Review Paper For Drive Train Optimization of Electric Vehicle With GWO

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Abstract- *The model will develop on the Simulink tool of Matlab. A Metaheuristic optimization algorithm GWO (grey wolf optimization) used to optimize the gain parameters of PI control. GWO based optimized PI controllers can adjust their gains values (K_p and K_i) in correspondence to deviations of EV speed and torque and results in stable speed and torque conditions. The proposed optimization controllers are having advantages over conventional controllers in terms of its robustness, to achieve better EV stability, no speed overshoot and accurate speeds. The GWO optimizer constantly monitors and controls the EV speed errors and effectively distributes the driving forces by considering the EV and road constraints.*

Keywords- GWO, PMSM Motor, PI Controller, Electric Vehicle Drive Train, Battery, Motor, Matlab.

I. INTRODUCTION

In the present scenario, the fuels demand is high, and their consumption increases. Due to the uses of these fuels in the vehicles Co_2 gas dissipated in the large amount. The carbon dioxide gas effect the environment varies badly. The Co_2 reduction is the main challenge, and it can be achieved by the Eco-friendly vehicle or car called Electric vehicle (EV). Due to the increasing cost of the fuels in the present days, the fuel cell vehicle is not economical. The EVs are very economical due to their driven process achieved by an electric motor. They do not pollute the environment. The cost of the batteries and motors are stable, so EV prefers than the fuel based vehicles.

The Electric Vehicle developed by the motor, battery, controller, converters, and wheels. The motor connected to the differential of the wheels. Figure 1 shows the block diagram of the electric vehicle construction.

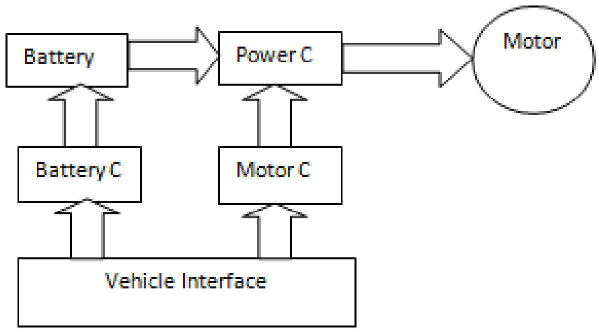

Figure 1 Electric Vehicle Drive Train [2]

An electric vehicle has the six main components as shown in figure 1

- Battery
- Motor
- Battery controller
- Motor controller
- Power electronics
- Vehicle interface

1.1 Battery

There are four different types of batteries used in the electric vehicle:

- Lead- Acid battery
- Nickel- Metal Hybrid battery
- Sodium/ nickel chloride
- Lithium-ion battery

Lead-Acid battery- The lead acid battery commonly used in the electric vehicle for the starting purpose with internal combustion engine for a very long time. Since electric vehicle were presented there is no replacement of the lead-acid battery. The lead-acid battery is very heavy in weight, but the cost is low and required rapid charge capability. Due to low specific energy capacity, the lead-acid battery is not used at a large scale [2].

Nickel- Metal Hybrid battery- in the present days the Ni-MH battery produced in the high volume for the electric vehicles. This type of battery has the double specific energy of the lead-acid battery. Therefore the lift cycle of Ni-MH battery very long and discharge rate is very small. Ni-MH used in the hybrid electric vehicles due to the rapid charge capability. It cannot be used for the pure electric vehicle because they needed the specific power for the working.

Sodium/Nickel Chloride battery- The Na/Nicl2 battery required the inner operation temperature approximately 300^0C. The temperature is very high so the proper insulation required for the internal portion of the vehicles. The energy losses are also high nearly 5W at per KWh due to the higher thermal losses of battery the battery cannot be used in the electric vehicle. Battery having lower specific power and longer life cycle uses for the hybrid vehicle application — the lithium ion battery used for the pure electrical vehicle due to their minimum heat requirement. The heat requirement for Na/Nicl2 battery is more than the Li-ion battery.

Lithium-ion battery-it is the latest invention in the field of batteries. The Li-ion battery used for the mobile and laptops in the starting period but now they can use for the automotive applications. The batteries contain cells which having a high voltage of 3.2 to 2.4 volt for each of them. The cells high voltage rating reduces the number of quantity of cells which affects the size of the battery. The Li-ion battery has a high specific capacity with the lower weight. The weight of the Li-ion battery for 20kw capacity is 180 kg, but lead-acid and Na/Nicl2 have 500kg and 300kg for the same rating battery. The entire requirements for the electric vehicle fulfill by the lithium-ion battery.

1.2 Motor

The traction motors are the basic components of the electric vehicle. There are two categories of motor available in the market; DC motor and AC motor. Both categories have different advantages and disadvantages. In this work we proposed AC motor which has the following requirements;

- For small motor design, high voltage and power density required
- Motor requires high torques at starting and climbing the stage and low torque in running condition, also high power for the high speed.
- High reliability and robustness.
- Low noise and cost.

II. LITERATURE SURVEY

Noëlle Janiaud et al. [2010] -presented different types of electrical vehicle drive train. The modeling of drive train platform performed on the Matlab Simulink tools. The model was developed based on optimizing performance and efficiency of the power train. The model was simple in construction. The optimization process considered for the range and performance of the model. In case of power train control laws the software optimization used and hardware optimization used for the system architecture. Both the optimization algorithms were complimentary and progressed in the loopback. This model was used to select the battery technology and parameters as per the requirements [1].

Y Mastanamma et al. [2017]-provided the simulation model of full electrical vehicle in Matlab/Simulink platform. The model developed to examine the power flow in case of motoring and generating the condition. The main system of the drive train has key components where each contains the motor, battery, motor controller; battery controller was acknowledge and modeled by using their mathematical equations. The basic parameters like torque and speed condition play important roles in terms of motoring and generating mode [2].

Jony J. Eckert et al. [2017]-presented the detailed analysis of an optimal configuration of the drive train. The configuration of the drive train depends on the multi-cycles in case of plug-in electric vehicle. There are four different configurations of drive train modeling were analyzed. Different motors and differential wheels were used in the four different configurations. The identified best configuration from the various model genetic algorithm of optimization proposed which analyzed the speed and torque characteristic of motor and performance of the EV model. The battery discharge was reduced due to the power management control which stables the power demand in the drive system. The reference driving cycles were FTP-75, HWFET and US06 tested for all the EV configurations [3].

Yu Wang et al. [2016]-provided the combination of EV power train model with the detailed model of two-speed dual clutch transmission system. The design parameters of this model were electric machine, wet clutch design in multi-plate, gear ratio change and gear shift change. The proposed model developed on the Matlab platform and applied to maximize the efficiency of the electric power train using the genetic algorithm. After the optimization, the different optimal results were analyzed on the new Europe drive cycle and urban dynamometer driving schedule. Therefore it was necessary to design the comprehensive model and optimization for a combined model. The greenhouse gas effect will reduce up to 40% in 2020[4].

P. M.W. Salehen et al. [2015]-proposed battery management system (BMS) by using the power performance optimization. The BMS is the main tool which provides the readable power management system. The fuel cells vehicles polluted the environment very badly, so as per the Go green campaign Hybrid Electric Vehicle (HEV) and Electric Vehicle (EV) mostly used since 2009. The main source of the EV is batteries; all the parameters of a vehicle depend on the life of the battery. The power management system affects the battery condition, so the optimization process provides the optimal condition of the battery management system [5].

Aalok Bhatt et al. [2016]- provided the step wise step mathematical calculations of the electric vehicle simulation model. The well known electric vehicle called Mahindra e2o from the popular brand in India Mahindra and Mahindra was simulated on the Simulink platform of Matlab. The performance evaluation of the EV model depends on the various speed inputs which provided the better state of charge of battery and vehicle range. After analyzing the performance of the electric vehicle concerning its range and battery state of charge then summarized the input parameters variations in the end [7].

Das et al. [2014]-proposed a mathematical model for the connection of Electric Vehicle to the grid. The integrating of EV with the grid help to improve the efficiency of the system and several numbers of EV can be charged at the same time. The peak hour energy was provided to the grid using integrating EV. In this study, a mathematical model was developed in which dual process achieved like energy transfer from EV to grid and grid to EV simultaneously. The proposed model is called Capacity loss (CL) model. An economical financial model was discussed based on different energy loss and grid loss [8].

Wicaksono et al. [2015]-presented a model of electric vehicle with the optimal design. The optimal design of the EV model is that which required minimum energy and provide maximum average speed — the optimal design EV constructed by Stateflow and Matlab. The various driving situations were tested on this model like, wind/drag; slope, etc. to minimize the battery discharge capacity. An optimal nutshell control and linear quadratic regulator managed to minimize the energy consumption of the EV model. Two simulation models were compared to each other on the Matlab platform. Our proposed model provided the minimum energy consumption for EV and the maximum average speed at the output of EV [9].

Zhou et al. [2014]-provided the advantages of physical, electric vehicle tool while compared with the Matlab software EV model. The model which was developed on the Matlab Simulink platform only tested in the single environment condition. But physical model tested in the various environment and conditions. The physical model of EV has multiple running rates and several solvers configurations. This model can easily simulate the power electronics nature both on the switch and average level. The proposed model developed on the Matlab platform and applied to maximize the efficiency of the electric power train using the genetic algorithm. For the heavy uses an Automated Mechanical Transmission (AMT) model developed for an example city bus. In this case, discontinues nature and longitudinal vibration was simulated [10].

III. OPTIMIZATION

Optimization is the process of finding the best value for the variables of a particular formulation to maximize or minimize an objective function called as an optimization. Optimization used in the various fields of research. There is two basic need of the optimization process, the parameters of the problem are identifiedby their nature (problem can be analog or digital), and constraints which applied to the parameters have to be recognized. The objective function of the given problem should be identified which can be classified as a single objective and multi-objective. Therefore the parameters selection, constraint recognition, and objective investigation employed to resolve the problem.

Optimization Problems

The main components of the optimization problem described below;

Objective Function:

It is mathematical expressions of the optimization problem which can be minimized or maximize as per the need. There are two categories of objective function single level and multi-level. The main aim of the objective function is to define the problem and provided the optimal solution based on variables. The variables provide the input to the objective function which further minimized and maximized.

Variables:

The set of unknown quantities which are a basic requirement of an objective function called variables. These variables are used to express the aim and limit of the problem. The variables cannot be selected randomly; all the time's variables are chosen as per some limit and needs of the objective function. The format of variables is Boolean, discrete and non-stop.

Constraints:

It is the set of limits which allows the variable to update as per random value with excluding the other one. It is also called the condition which followed by variables at the time of optimization. The feasible solution of the problem achieved as the value of the variable.

IV. GREY WOLF OPTIMIZATION (GWO)

The grey wolf optimization algorithm inspired by the hunting behavior of the wolves. The wolfs are lived in a group. There is 5 to 12 member of wolfs present in a group. The wolfs are the top of the food chain. The dominance of wolfs in a group decreases from top to down. As shown in the figure 3.1, there are three categories of wolfs.

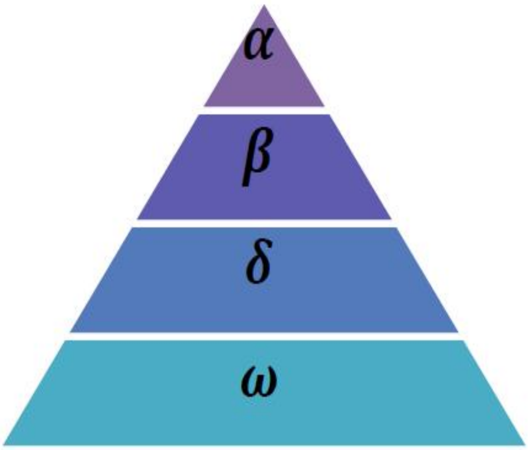

Figure 2 hierarchy of a grey wolf

Alpha (α) are the leaders of the group which have the authority to take a decision. They may be male and female which responsible for the making decision like hunting, place of sleeping and so on. The alpha member provided the good management to the group but they are not the strongest one. They work as an organization and maintained discipline in the group which is most important than the strength.

The next member is Beta (β) wolves in the group. The beta can be male or female, and he/she plays the role of advisor to alpha. The beta wolves help the alpha wolves in decision making and providing a command to the lower member of the group. They are the replacement of the alpha wolves in case of alpha passes away or become old. The delivered the command of alpha in the entire group and giving feedback response to alpha.

The lower member of the wolves group is omega (ω). The omegas play the role of scapegoat. They are the last member of the group which allowed eating. These are not the important member of the group but the entire group face internal problem while losing any omega. Some omegas in the group work as a babysitter.

V. CONCLUSION

In this review paper, the proposed model will developed on the Simulink tool of Matlab. A Metaheuristic optimization algorithm GWO (grey wolf optimization) used to optimize the gain parameters of PI control. Proposed EV wheel drive system which is having individual front and rear control, improves the EV performance such as torque and speed stability, steer ability, drivability, and safety at low speed and high-speed operations.

The scope of the present work can be extended by developing efficient controllers that can reduce the charging time of the EV battery.

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