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SIMULATION DESIGN OF AUTOMATIC SLIDING GATE CONTROL DEVICES

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Abstract. The gate is a means of dividing the land between the house and the road. The gate also serves for security and comfort as a place to live. As a home security, the gate is made high and equipped with a safety lock. With a gate, you will feel comfortable because other people who come can't enter the house directly, and it's often difficult or overwhelmed when opening or closing the gate. In the case of a gate that has a large size and is also heavy, this will overwhelm us so that a lot of energy and time is needed. The automatic gate control device designed is an electric motor that makes it easier for people to open or close the gate by remote control while at home or at work. Based on the results of the design that has been made, the simulation of the automatic sliding gate control device is expected to solve the problems encountered in the field where the dimensions of the gate are 1500mm x 1000mm x 80mm with a weight of 27kg, the electric motor used is reversible AC which has a speed of 1300 RPM, a power of 60 watts and a 1: 60 gearbox which has become 1 part, the speed of the electric motor is transmitted by a gear with a diameter of 78mm, so that the average gate opening and closing speed is 12.52 and 13.21s with a difference of 0.69s, with the The controller used is the AK-T02 module and the AKJ027 remote can work up to a distance of 10 m. It is hoped that making this control device simulation can be a reference in making automatic gate control devices for homes and other gates.

Keywords: gate, sliding gate, control device, automatic.

1. INTRODUCTION

The gate is a means of dividing the land between the house and the road. The gate also functions for the safety and comfort of the residence, the house safety is made high and equipped with a safety lock. With the gate, you will feel comfortable because other people or guests who come do not directly enter the home page. In this regard, we tried to design a gate that is controlled automatically.

Design is a series of procedures for translating the results of the analysis of a system into a programming language to describe in detail how the system components are implemented [1][2][3]. Design or planning is an activity that can create a new system or replace or improve the existing system as a whole [4][5][6]. With the rapid development of technology today, we can see a lot of progress has been made. With so many technologies being made, there is also a lot of public interest in making technology that can make everyday life easier, one of which is at the gate. Usually we often have difficulty or are overwhelmed when opening or closing the gate as shown in Figure 2.1, in general in the field we often find cases of gates that have a large size and are also heavy, so this will make them overwhelmed when opening and closing the gate so that a lot of energy is lost. will be used. The automatic gate control device designed is an electric motor machine that makes it easier for us to open or close the gate by remote control while at home or outside the house when coming from work or when traveling. It is hoped that the simulation of this control device can be a reference in making automatic gate control devices for residential houses and other gates.

Based on the above understanding, we conclude that design is an activity or procedure to produce an analysis of a system or component so that it can create a new system or tool or improve an existing system or tool.

Making a tool requires a design or planning of components that will be used to meet the needs of the mechanism of the tool being made, and as for the considerations that must be made in a design of a tool, namely: easy and simple, economical, aesthetic and effective. [7][8][9].

Based on the scope of the problems in the simulation design of this automatic sliding gate control device, the problems can be formulated, namely: (a) How can the simulation design of the automatic sliding gate control device work optimally? Is the maximum load that can be driven by this designed control device?, (b) Is the automatic sliding gate control device able to work according to a predetermined time?.

In this design, the selection of materials and the manufacture of components must be in accordance with the results of the planning as well as the purchase of other components. We only discuss about the control devices that will be designed, namely: (a) design and build an automatic sliding gate control device, (b) calculating travel speed in the design of automatic sliding gates. Research purposes are design and build an automatic sliding gate control device with the ability to drive a sliding gate using an electric motor, and can test an automatic sliding gate control device with a predetermined load and time limit

2. METHODS

a. Research procedure

In this simulation design of automatic sliding gate control device, we want to make a simulation design of automatic sliding gate control device with electric motor drive. Currently, there are still many who use manual methods or with human power, so the opening process will take a lot of time needed in the sense that it is too long and less efficient [10][11].

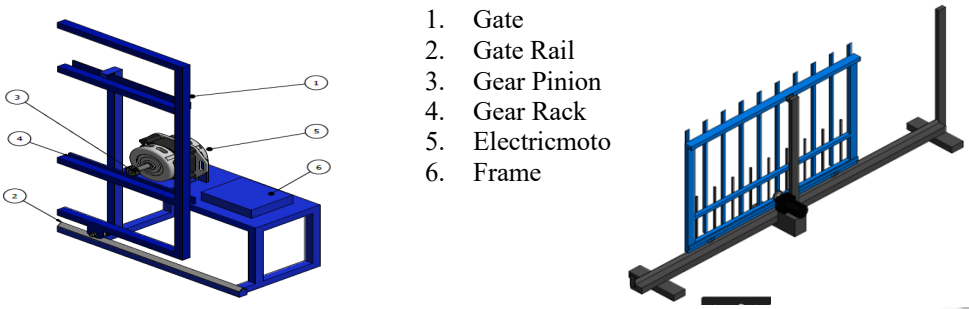
b. Previousmodel

The previous model is a sliding gate that uses human power to open or close the door by pulling or pushing the gate on the East Ring of Bali Arum, Jimbaran, Badung which is one of the gates as a reference in this design, as shown in Figure 2.1. Older models provide less effectiveness and provide greater resistance [12][13][14].

Figure 1. Conventional sliding gate

c. Design models created

The simulation design model for the automatic sliding gate control device is made as minimal as possible, both for this research or outside so that it can reduce space consumption but the power generated is as needed and of course still comfortable to look at [15][16][17]. The model of the design can be seen in the following Figure 2:



1. Gate
2. Gate Rail
3. Gear Pinion
4. Gear Rack
5. Electricmoto
6. Frame

Figure 2. Simulation design of automatic slidinggate control device

d. Location and time

The simulation design for this automatic sliding gate was carried out at the East Bali Arum Circle, Jimbaran, Badung. We hope that this tool can simplify and streamline the time in opening and closing the gate. Making a simulation design for this automatic sliding gate control device at the Bali State Polytechnic Mechanical Engineering Work Shop, and the time it takes is approximately 3 months, starting from 1 December 2020 to 5 February 2021.

e. Determination of data sources

Determination of data sources is done through a literature review related to theories related to automatic sliding gates, rack pinion gears and carrying out a field survey. This design is expected to simplify the process of opening and closing sliding gates automatically.

f. Instrument

The research instrument is a tool needed to conduct testing on the design.

a. Stopwatch to measure gate travel time
b. Tachomete to measure the speed of the electric motor RPM
c. Scales are used to measure the mass of the scales
d. Gauges are used to measure the length and width of the frame and also the length of the gate rail line

3. RESULTS AND DISCUSSION

3.1 Design Result

Simulation design of automatic sliding gate control device is a remote control device that helps to open or close sliding gates both large and small with an electric motor as the driving device. This sliding gate is made of 60mmx30mmx1mm hollow steel with a length of 1.5m, a height of 1m and a width according to the hollow steel used. The weight obtained is 26.65 kg. if because of that to simplify the calculation, the weight is rounded to 27kg.

a. Calculation of the force that occurs

The friction that occurs is usually on the door wheel.

$$fs = \mu s.F \quad (1)$$

The value of μs for steel with steel is 0.74 can be seen in the table in the appendix. Then the calculation will be..

$F = m.g$, = 27kg. 9,81m/s^2, = 264.87N

With a value of F 264.87N, the value of the friction force that occurs on the gate wheels is

fs = 0,74 . 264,87N= 196,0036N

The value of the normal force on the gate is 264.87N and the frictional force that occurs at the gate is 196.0063N.

b. Calculation of electric motor selection

After getting the above calculations, the next step is to choose an electric motor that will be used to drive the sliding gate. Thus:

$$T = F_{total} \cdot r \quad (2)$$

Before calculating torque. Find the Total value first. The calculation as follows

$$Ftotal = F + fs$$

= 264,87N + 196,0036N= 460,87N

With a Ftotal value of 460.87N, to find the torque to move this sliding gate is

T = 460,87N. 0.037m = 17.513 Nm

After getting the Torque value, it will then look for the required power value.

$$PD = \frac{2\pi\, n\, T}{60} \quad (3)$$

The value of n that we estimate is 20 RPM then the calculation is as follows

$PD = \frac{2\pi\ 20\ 17.513 Nm}{60} = \frac{2199,623}{60}$ = 36,6watt

The design power obtained is multiplied again by the safety factor, then

$$P = PD \times fc \quad (4)$$

P = 36.6 x 1.5= 54.99watt

The fc value is the correction factor value for the transmitted power, a list of values can be seen in the appendix. The power required to drive the sliding gate is 54.99watts. Because the electric motor is 55.99 watts and 20 RPM and can do rounds back and forth (reversible), the motor used is 60 watts. After looking for an electric motor, it is obtained with the following specifications:

Figure 3. Electric motor

Specifications:

Name of motor	: Oriental Motor
Type	: 6RK60GK-C2
Revesible : yes	
RPM	: 1300
Power	: 60watt
Volt	: 200v
Name of gearbox	: Oriental Motor Gear Head
Type	: 6GK60K

Ratio : 1 : 60

c. Calculation ofnuts and bolts selections

$$d_i = \sqrt{\frac{4.F}{\pi.\sigma}} \quad (5)$$

Which:

$$\sigma = \frac{\sigma t}{v}, \qquad \sigma t = grade\ x\ 10N/mm^2 = 4\ x\ 6\ x\ 10N/mm^2 = 240\ N/mm^2$$

It was found that the tensile stress for bolts with grade 4.6 was 240N/mm2. Then for the allowable tensile stress is

$$\sigma = \frac{\sigma t}{v}, \sigma = \frac{240}{8}, \qquad \sigma = 30\text{MPa}$$

The value of v is the safety factor for the material, it can be seen in the appendix. With a allowable tensile stress of 30MPa, the diameter calculation to be used is

$$d_i = \sqrt{\frac{4.F}{\pi.\sigma}} = \sqrt{\frac{4\ x\ 264{,}87}{3.14\ x\ 30}} = \sqrt{\frac{1059{,}48}{94{,}2}} = \sqrt{11{,}24} = 3{,}35 \text{ x Sf} = 3{,}35 \text{ x } 2 = 6{,}7\text{mm} = \text{M7}$$

So, the bolts to be used are bolts that must exceed M7. Because the M7 bolt is too small for the gate wheel hole diameter, M12 bolts are used

d. Rack pinion calculation

$$\mathbf{Fn = Ftotal + m.a + F} \quad (6)$$

Fn = 460.87 + 27 .0.1 = 463,57N

$$\mathbf{Tn = \frac{(Fn.dp)}{2000}} \quad (7)$$

$$Tn = \frac{(463{,}57\ .\ 78)}{2000} = 17{,}61 \text{ Nm}$$

To move the rack pinion that supports the gate load, the torque needed is 17.61Nm

e. Work process

In the process of working on the Simulation Design of Automatic Sliding Gate Control Devices, first the components of the tools used to be made or purchased will be prepared. These components will be explained in Table 1 below:

Tabel 1 The Component ofToolsandMaterials

No	Name	Spesifications	Total amount	Description
1	Hollow iron	60mm x 30mm	6 Meter	Bought
2	Hollow iron	20mm x 20mm	6 Meter	Bought
3	Hollow iron	100mm x 50mm	3 Meter	Bought
4	Elbowiron	30mm x 30mm	6 Meter	Bought
5	Metal	10mm x 10mm	6 Meter	Bought
6	Electric motor	6RK60GK-C2	1 pc	Bought
7	Gearbox	6GK60K	1 pc	Bought
8	Wheelgate	$Ø70mm$	2 pcs	Bought
9	MCB	Brocco 4A	1 pc	Bought
10	Module+Remote	AK-T02 + AKJ027	1 pc	Bought
11	Bolts	M12	2 pcs	Bought
12	Limit Switch	260v 15A	2 pcs	Bought
13	Rack Pinion	$Ø36\ T18$	1 pc	Bought
14	Cable	NYM 3 x 1.5 mm^3	3 Meter	Bought
15	Paint	Pioneer Ocean Blue	1 liter	Bought
16	Welding electrode	RD400 $Ø2.0\ x\ 300mm$	1 box	Bought
17	Thinner A	-	1 liter	Bought
18	Grinding	-	1 pc	Borrowed
19	Grindingwheel	$Ø100\ x\ 1\ x\ 16mm$	1 box	Bought
20	Hand drill	-	1 pc	Borrowed
21	Drill bit	$Ø10$	1 pc	Bought
22	Grinding sandpaper	$Ø100\ x\ 1\ x\ 16mm$	1 pc	Bought
23	Boxcontactor	6uf 240v	1 pc	Bought

1) The following is the process of working on the Simulation Design for Automatic Gate Control Devices. Understanding the working drawings that have been made, preparing the tools and materials used, measuring and drawing according to the working drawings, then cutting, cutting 60mm x 30mm hollow iron, spot welding first on each side of the door followed by welding the whole, then do the drilling at the bottom to put the wheel on the gate, make cuts on the 20mm x 20mm hollow iron and 10mm x 10mm nako iron for weight-adding ornaments, do the welding according to the drawings and markings that have been given, then clean the whole weld.

Figure 4. Ironcutting

2) Manufacture of rail mounts. First, make cuts on 100mm x 50mm hollow iron, 60mm x 30mm hollow iron and 30mm x 30mm angle iron, determine the position of the rails, gate holders and boundaries according to working drawings, do spot welding first to ensure the position, after the frame is in accordance with position and shape according to the drawing then do the welding permanently, do the drilling on the gate holder pole for the electrical path and do the cleaning of the rest of the weld as a whole
3) The painting process is carried out after the assembly process. Then the tools that can be removed include electric motors, limit switches and others. Separate the gate and rails and then do some painting
4) The assembly process is carried out after the manufacturing process. Then the component assembly process is then carried out to form a series of gates according to the planned drawings to adjust all component positions.
5) Making electrical circuits, the electrical circuit is another important component to drive the gate later. Therefore, for the electrical circuit current is planned so that electricity does not occur damage or short circuit.

Figure 5. Electrical Installation Process

3.2 Discussions

1. Design results

After all the components have been assembled, the results of the assembly can be seen in the image below.

Figure 6. Design Results

After the assembly is complete, the next step is to test the simulation tool for the automatic sliding gate control device. The test of the simulation of the automatic sliding gate control device is the time taken when pressing the button on the remote until the gate reaches the fully open and close position or until the gate stops moving.

2. Test result

By testing the tool five times opening and closing the gate, the following data were obtained.

Tabel 2 Data Pengujian

No	Weight (kg)	Distance (cm)	Open (s)	Closed (s)
1			13.2	13.42
2			12.45	12.78
3	27	130	12.39	13.13
4			12.37	13.34
5			12.17	13.38

With these data, we can find the average time taken, namely:

a. Average time to open the gate

$$\frac{13{,}2 + 12{,}45 + 12{,}39 + 12{,}39 + 12{,}17}{5} = 12{,}52\text{s}$$

b. Average time to close the gate

$$\frac{13{,}42 + 12{,}78 + 13{,}13 + 13{,}34 + 13{,}38}{5} = 13{,}21\text{s}$$

c. Average time diference

13,21 – 12,52 = 0,69s

From the data that has been obtained, the average time obtained with an electric motor of 20 RPM and a gear diameter of 78 mm can open the gate 12.52s and the average time to close the gate is 13.21s, so the difference obtained is 0 ,69s. The use of electric motors and remote controls will make work more effective [18][19].

4. CONCLUSION

Based on the design results that have been made, namely the simulation of the automatic sliding gate control device, it is expected to be able to answer the problem formulation so that it can be concluded that, the dimensions of the gate are 1500mm x 1000mm x 80mm with a weight obtained of 27kg, the electric motor used is reversible AC which has a speed of 1300 RPM, 60 watts of power and a 1:60 gearbox which has become 1 part, the speed of this electric motor is transmitted by a gear with a diameter of 78mm, resulting in an average gate opening and closing speed of 12.52 and 13.21s with a difference of 0.69s, with the control device used is the AK-T02 module and the AKJ027 remote can work up to a distance of 10m.

In the design of this tool still has many shortcomings. Therefore, it is hoped that this design can be developed for more perfect results. The speed of opening and closing the gate can be increased by changing the gears or accelerating the RPM of the motor. However, keep in mind the power and torque of the designed motor of this tool, and later it can be used for its actual form so that people can use it.

5. REFERENCES

[1] Lawrie, Robert J., “Electric Motor Manual”, McGrawHill, 2007.
[2] Kissell, T. E. 2009, Modern Industrial / Electrical Motor Controls, Prentice Hall, New Jersey.
[3] K. Ogata, 2010. Modern Control Engineering, 5th ed. New Jersey: Prentice Hall.
[4] Syahputra, R., Soesanti, I. (2015). “Control of Synchronous Generator in Wind Power Systems Using Neuro-Fuzzy Approach”, Proceeding of International Conference on Vocational Education and Electrical Engineering (ICVEE) 2015, UNESA Surabaya.
[5] Arsitur Studio, 2020. *3 JenisPintuGerbang yang Populer.*
[6] Aslah, Taufan Yusuf., Hans F. Wowor., dan Virginia Tulenan. 2017. *PerancanganAnimasi 3D ObjekWisata Museum BudayaWatuPinawetengan*. E-Journal TeknikInformatika.
[7] Buchari, Muhamad Z., Steven R. Sentinuwo., danOktavian A. Lantang. 2015. *RancangBangun Video Animasi 3 DimensiUntukMekanismePengujianKendaraanBermotor di DinasPerhubungan, Kebudayaan, Pariwisata, KomunikasidanInformasi*. E-Journal TeknikInformatika.
[8] Danielle Collins, 2019. *How to size a rack and pinion drive.*
[9] Fakhri Aziz Firmansyah, 2019. *Pengertian MCB BesertaFungsi, Cara KerjadanMacam-Macamnya.* https://www.nesabamedia.com/pengertian-mcb/. Accessed January 19th, 2022
[10] Gunakarta, 2017. *Gerbang*. https://id.wikipedia.org/wiki/Gerbang. Accessed January 19th, 2022
[11] M.J.T. Lewis 1993. *Gearing in the ancient world*. Elsevier Ltd. ST Louis-USA

[12] Muhammad Reza Furqoni, 2021. *Roda Gigi*. https://teknikece.com/roda-gigi/. Accessed January 19th, 2022
[13] Mott Robert L, P.e, 2004. *Elemen – ElemenMesinDalamPerencanganMekanis* 1, Yogyakarta: Penerbit Andi.
[14] Sularso, & Suga, K. (2002). *Dasar Perencanaan dan Pemilihan Elemen Mesin*. PT. Pradnya Paramita. Jakarta.
[15] Tata Surdia – Shinroku Sito (1999), *Pengetahuan Bahan Teknik*, PT. Pradnya Paramita. Jakarta.
[16] Ugural A. C. 2015, *Mechanical Design of Machine Components.* Second Edition. CRC Press New York-USA
[17] Yan F Huda, MahirMenggunakanAutodesk Inventor Pro 2013 untukMenggambarMesin 3D, ANDI Yogyakarta
[18] Yefri Chan, 2007. *RodaGigi*. ElemenMesin II. Universitas Darma Persada.
[19] Sasmita Behera, Prabhat Kumar Muduli. 2017. Remote Control of BLDC Motor. International Journal of System and Software Engineering. Volume 5 Issue 1, June 2017.