Robot Suspension System

Suspension System: It is a system usually used in the wheels, which consists of two main components, a spring to maintain the stability and adhesion of the wheels on the road or path, and a damper to absorb the energy caused by the change in the shape of the road or path and absorb the emerging vibrations.

The suspension system is placed on the chassis of the car.

As We Can See In Figure. 1

Fig.1

But in robots, we do not need a suspension system, but sometimes it is bumpy or we need the robot to walk quickly, which causes vibrations, but in these cases we do not need a suspension system, but we can use flexible materials because flexible materials return the wheels to the robot to the ground as in the spring because the spring is considered A flexible material that also has energy damping due to the structure damping, which is the damping of energy in the structure of the material itself, but in the case of the car, we do not want damping in the structure, so we use viscous damping, but because of the energy that dissolves on the robot suspension system, friction and other forces, it will cause stress and even shape It also affects us, so we use the Finite Element Method program to study the stresses and the strongest and deformations that obtain the materials as in Figure 2a and we have obtained an appropriate form as we see in Figure 2b

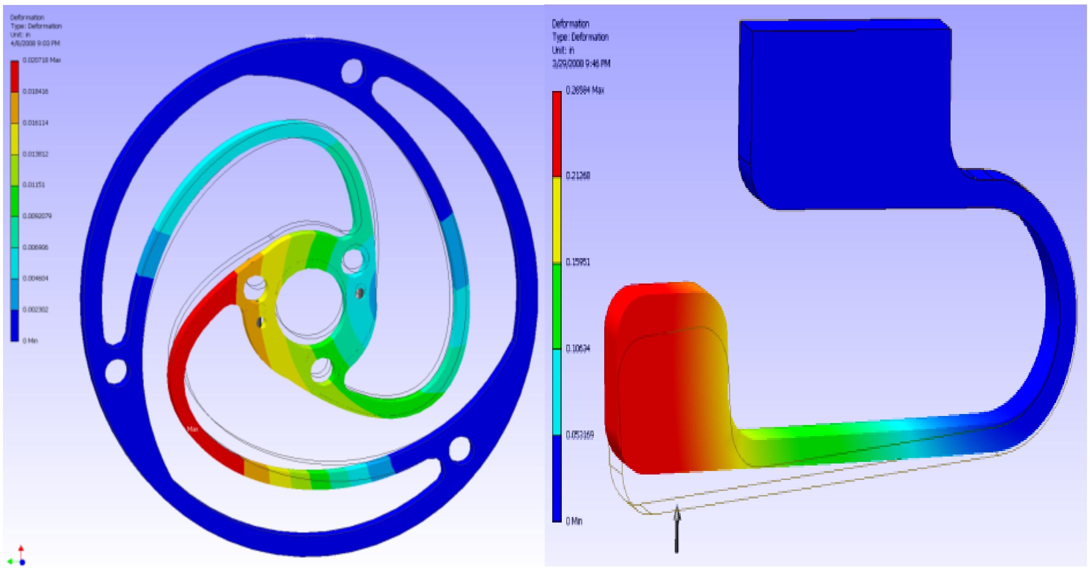

Fig.2a

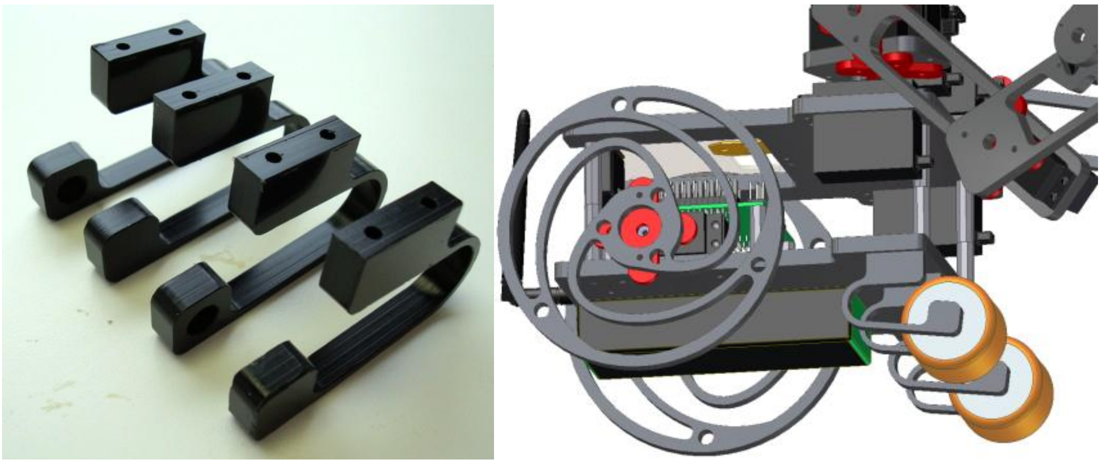

Fig2.b

As we saw previously in the wheels of cars and robots, we see the real model, but if we want to study this system in physics, we can convert it to the following figure, Figure 3, which is similar to the physical model of the suspension system.

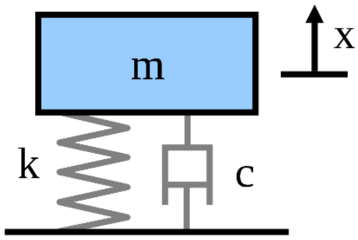

Fig.3

Then we find the mathematical model using differential equations and Newton's second law Fig. 4

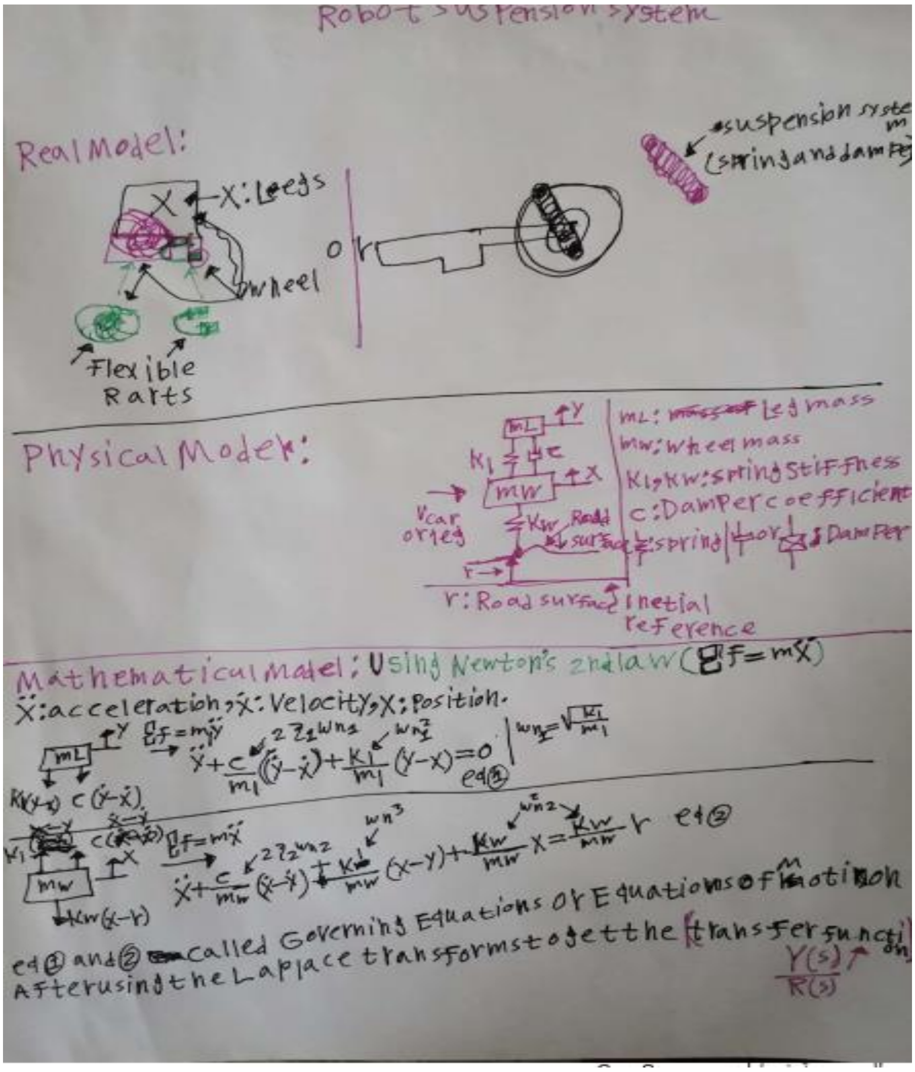

Fig.4

where r represents the path or road.

Using Laplace Transforms to Get Transfer Function $\frac{Y(s)}{R(s)}$ fig.4 and 5

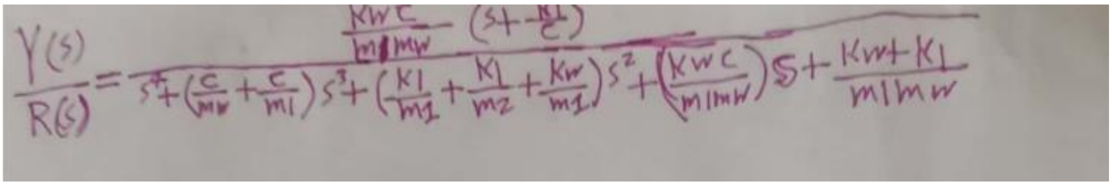

Fig.5

The Transfer Function helps us to know the relationship between the robot leg and the shape of the track and by taking into account the damping and the elastic material, whether it is a spring or other, and the mass as well, and we can also use it to control the suspension system.

Manipulators

Figure 6 shows the manipulators

Fig.6

The manipulator is the most used robot in the industry, and it consists of a group of link and joint, linkage or kinematic chain, and at the end there is the end effector, and the end effector varies according to the task required, for example Figure 7

Fig.7

It can be used in moving something from one place to another, in welding, in the installation of car parts, and many more.

There are several factors that we need to know or define in this type, the number of the interviewer who will work in it - the degrees of freedom - the space of the place in which it is located - the payload - the accuracy.

In this task, the goal was to reach the end effector using forward and inverse kinematics. Figure 8

forward kinematics: It's me locating the robot in terms of the angles of the joints.

inverse kinematics: If you want the robot to be in a specific place and calculate the angles for the joints opposite the forward kinematics.

In Figure 8, to simplify, we assumed that we have two links for simplification, and the first time was forward kinematics and the second time was inverse kinematics.

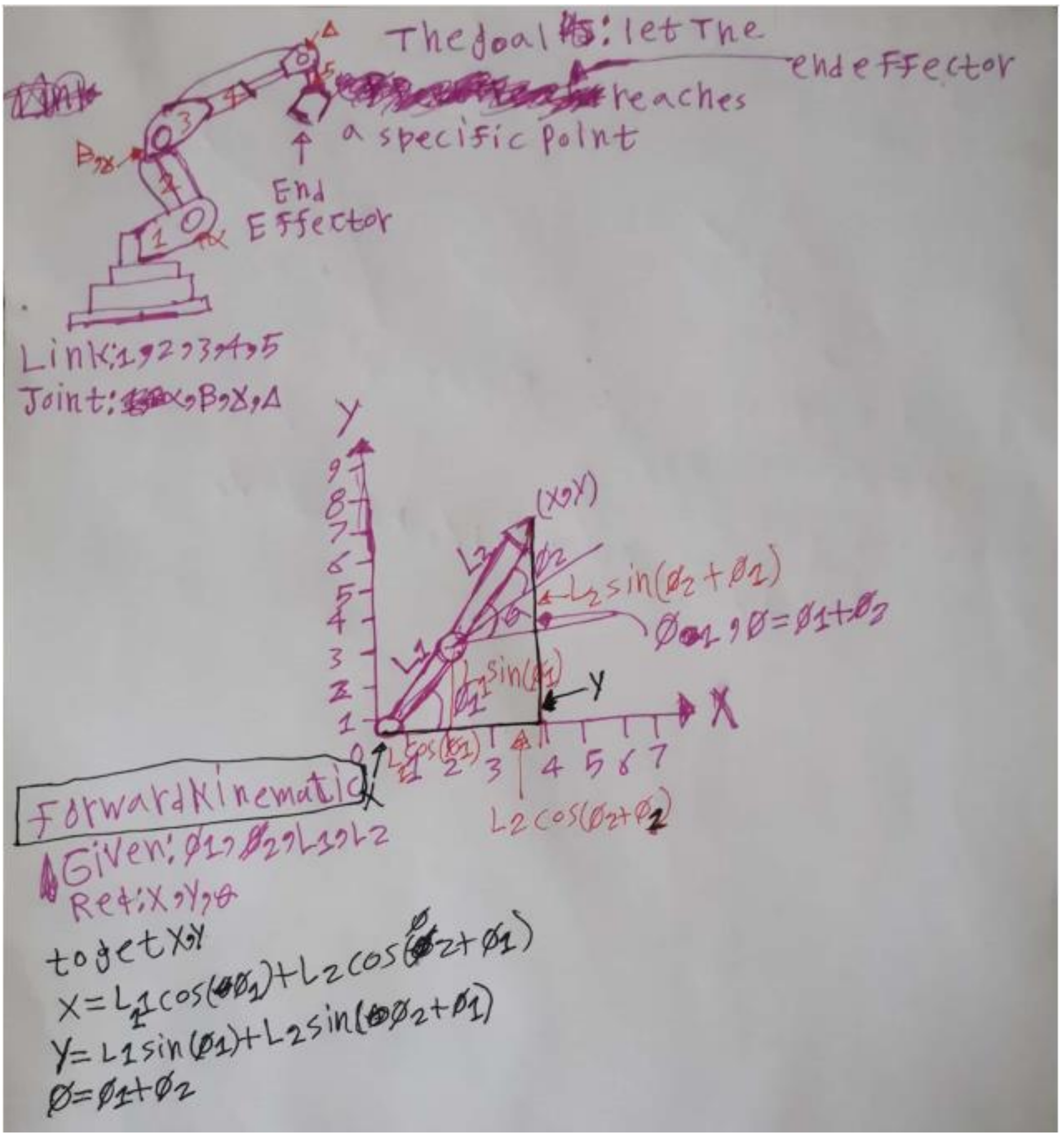

Fig.8.1

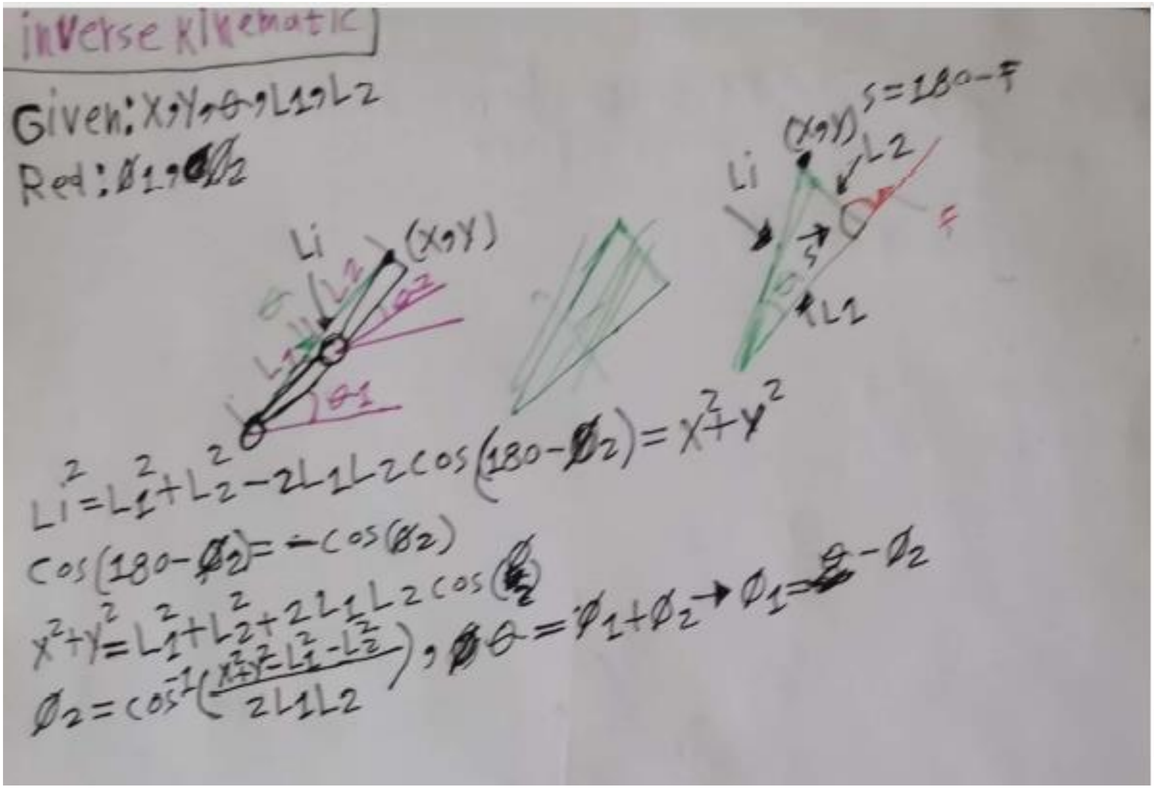
inverse kinematic
Given: x, y, θ, L1, L2
Req: Ø1, Ø2
Li
(x, y)
L2
L1
θ
Ø1
Ø2
s = 180 - F
Li
(x, y)
L2
L2
F
Li^2 = L1^2 + L2^2 - 2L1L2cos(180-Ø2) = x^2+y^2
cos(180-Ø2) = -cos(Ø2)
x^2+y^2 = L1^2+L2^2+2L1L2cos(Ø2)
Ø2 = cos^-1((x^2+y^2-L1^2-L2^2)/2L1L2), θ = Ø1+Ø2 → Ø1 = θ - Ø2

Fig.8.2