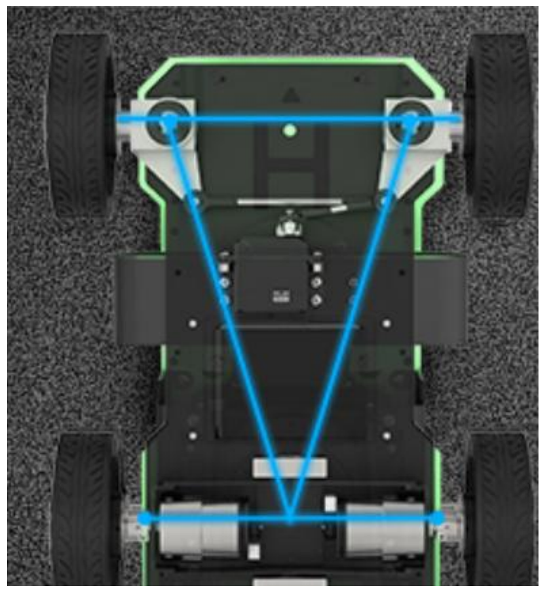
2.6 Ackerman Chassis

The robot is built with an Ackerman chassis structure, allowing it to be driven by the rear wheel while being controlled by the front wheel. The front wheel steering mechanism resembles that of a real car, enabling basic driving functions such as forward movement, reverse, and wide-radius steering. However, it does not support in-place steering.

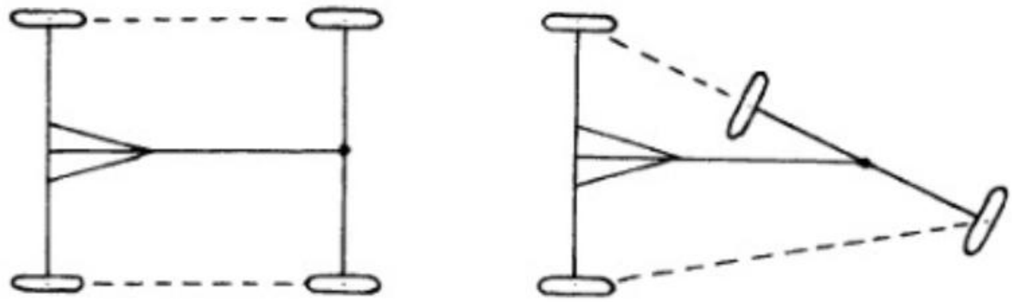
The Ackerman chassis offers not only excellent steering capabilities but also a certain degree of climbing ability.



Ackermann Chassis Working Principle

1. Preface

Ackermann's steering structure was initially proposed by a German carriage engineer in 1817. Later, his agent Ackermann applied for a patent in 1818, and as a result, the steering principle came to be known as Ackermann's steering geometry. The primary purpose of this design was to enhance the steering mechanism for carriages, as depicted in the figure below:



The limitations of such a structure are evident and include the following:

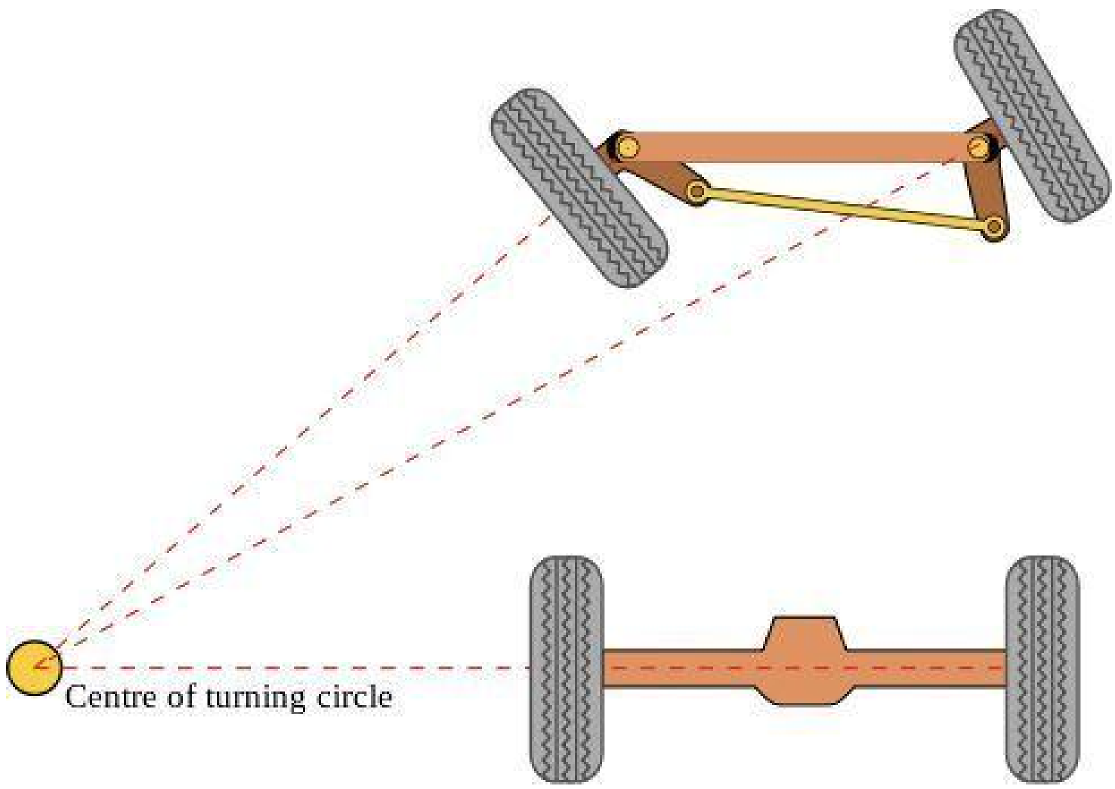
Turning around a single axis during vehicle turns results in limited space for turning, preventing the wheels from being made into a larger size. Consequently, encountering gravel or obstacles on the road can easily lift the vehicle.

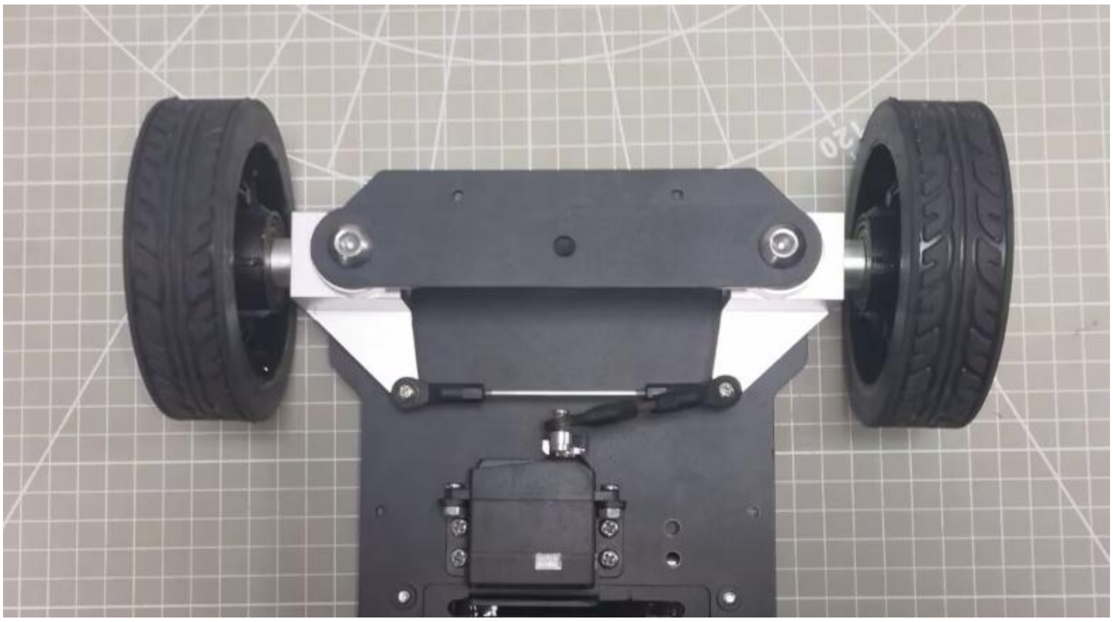
The parallel steering of the two front wheels in this design can cause the four wheels to form a "triangle" when turning with a large steering angle. This situation can lead to the vehicle getting stuck in one position and becoming immovable.

To address these challenges, the Ackermann's steering structure was introduced and has since found applications in the automotive field. The Ackermann steering structure boasts excellent turning capability and can handle significant loads during turns. Additionally, the inclusion of rear wheel suspension enables smooth ground contact and provides the robot with a certain level of climbing ability.

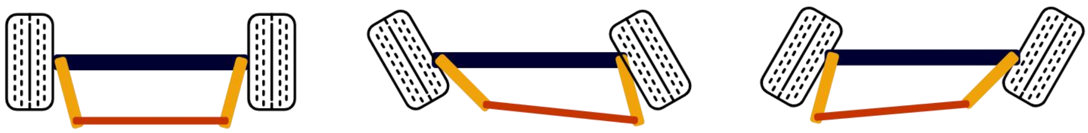
2. Ackermann Chassis Structure

JetAcker utilizes the Ackermann chassis design. To achieve stable turning, it is essential to ensure that the two front wheels rotate around the same circle origin. Consequently, the rotation angle of the two front wheels may vary. These front wheels can be categorized as the outside wheel and the inside wheel. The diagram below illustrates the turning mechanism of the Ackermann chassis:





The driving mechanism consists of servos, links, and wheels. The servos are connected to the links, and these links, in turn, are connected to the wheels. By rotating the servos, the movement of the links is controlled, thereby determining the turning direction of the front wheels. The working principle of this mechanism is as follows:



而后轮的控制是由电机以及车轮构成的，通过电机的转动来控制机器人前进后退以及速度。

机器人转弯时，如果两个轮子是平行状态，即两个车轮转动的角度是一样的，则它们的垂线与两个后轮连线的延长线将不会交于一点，这种情况下机器人运行反馈到车上就是打滑、拖拽的感觉。

在经过测试之后得知，内侧轮转动的角度需要比外侧轮转动的角度大，它们的垂线才能够与后轮的延长线交于一点，这样在转弯时机器人的各个轮子才能沿着同一圆心旋转。

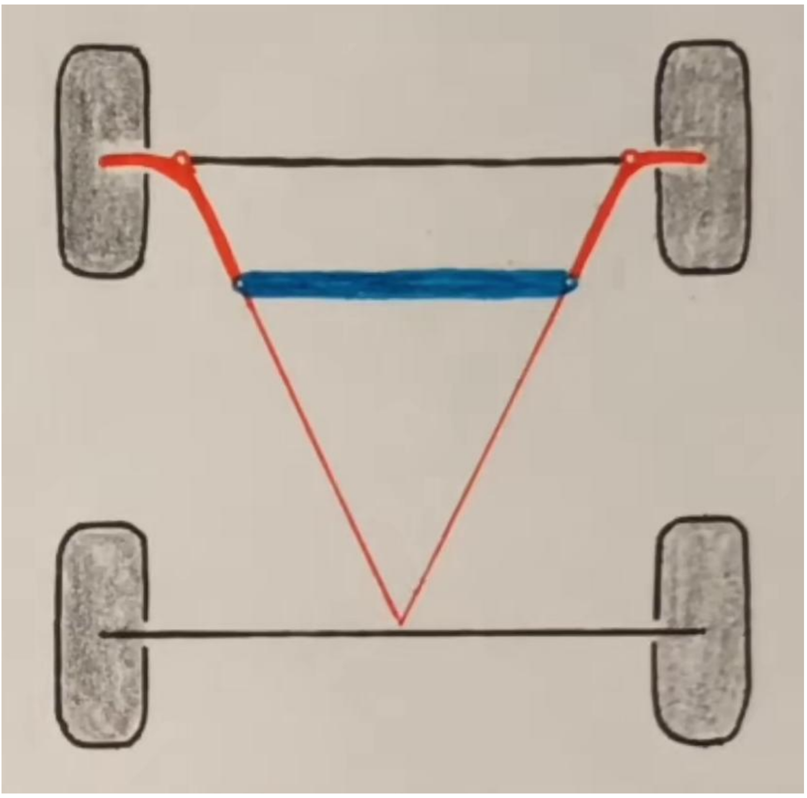
想要达到以上效果，只需要前轮的两个轮子与连杆的延长线交汇于后轴中心点即可。这样无论前轮往那边转弯，打多少角度，轮子都会始终围绕着同一个圆心旋转。

The control system for the rear wheels consists of a motor and the wheels. The robot's forward, backward, and speed movements are regulated by the motor's rotation.

During turning, if the two wheels are in a parallel state, meaning they rotate at the same angle, their vertical lines and the extension line connecting the two rear wheels will not intersect at a single point. This results in a sensation of slipping and dragging when the robot is in motion.

Through testing, it has been determined that the rotation angle of the inner wheel must be larger than that of the outer wheel. This adjustment ensures that their vertical lines intersect with the extension line of the rear wheel, allowing each wheel of the robot to rotate along the same center of the circle during turning.

To achieve this effect, it is necessary for the two front wheels and the extension line of the connecting rod to meet at the center point of the rear axle. By doing so, regardless of the direction or angle of rotation of the front wheels, the wheels will consistently rotate around the same center, ensuring smoother and more controlled turns.



Consequently, during turning, the front wheels are utilized to change the robot's direction, while the rear wheels provide the necessary force for JetAcker to move forward. This design allows the robot to rotate around the center of the circle, enabling smooth and controlled turns.

3. Motion Analysis

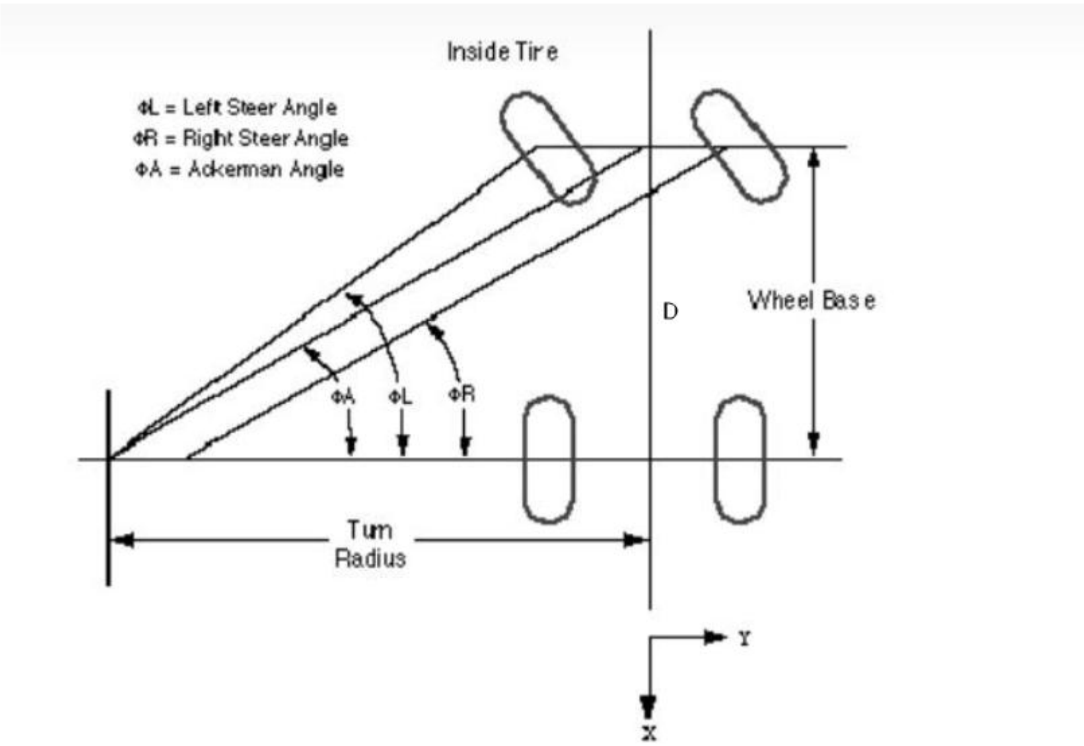
To make JetAcker turn left, both front wheels should shift to the left. During this maneuver, the left wheel is regarded as the inside wheel, and the right wheel as the outside wheel. The angle between the inside wheel and the extension line of the rear wheel is denoted as Φ_L, while the angle between the outside wheel and the extension line of the rear wheel is Φ_R.

Following the mathematical model of automobile kinematics, we can derive the following formula:

Φ_A= （Φ_L+Φ_R）/2

Based on the triangle function, the following formula can be obtained.

tanΦ_A=D/R. Φ_A is the turning angle of the robot.



Based on the formula above, it can be deduced that the radius of the turn = wheelbase /tanΦA, that is, R=D/tanΦA

In summary, to get the turning radius and angular velocity, we only need to set the linear velocity and turning angle of JetAcker.