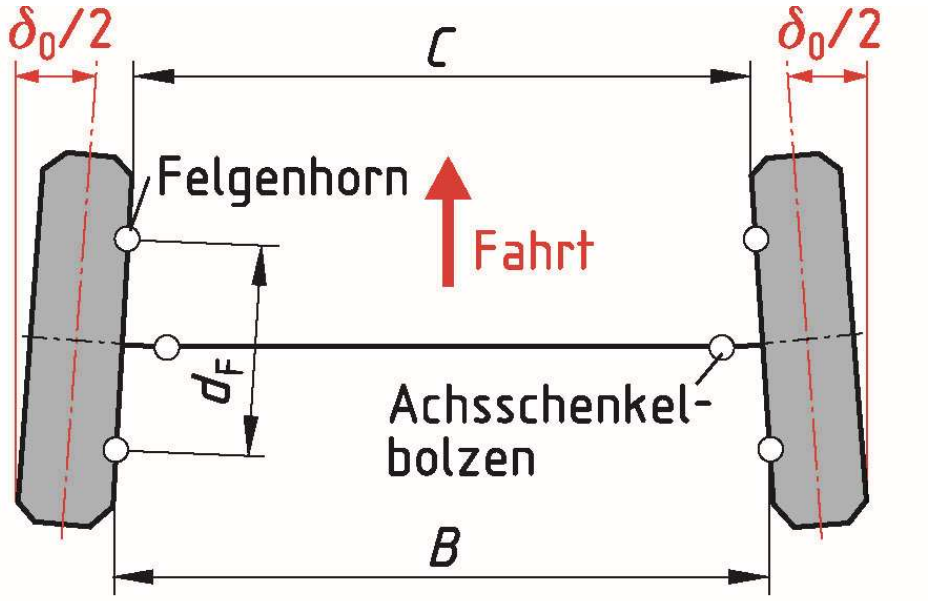


Fig 6: Toe angle

The two distances will be measured with range-finder modules, and the angle will be computed from the two measurements.

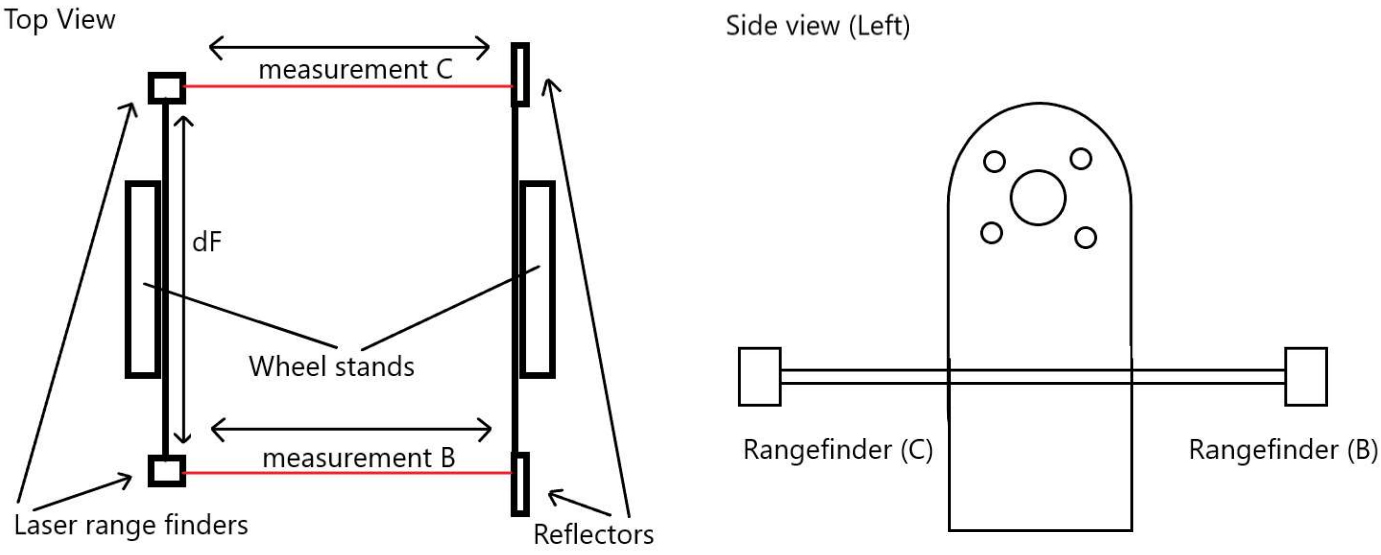
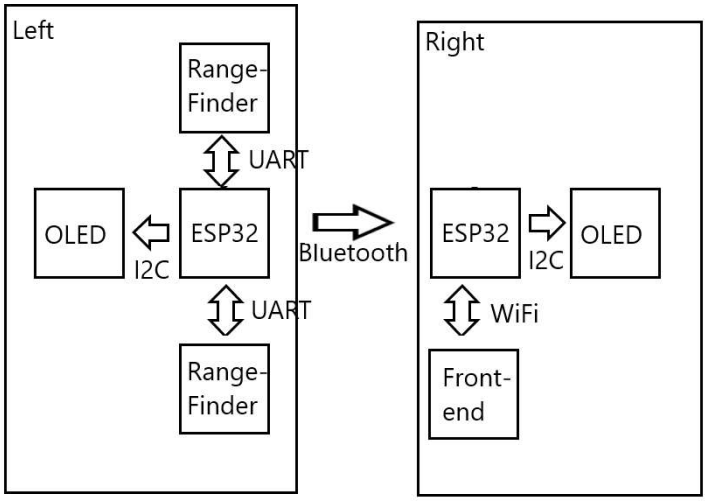


Fig 7: Toe measurement capture via laser range finders

Schematic

The left side will display the toe and the left camber on the OLED screen. It will also send this information via bluetooth to the right side.

The right side will display the right camber and the toe, and will transmit the left camber, right camber, and toe to the front end.


Left
Range-
Finder
UART
OLED
I2C
ESP32
Bluetooth
UART
Range-
Finder
Right
ESP32
I2C
OLED
WiFi
Front-
end