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Solar Powered Sliding Gate Semi Automation of Educational Institute

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***Abstract*— This paper proposes the new control strategy for semi automation gate using solar energy. Semi automatic gate is mostly used in industries, Apartments, Hotels, colonies, colleges and schools. The objective of this paper is to overcome the problem in manually operated entrance gate, which requires more effort to open and close the gate and requires man power. So with respect to this a design for the semi automation sliding gate with the application of solar has been implemented. The main objectives in this paper is to develop a new mechanism with reference to the renewable energy which is safe easily available and to operate at any crucial conditions. In this paper rack and pinion mechanism are used to operate gate. This paper, it also mainly consists of design aspects such as analysis of a stress, load management, and design for selection of material, size of material etc. Therefore, the design is carried out in such way that the durability assessment results are significant to reduce the Cost and improve the over operating efficiency the product reliability.**

I. INTRODUCTION

Semi- automated Gates are in use all over the world to keep things and people in or out. Some gates have sophisticated automatic opening systems with features that include things like remote operation, allowing the user to open the gate with the push of a button. When compared with the manually operated entrance gate which requires more effort and man power to operate the gate manually and hence, It is very tedious job for them. So, there is a need to make a semi-automatic gate opening system. Most commonly, automatic gates are used at the entrance to the facility, and are used to control vehicular access on and off of the site. For example, a manufacturing plant may use an automatic gate at its main entrance. All vehicles entering and exiting the plant must do so through the automatic gate. Automatic gates are also used at interior areas within a facility. For example, automatic gates are commonly used within the inside of a parking garage to separate employee parking areas from public areas of the garage. As and on in the modern times many design of semi-automated gates have come with the application of control system. Therefore, the gate can be opened and closed within specific time and reduces human efforts. Automatic gates are used to control access into a secured area. In this paper a new design with the application of Renewable energy source (Solar energy) is proposed to design a semi-automated gate.

II. PROBLEM DEFINITION

Automatic gates are used to control access into a secured area. Most commonly, automatic gates are used at the entrance to the facility, and are used to control vehicular access on and off of the site. For example, a manufacturing plant may use an automatic gate at its main entrance. All vehicles entering and exiting the plant must do so through the automatic gate. The problem which we have observed is the manually operated entrance gate requires more effort and it is very time consuming because every time security person has to push or pull the gate for every person and vehicle coming inside and going outside. In this paper a new control design & strategy is proposed with the application of solar energy.

III. OBJECTIVES

The main objective in this paper is to design ;

1) The control mechanism.
2) Design of hardware to open/close gate automatically.
3) Design of gate with solar energy.
4) Reduced overall cost.
5) Easy maintenance and high operating efficiency

IV. METHODOLOGY

The main objective in this paper is to design mechanical and electrical aspects to achieve the automation of the sliding gate. In this proposed method we are using rack and pinion mechanism for sliding the gate towards forward and reverse direction. The basic design of this mechanism is shown in the Fig 1 below.

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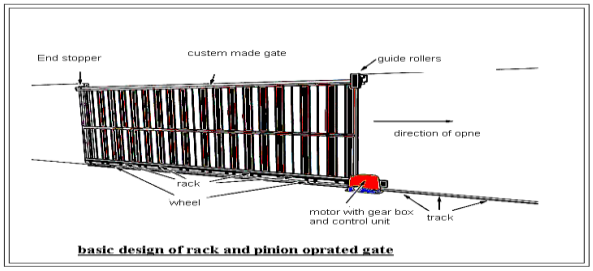

Fig.1. Basic working design of gate

V. DESIGN OF SEMI- AUTOMATED GATE

The design of Semi-automated gate consists of two parts viz., Electrical design and Mechanical design. Fig 2 represents the complete Block diagram of Semi-automated gate. It mainly consists of five modules viz., Power source, Electronic Converter, Induction Motor and Controller. Firstly with the application of solar panels power is stored in the batteries and then it is converted to AC power by the electronic converter which is fed to the AC induction motors, which is responsible to move the gate in forward and reverse direction. As shown in the fig 2, the mechanical load consists of Gate and gear box which works on the basic principle of Rack and pinion mechanism. And Hence overall operations is been controlled by the controller.

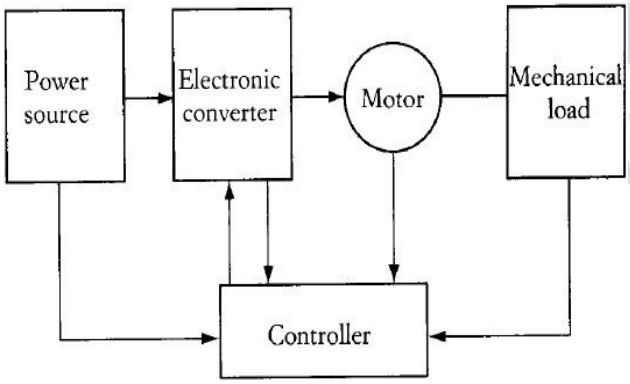

Fig. 2. Block Diagram

VI. DESIGN CALCULATION:

Gate Dimension:-

1. Length of gate door = 35 feet
2. Height of gate door = 6 feet
3. Width of gate door = 3 inches
4. Thickness of each section = 5mm
5. No. of section = 61

Material used for the fabrication of gate door is Mild Steel. The density of M.S is 7.85g/cm^3. Calculations were carried out using above data and mass of gate door was calculated to be 1797.74 kg.

Mechanical Calculations:

1. Coefficient of friction between rollers and track , μ=0.23
2. Assumptions made :
   - Module of pinion, m=2
   - No. of teeth on pinion, T = 30
   - So, m = D/T = D/30
   - Pitch circle dia. D= 60 mm = 0.06
3. Mass of the gate door, M= 1797.74 kg (M≈ 2000 kg, for safer operation)
4. Acceleration due to gravity, g = 9.81 m/s^2
5. Force , F = μ×M× g
   = 0.23 × 2000×9.81
   = 4512.6 N -- (1)
6. Torque, T = F × x
   Where, x= ⊥ distance between rack and centre of pinion

So, x = D/2
= 0.03
Now, T = 4512.6 × 0.03
T = 135.378 Nm -- (2)

7. Velocity, V = Distance/time

Time, t =30 sec
Distance, D= (20 ft /3.3) = 6 m
V = 6/30 = 0.2 m/s
V = πDN/60
0.2 = (π × 6×10^{-3} ×N)/60
N = 63.69 rpm -- (3)

8. Speed of revaluation, N = 63.69 rpm
9. Power required,
   P = 2πNT/60
   = (2× π 63.69× 135.378)/60
   P = 902.45 W -- (4)

We know that, 1HP = 746 W
So, P = 902.45/746
P = 1.21 HP
Let, P ≈ 1.5 HP

10. solar plate power generate=100watt

No. of solar plate = 12

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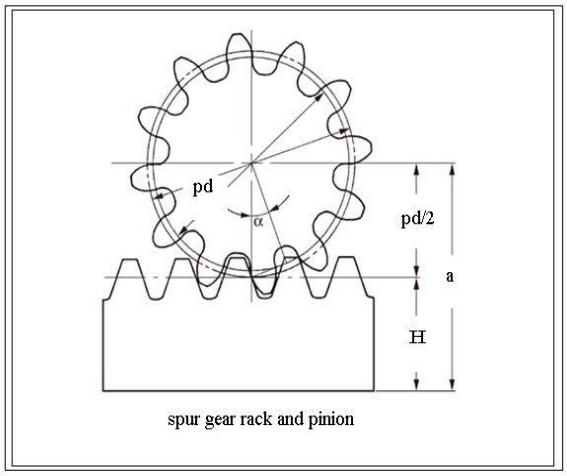

Fig. 3. Basic Rack & Pinion Design

Sr. No.	Equipment	Quantity
1	Induction motor with gear box	1
2	Limit switch	2
3	Ultrasonic sensor	1
4	Rack & Pinion	1
5	Indicator	1
6	Control circuit	1
7	Reverse/Forward switch	3
8	Circuit Breaker	1
9	Solar Plate(4.5×2.5)	6
10	Battery & Inverter kit	1

Table 1. List of equipment's -

VI. SOLAR POWER

Solar energy uses the sun as a source of heat, light or power. Power production comes from such active solar energy as photovoltaic cells, while natural light and heat require only proper orientation of a structure to reap the most benefits from the sun.

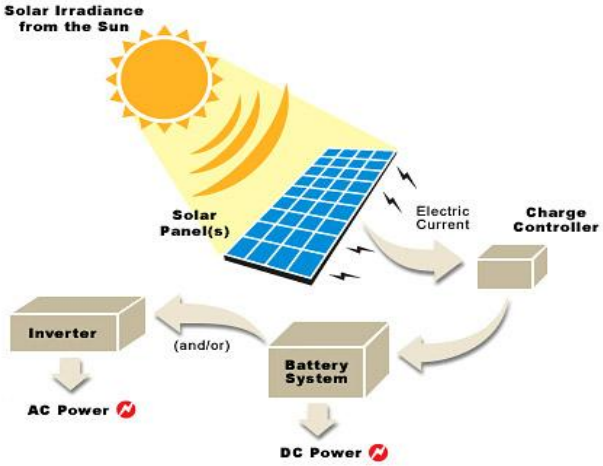

Fig. 4. Solar Energy

Solar energy takes two forms passive and active. Passive solar energy does not require any additional electronics or mechanics and relies solely on the design and orientation of a structure. The orientation of a building, the size and placement of its windows and the type of insulation all play a part in efficient passive solar power. Structures using passive solar energy effectively achieve heating, cooling and lighting while minimizing energy costs. Active solar energy relies on such devices as solar photovoltaic cells to capture energy from the sun. These cells use semiconducting materials to create an electrical charge upon contact with sunlight. A circuit passes this charge to any device requiring electricity. Photovoltaic cells are useful as single panels for small-scale energy needs or in larger arrays to produce energy for larger homes or facilities. Because solar energy is inherently intermittent, many solar power systems utilize some means of storing energy for cloudy days. When storage is not possible, a backup power system provides energy when necessary.

A. Solar panel

Photovoltaic (PV) solar panels are made up of many solar cells. Solar cells are made of silicon, like semiconductors. They are constructed with a positive layer and a negative layer, which together create an electric field, just like in a battery. When photons hit a solar cell, they knock electrons loose from their atoms. If conductors are attached to the positive and negative sides of a cell, it forms an electrical circuit. When electrons flow through such a circuit, they generate electricity. Multiple cells make up a solar panel, and multiple panels (modules) can be wired together to form a solar array. The more panels you can deploy, the more energy you can expect to generate.

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This generated energy is stored in battery unit by using solar charge controller then this supply is given to the motor through PWM type three phase inverter.

IX. CONCLUSION

This paper centered on the design, construction and development of an semi automated entrance gate system. This automatically gate is most useful in residential commercial, industrial area and simply to operate at any condition. Because of atomization, no manual force requires.

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