Design and Fabrication of Hybrid Electric Bicycle

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Abstract - *The purpose of this study is to increase the battery life of hybrid electric bicycle. During peak loads where high power density is required current from super-capacitor will be drawn and will be provided to the Lithium iron phosphate battery (LiFePo4) through the boost convertor. Now boost convertor will provide the current to the LiFePo4 battery. In this way we can increase the life of battery.*

Key Words: Battery life, super-capacitor, boost convertor, peak loads, Lithium iron phosphate battery.

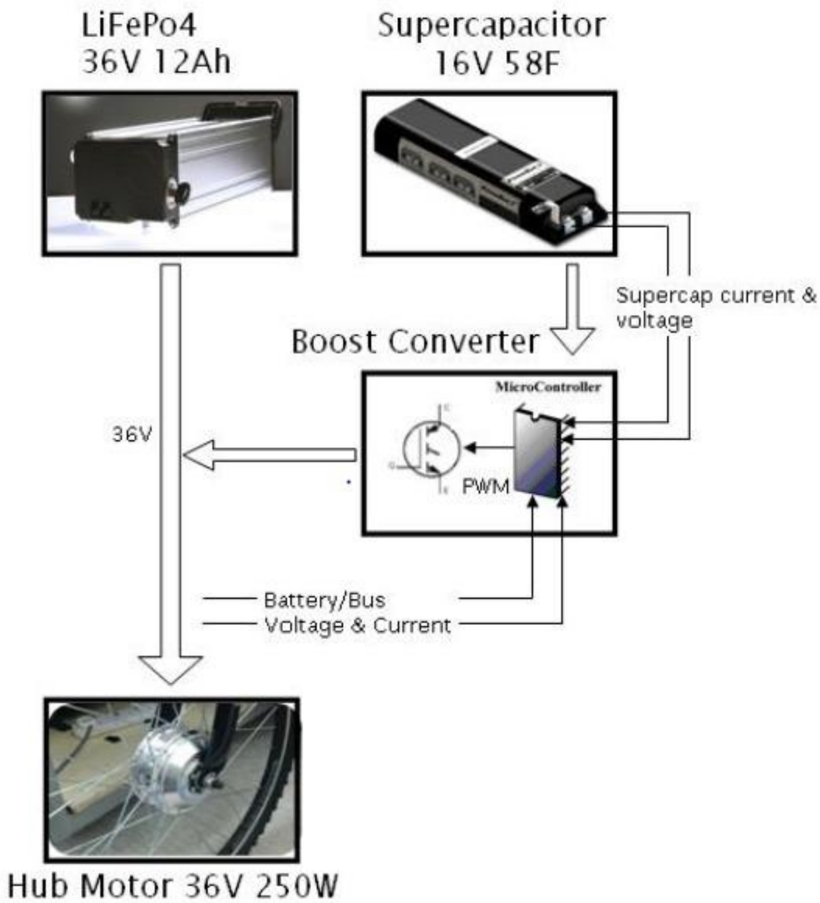
1. INTRODUCTION

The most trending invention of this decade is electrical vehicles (EV) which are widely utilized around the world. The driving distance of the vehicle is strictly restricted up to energy storage of inbuilt battery. The important feature of this EV is that it is able to recover the energy during braking. The operation of brushless DC motor is to be controlled to generate enough amount of force during braking and this braking energy is being recovered as much as possible and finally, the energy can be stored in super-capacitor and then, it is being reused to increase the driving force, driving distance and system efficiency. Each complementary energy sources having its own advantages and drawbacks but among alternatives, super-capacitor will assist the vehicle battery during peak power demand effectively. To achieve the overall efficiency in regenerative braking system, it needs to make a decision on the power split between the battery and the super capacitor. Therefore, the proposed a strategy will increase the characteristic of EV during regenerative braking also the as efficiency of battery, range, life of battery, pickup, capacity.

2. Methodology

The study is all about hybrid electric cycle. So in this the main innovation is to use hybrid energy system rather than using a single battery source. Now hybrid energy system consists of super capacitor and boost convertor

Now generally what happens is in a single battery source where there is only battery and motor, the range and life of battery reduces during peak loads or during inclined planes where high power density is required for the motor, there the battery itself provides the voltage directly and which reduces the life span of the battery. And therefore to tackle this problem we have implemented a concept of hybrid energy system, wherein during the inclined plane or peak loads where high voltage is required the super capacitor will provide the necessary voltage which was earlier provided by the battery. But the super capacitor is of 16 V but the battery is of 36 V now to achieve 36 V we will be using a boost convertor which can boost the voltage provided by the super capacitor from 16 V to 36 V. And once the desired voltage is achieved the boost convertor will automatically cut off and then battery will be providing the voltage to the motor. In this way life and range of electric cycle increases, which was less before.



3. Simulation through PI controller

The simulation of the HESS for EV was operated on MATLAB/SIMULINK and was evaluated for its dynamic performance. The simulation with PI controller was implemented first and its results were obtained. Then, the simulation with Artificial Neural Network (ANN) was carried out and tested for system parameters. The two control strategies were mainly compared against three parameters i.e. battery current, super-capacitor current and load voltage.

The simulation results of PI control strategy are shown in the figure Q below. The battery current, super-capacitor current and load voltage are assessed for their stability and response time. Distortion, noise and ripples are observed in the output signals. The battery current is smooth than the super-capacitor current where the instantaneous rise edges pester the signal.

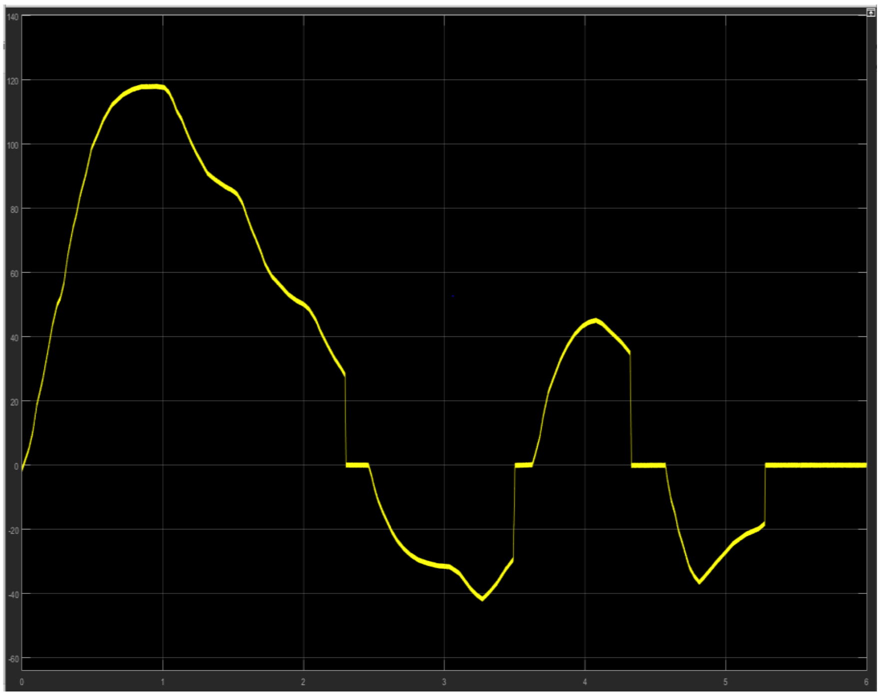


Fig -3.1: Battery current

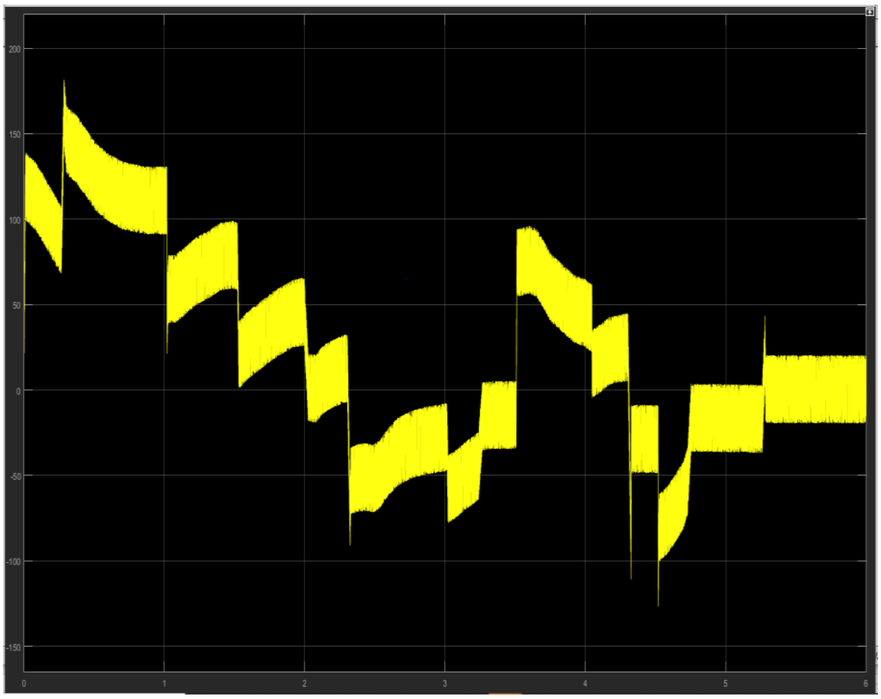


Fig -3.2: Super-capacitor current

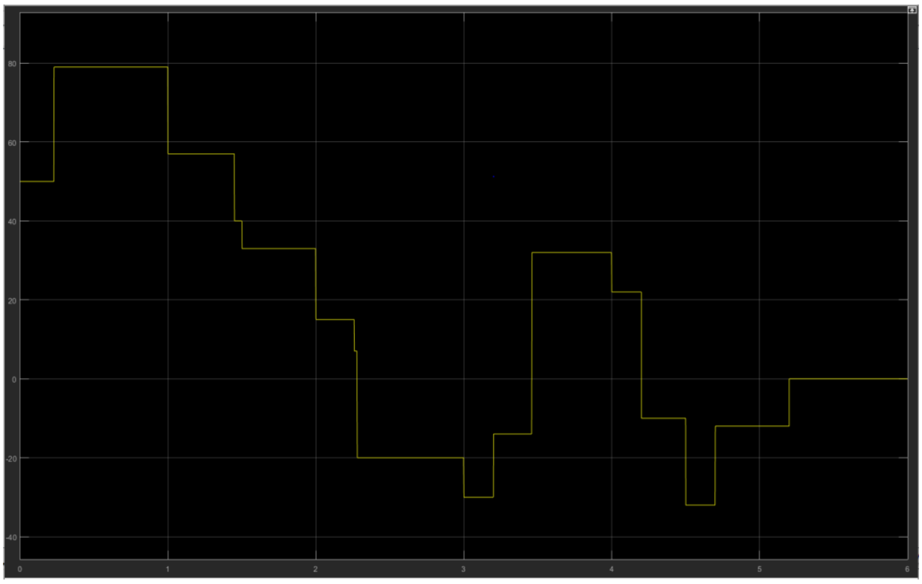


Fig -3.3: Load current

Fig -3.4: Load voltage

Fig -4: Simulation results of HESS applied on EVs with PI Controller.

4. Simulation through ANN controller

The simulation results of HESS applied on EVs with Artificial Neural Network based control strategy is shown in figure below. This simulation result is also scrutinized for battery, super-capacitor, load currents and load voltage respectively. In this case, responses recorded show the exact same response as obtained with PI controller, but with much more reduction in the amplitude of noise and distortion.

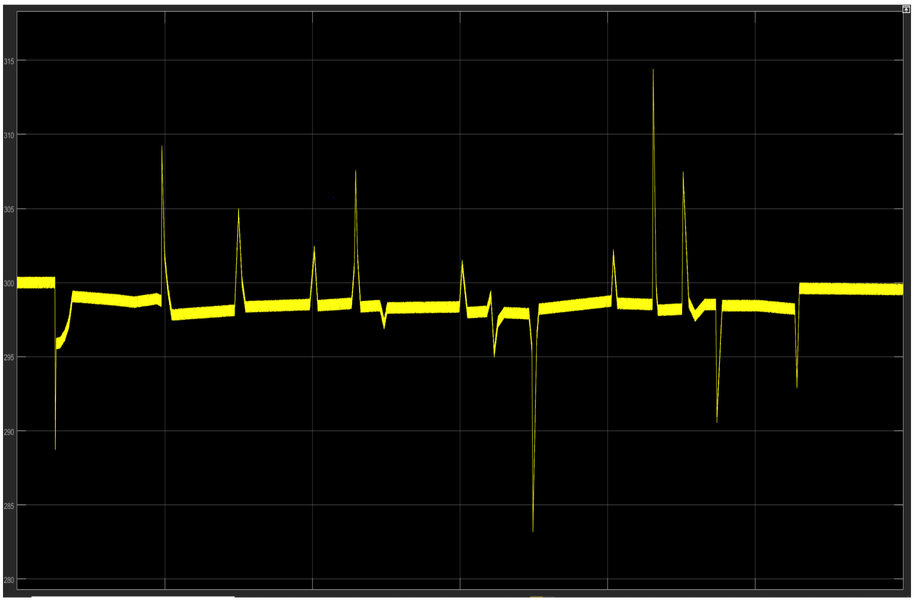


Fig -4.1: Load voltage

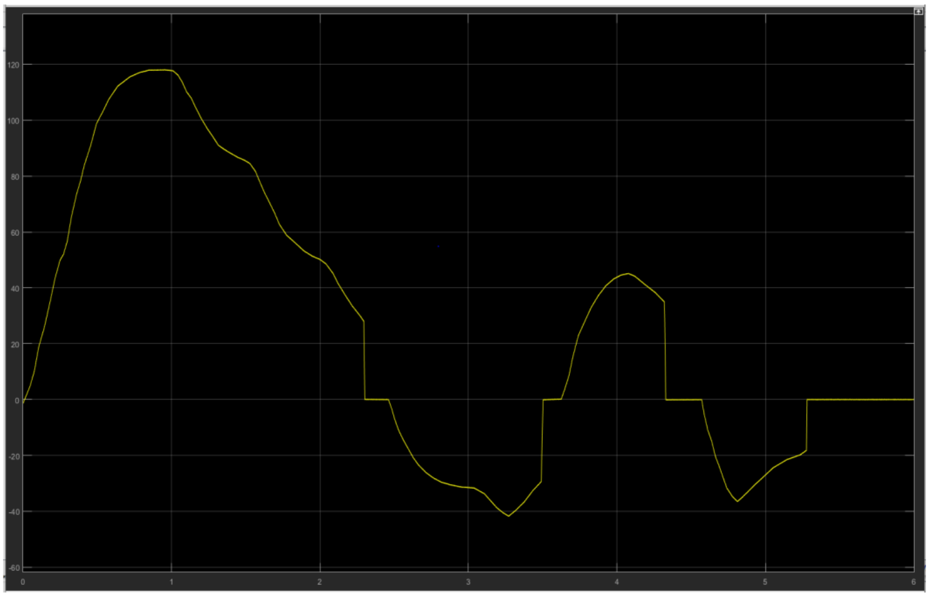


Fig -4.2: Battery current

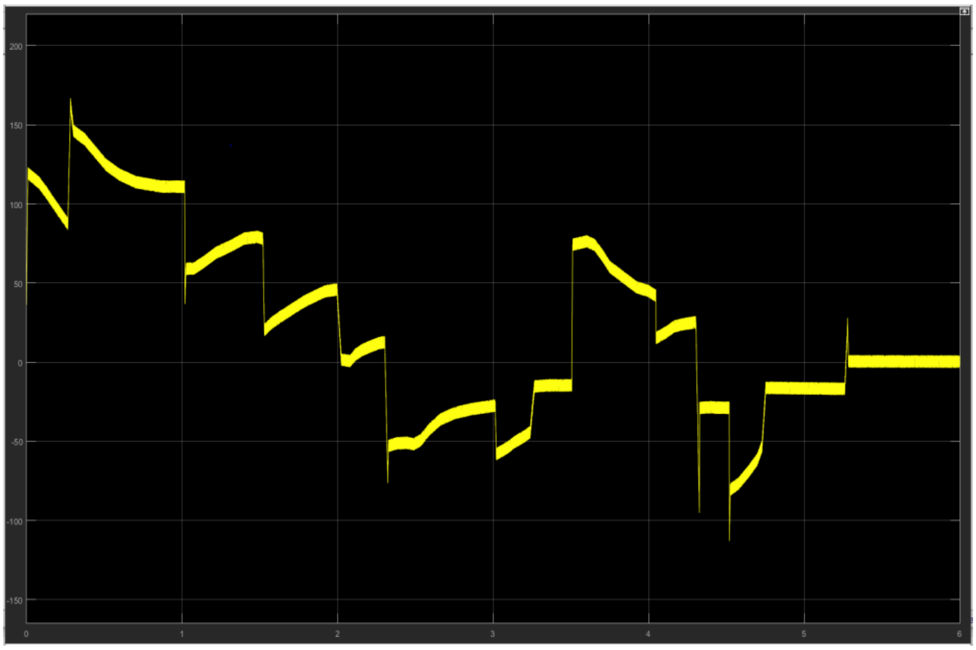


Fig -4.3: Super-capacitor current

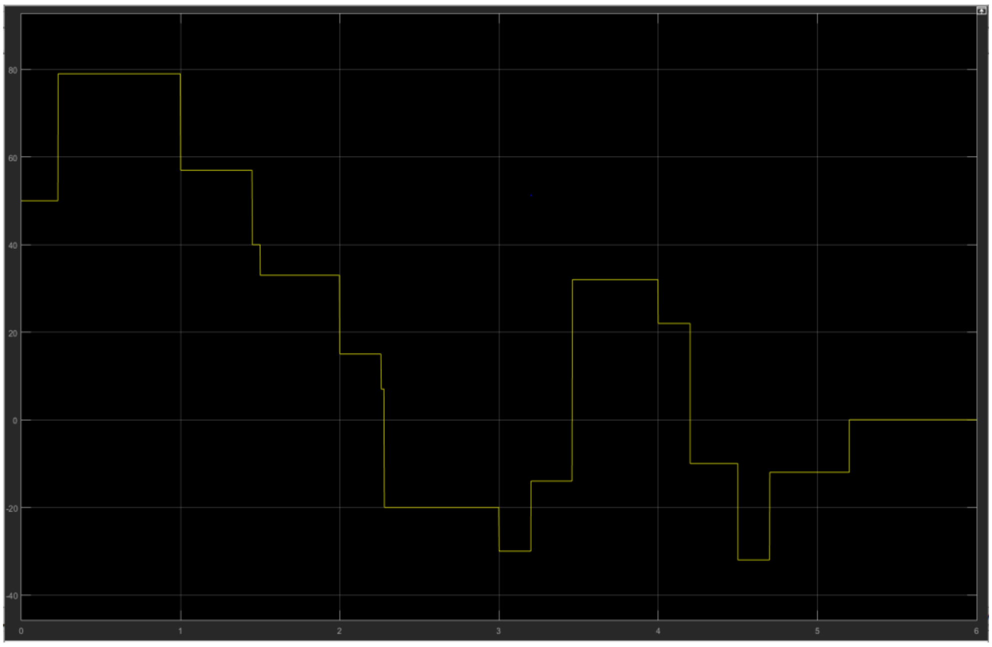


Fig -4.4: Load current

Fig -5: Simulation results of HESS applied on EVs applied with ANN based controller

Through these graphs on MATLAB we studied the electrical response of battery and super-capacitor in order to eventually understand battery life extension. PI controller is being used so that we can get feedback. Now to improve harmonics and notches by the PI controller we have used Artificial Neural Network.

As seen from the simulation results of the two control strategies, the responses from the ANN controllers are smooth and the distortion in the current and voltage responses are lesser than responses obtained from PI controller. Improvements with the ANN controller are shown in the graphs below. In graphs it is clear that the distortion is reduced with ANN controller and the noise amplitude in the load voltage is also brought down to 315 when compared against the PI controllers. Both control strategies did not have any discrepancy when the load current was scrutinized. Reduction in the noise and distortion will increase the vehicle battery life and it is performance will also increase by a great margin.

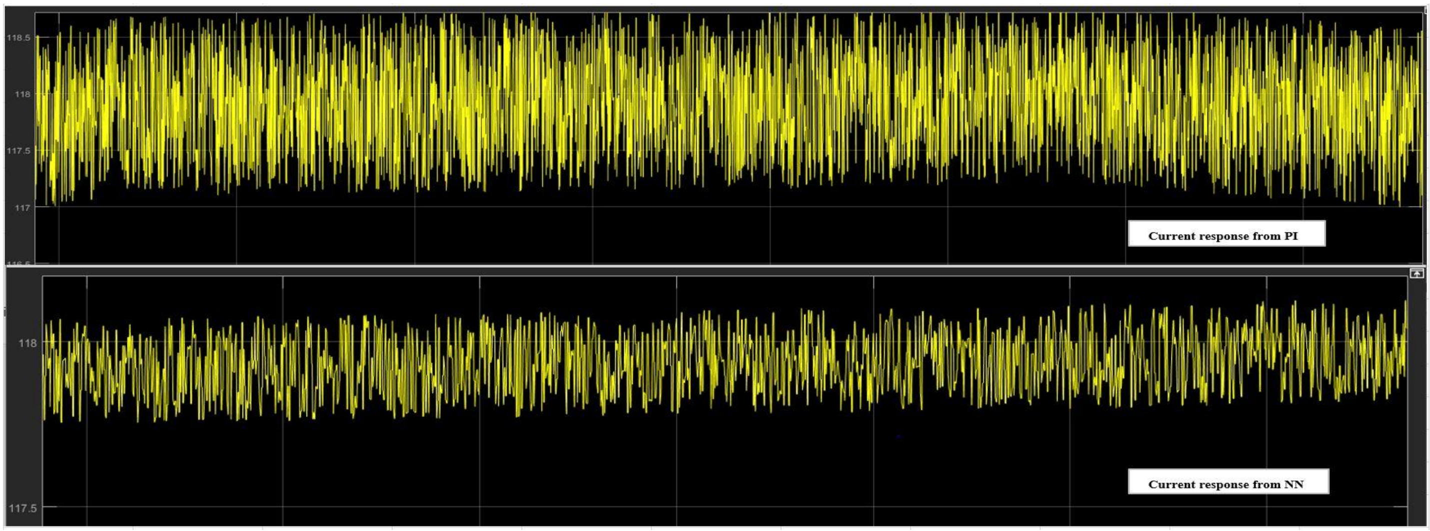


Fig -4.5 -: Graphs comparing battery current responses from PI and ANN based controllers

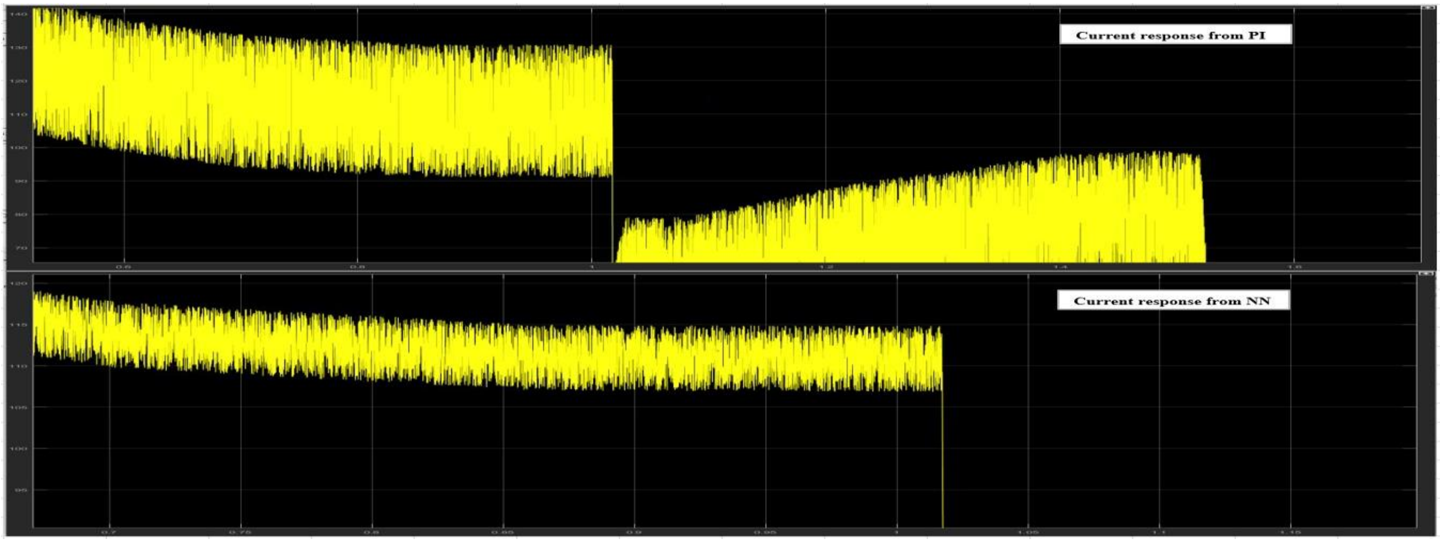


Fig -4.6: Graph comparing super-capacitor current responses from PI and ANN based controllers

Fig -4.7: Graphs comparing load voltage responses from PI and ANN based controllers.

Above graphs give a clear glimpse that ANN controllers are better than PI controllers since it reduces the notches which in turn increases the life of the battery.

5. CAD model of E-cycle

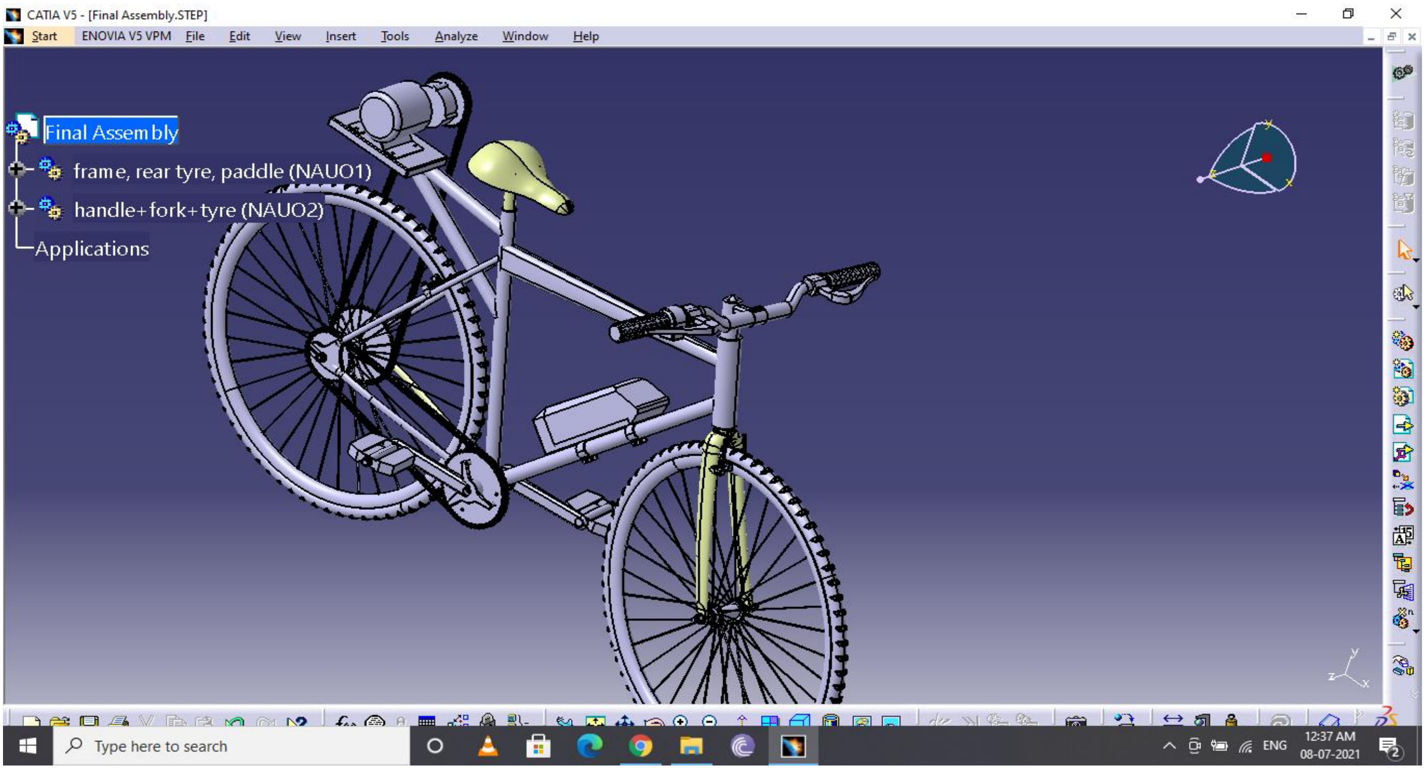


Fig -5.1: CAD model

Fig -5.2: Pictorial representation of E-cycle

We worked on the Computer Aided Three-dimensional Interactive application (CATIA) to show how the cycle would like. The BLDC (Brushless DC electric motor) motor will be fitted on the carrier through a belt which in turn will be connected to a chain. The motor rating is 36V, 250W. Super-capacitor is placed on the connecting rod rating is at 16V, 58F. LiFePo4 battery has a rating of 36V, 12Ah.

6. CONCLUSION

Using the hybrid electric vehicle i.e. making the use of the super-capacitor, boost convertor and BLDC motor we were successful in increasing the life of the battery which contributes in a big way to the humanity. Decreasing the usage of IC engines and acknowledging more of electric vehicle will surely be beneficial for the society.

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