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MODELLING OF SURVEILLANCE CAMERA MOVEMENT BY FULFILLING CUSTOMER REQUIREMENT

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Abstract:- *In this paper I have designed a surveillance system starting from the very basic of any design problem .First step was to collect the customer requirements, after that I went through the existing bench -marks, then technical specification related to customer requirement .After that I have selected the target based on which I designed the system model and proposed my solution.*

Keywords: Security, speed of the camera, Torque

1. INTRODUCTION

The security is an important part of our everyday life .And surveillance camera plays a great role in it. It has been widely used all over the world .It is used in large business buildings, industries, banks and even at our homes. To be honest the security camera became a part of our everyday life .We consciously and unconsciously deal with the surveillance camera all the time.

Fig.1: Available design [courtesy SIQURA]

2. LITERATURE REVIEW

2.1 Customer requirements

The customer requirement is basically derived from talking with a group of people of university of Trento, Italy and also some people from outside the university. The table below shows the customer requirement with their relative ranks. [2]

Table 1: Customer requirements

Requirement	Rank
Aesthetics	3
Tracking capability	2
Area of coverage	1
Speed of the Camera	4
Weight of it	5
Compactness	7
Cost of it	6

As from the table it is clear that the most important customer requirement is the area of coverage of the camera. The 2nd most important is tracking capability.

2.2 Benchmarks

There are several surveillance camera systems available in the market. These also satisfy most of the customer requirement, such as the aesthetic, Compactness, Tracking capability and weight requirement are almost satisfied by the available systems. The speed of the camera is also very standard. The one we want to implement is the human eye movement [2].

2.3 Technical specifications

The table-2 shows the technical specifications that are related to the customer requirements. They don't completely satisfy the requirements, due to the fact that for the analysis we made some simplifications and also because we didn't have all the information's about the analyzed devices. For example the customer requirements cost depends strongly from the product process of the Camera, or the weight depends of what material is used for making the device, but in this analysis these aspects were not taken into account. [1, 3, 7]

Table 2: Technical specifications

Technical specifications	Unit	Rank
Angle of rotation	deg	2
Weight	*m*	5
Angular velocity	deg/s	6
Force	N	7
Moment of Inertia	Kgm^2	3
Torque	N-m	1
Angular acceleration	deg/s^2	4

2.4 Targets/Goals and parameters

The value for the technical specifications that are directly related with the movement of the camera, like the Angular velocity, Angular acceleration, Force and the torque, were obtained from the literature [1]. The minimum and maximum values have been calculated by taking the ± 20% from the target value.[3,7]

Table 3: Technical specifications

Technical specifications	Unit	Min Value	Max Value
Angular velocity	deg/s	35	90
Angular acceleration	deg/s^2	230	350
Force	N	4	6
Torque	N-m	0.8	1.4

3. MECHANICAL SYSTEM AND MODEL SOLUTIONS

The camera movement is analyzed by using Working Model2D software .here we have one degree of freedom and by using a revolute joint attached to the rotating motor we can model the system .The camera's angel of rotation range is 90 degree .And for total surveillance of one corner we have to use minimum two system .For defining the angle of rotation we have use the following equation.

$$\alpha = A(1 + \cos\omega t)$$

Where A is a constant amplitude. Now by taking the first derivative of this equation we can calculate angular velocity.

$$\dot{\alpha} = -\omega A \sin\omega t$$

And by taking the 2nd derivative we can calculate the angular acceleration.

$$\ddot{\alpha} = -\omega^2 A \cos\omega t$$

The angular velocity of the camera is shown in the Figure-2.we can see that the max velocity is 70 degree per second .As the camera has to move back and forth we see the positive and negative value of it.

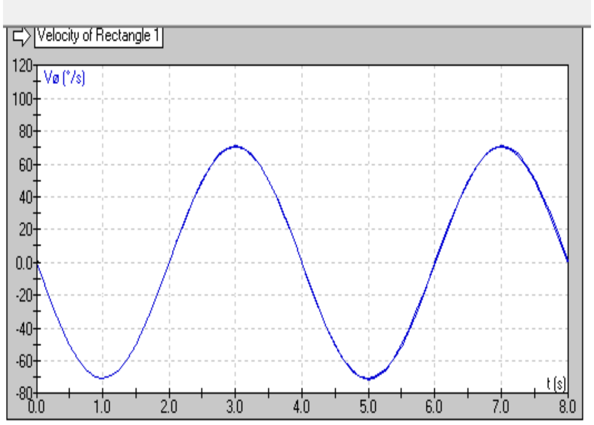

Fig.2: Angular velocity

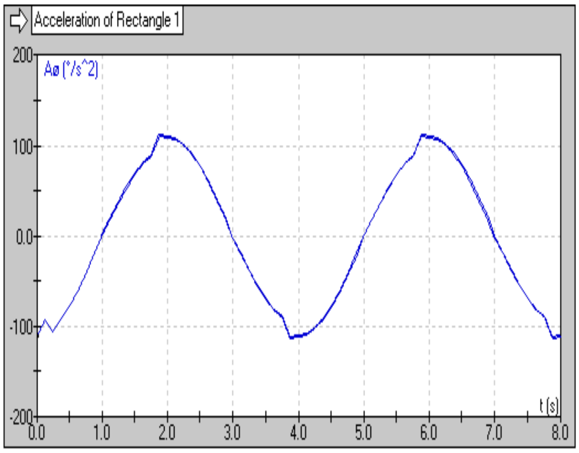

Fig.3: Angular acceleration

The angular acceleration of the camera is shown in the shown in the Figure-3. From the graph we can see that the max Angular acceleration is 105 degree per second². And also as the camera is moving back and forth. This value is quite less compared to targeted value ,one of the major cause for this is that ,here in the design we have assumed one camera will serve only 90 degree instead of 180 degree.

Figure-4 shows the graph of the Torque of the motor vs. time .We can see from the graph the max torque is 1.4 N-m. We are only considering the magnitude not the sign as it depends on the direction of rotation.

Figure-5 shows the graph of the forces of the motor vs. time. From the graph we can see that the force component along X-axis is very small almost near to zero .And the force along the Y-axis is near to 5 N. As the force along X- axis is near to zero the total force of the motor is also near to 5 N.

Figure-6 shows the graph for Forces on the camera vs. time. As we can see from the graph the total force is near to 0.2N .Which is less than the force exerted from the motor .One of the cause for it is, we have taken air resistance into consideration, which have max 0.06 N of the magnitude.

Figure-7 shows the graph for the power of the motor

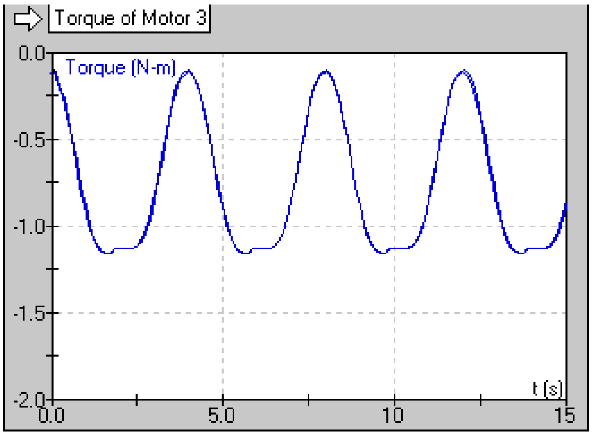

Fig.4: Torque of the motor

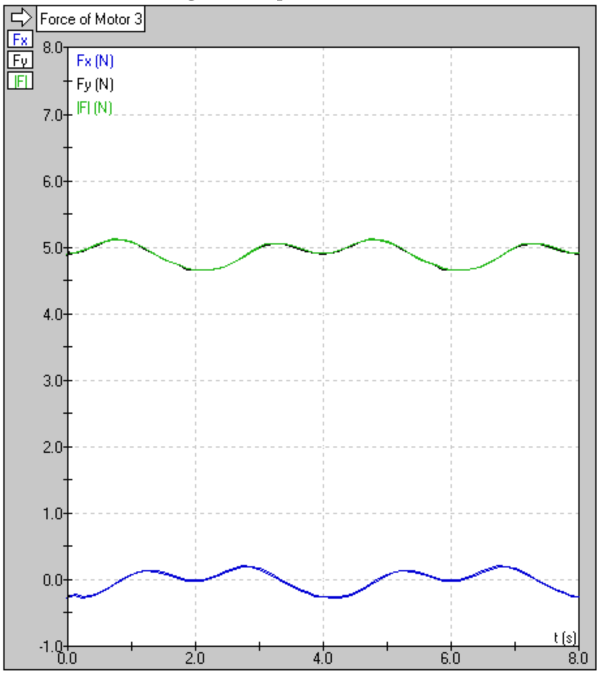

Fig.5: Forces of motor

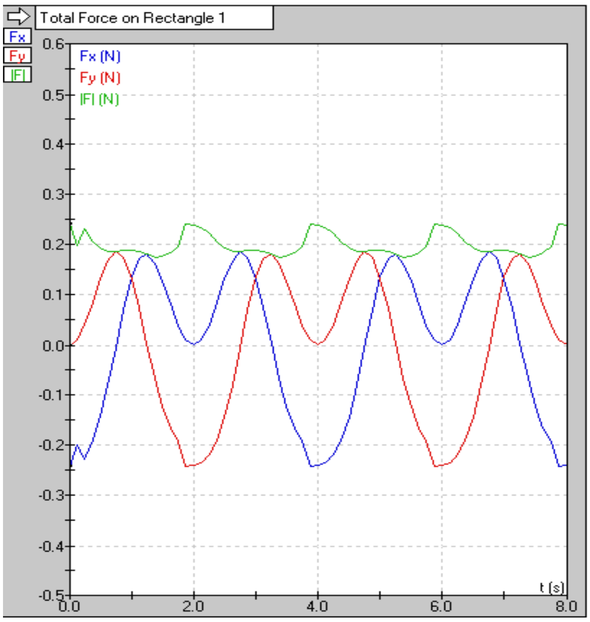

Fig.6: Forces on the camera

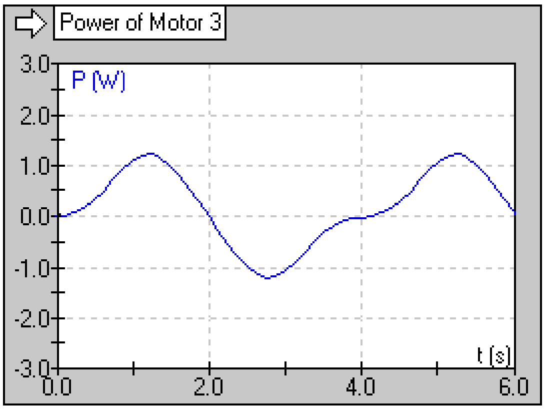

Fig.7: Power of motor

4. RESULT DISCUSSION

From the above analysis we can see that the design that is provided here satisfies the goal for the angular velocity .But the design does not satisfies the angular acceleration target. The model also gives the value for torque and force which is almost same as the target value. So for improving the result we have to implement some sorts of Optimization technique.

5. CONCLUSIONS

In the above design the range for angel of rotation is 90 degree. So for full area coverage we need minimum two surveillance system and place such that while one is in the far end the other one should be in the near end. In the above design the reference that we have followed is the humanoid robot system. So two cameras actually resembles two eye of the human .The range of the rotation can also be taken as 180 degree in that case one camera will be enough but the speed of the rotation as well as the speed of the camera (that is the frame per second, fps) will also have to be high.For the best solution we have to make a trade of between the cost and the performance of the system. In this analysis we didn't considered the tracking capability of the camera as it is done by the electronic control part but here we have only discussed about the mechanical part of the system.

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