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Minimizing Energy Losses in the modern E-bikes by New Integrated Strategies for Adaptive Control

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Objectives

- **Introduction**
- **Mathematical model**
- **Simulation by MatLab**
- **Psice model for discharge**
- **Prototype produced by University**
- **Measured results**
- **Power estimation**
- **Power validation and Future work**
- **Conclusion**

1. INTRODUCTION

- This paper presents a study on the mathematical equations of discharge and optimal operation of batteries used in modern travel systems;
- Use in real operating conditions is very difficult due to the multiple parameters that affect their performances;
- The paper aims to operate a methodology for evaluating and estimating the most important parameters that affect their performance;
- The article will review the relevant aspects of the practical realization and the main challenges due to the measurements and experimental validation.

2. MATHEMATICAL MODEL

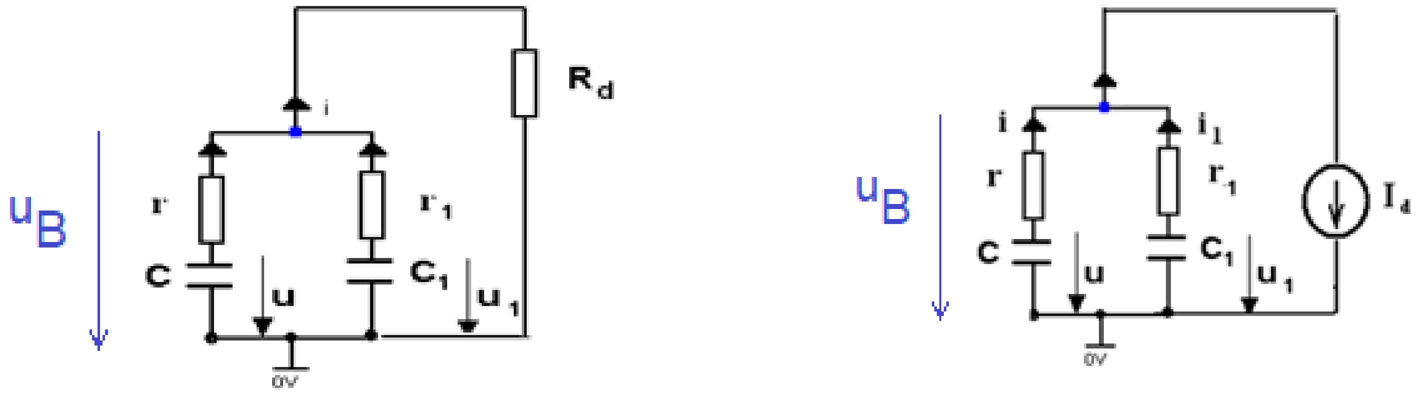
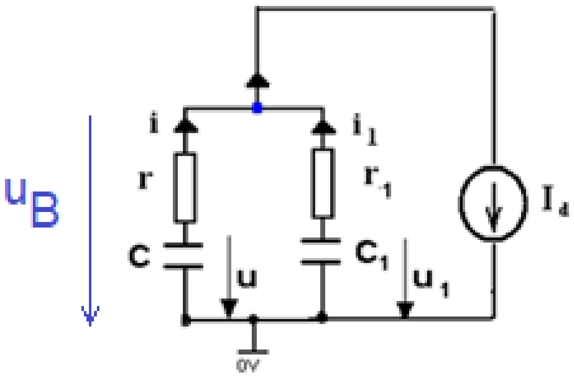


Fig. 1. The mathematical model of the battery discharge at constant load a). and constant current b).

$$u_B = u + rC\frac{du}{dt} = \frac{uR_d\left(1-\frac{r}{r_1}\right) + (u+u_1)R_d\frac{r}{r_1}}{R_d + r + R_d\frac{r}{r_1}} \qquad \textbf{(2)}$$

$$u_B = u + rC\frac{du}{dt} = \frac{u_1 r + u r_1 - I_d r r_1}{r + r_1} \qquad \textbf{(5)}$$

3. MATHEMATICAL MODEL
– simulated by Matlab



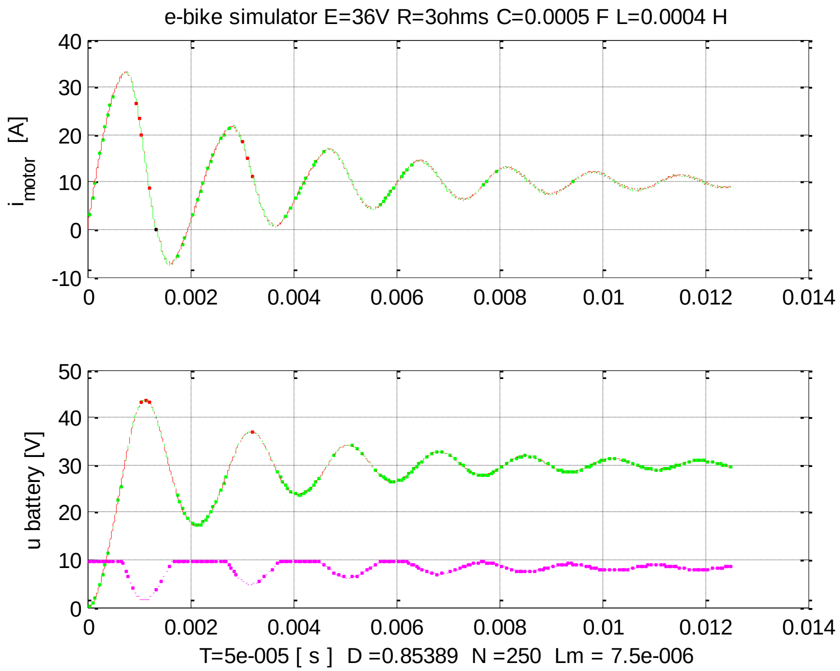


Fig. 2. The mathematical approach for e-bikes batteries with 36 V and 11 Ah

4. SIMULATION AND MEASUREMENT RESULTS
Pspice Schematic

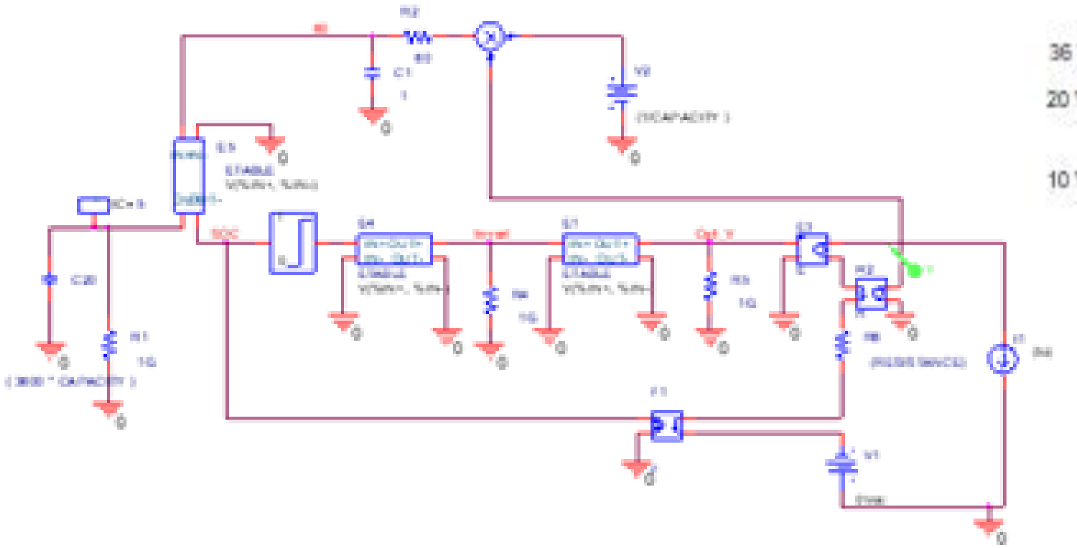
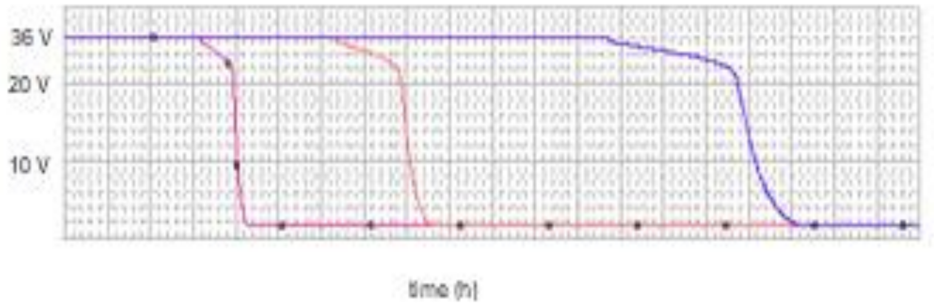
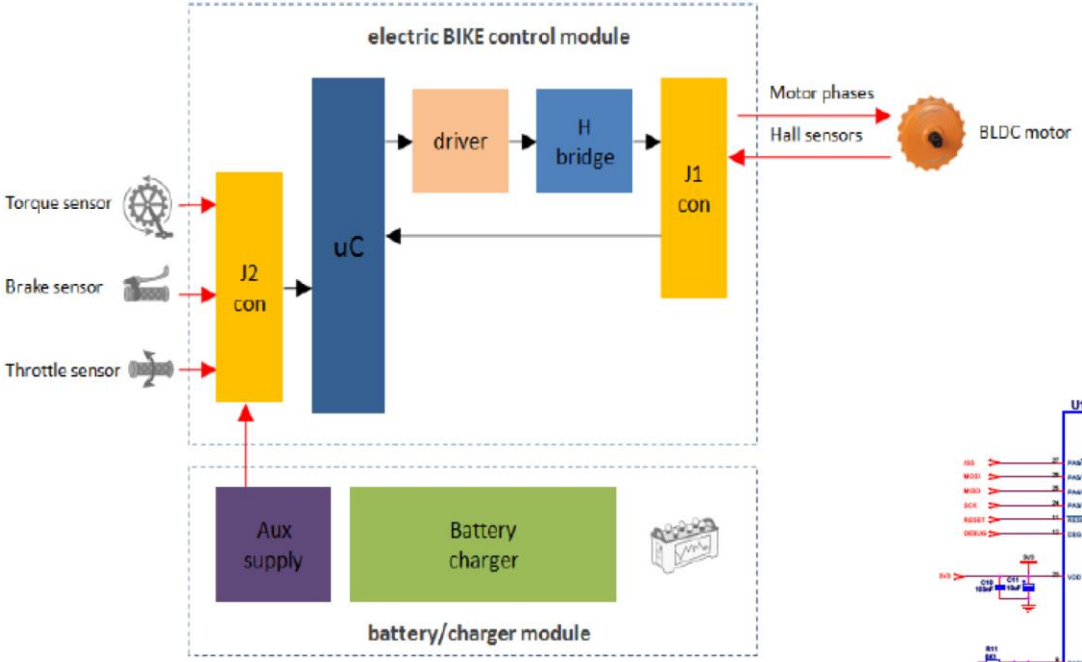


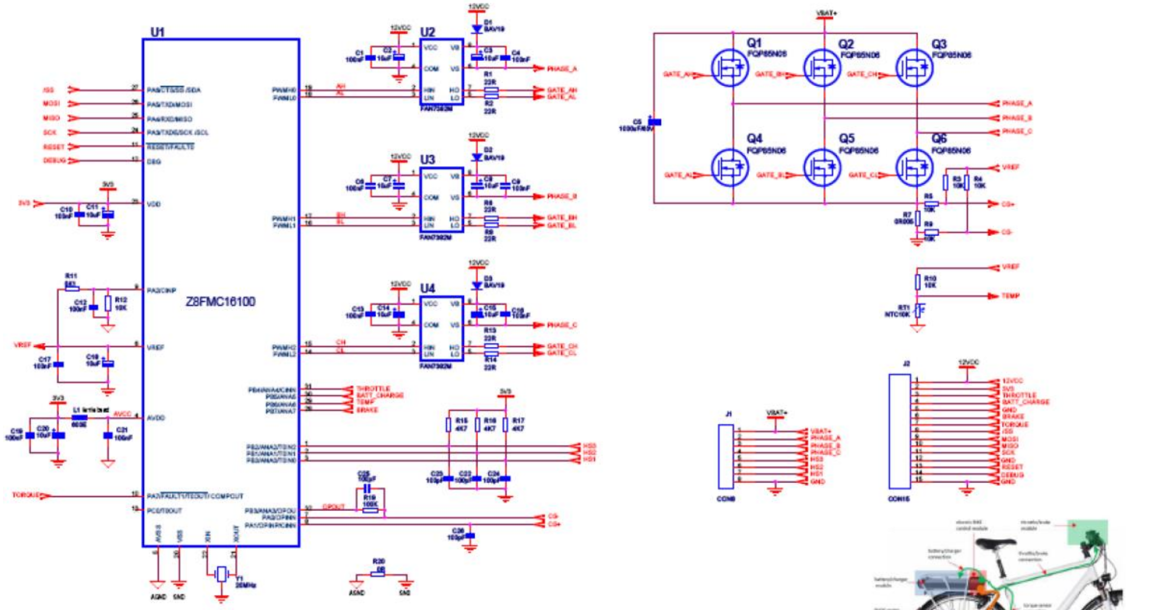
Fig. 3. The schematic model of the battery discharge at constant current load.



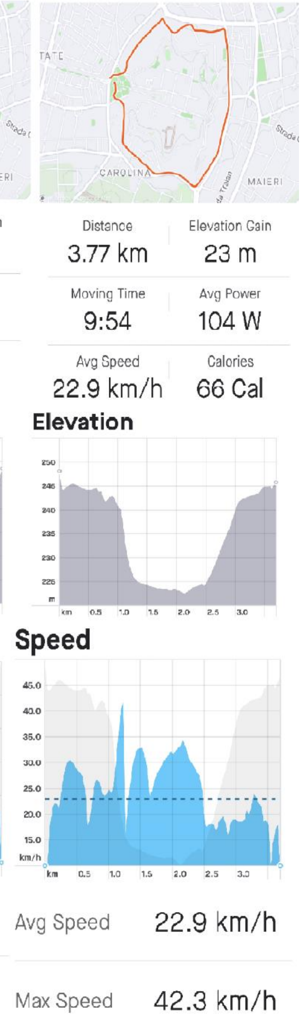
(36V11Ah)	Experimental	Simulated
Io=1A	12 h	16 h
Io=3.5A	6 h	8 h
Io=11A	1.5 h	1.8 h

5. Prototype - 1 DECEMBRIE 1918 University





6. MEASUREMENT and RESULTS



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7. POWER ESTIMATION

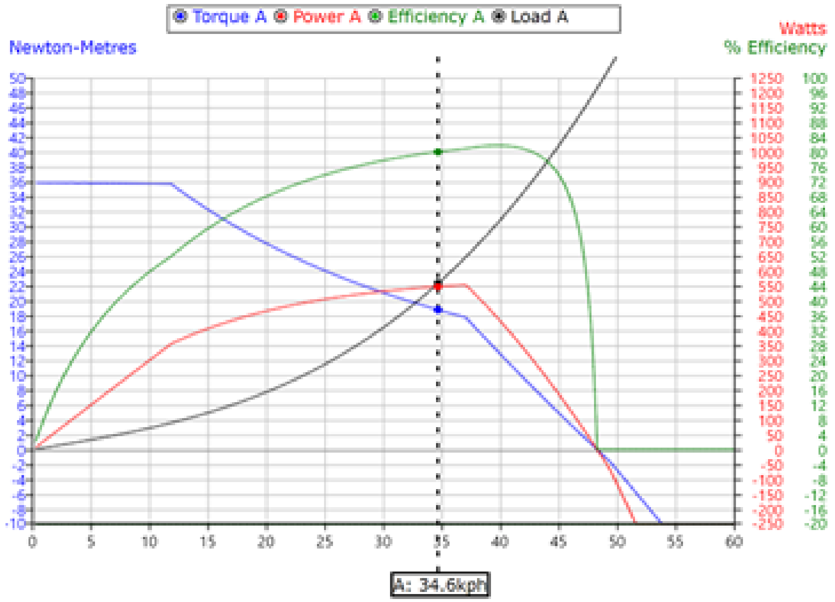

Fig. 10. The simulation result for a road with 2% grade

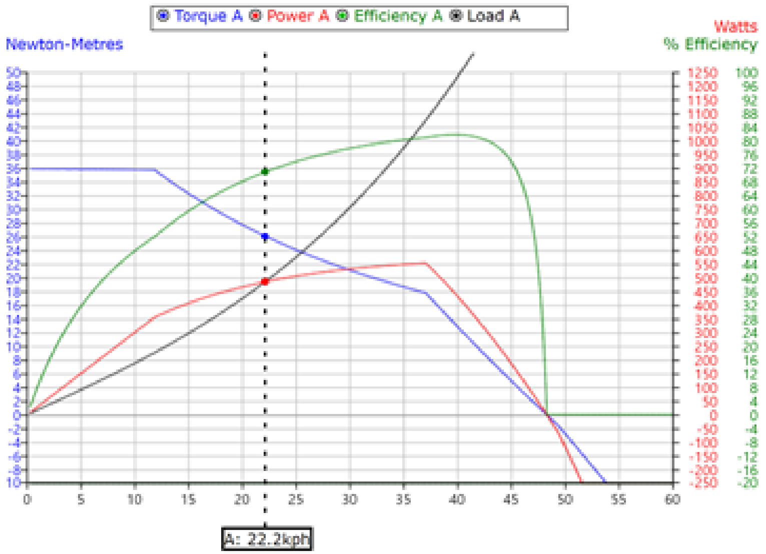

Fig. 11. The simulation result for a road with 7% grade

Human Pwr (W)	Wheel Torq (Nm)	Mtr Pwr (W)	Load (W)	Eff (%)	Speed (kph)	Mtr RPM	Mtr Current (A)	Batt Pwr (W)	Batt Current (A)	Batt Volts (V)	Acc (kph/s)	Consump (Wh/km)	Range (km)	Overheat In (mins)	Final Temp (°C)
96	17.7	552	648	80.9	37.0	297.6	20.7	682	19.9	34.3	-0.00	18.4	22	never	61
108	17.4	544	656	81.0	37.3	299.2	20.4	672	19.6	34.3	-0.02	18.0	22	never	60
120	17.1	539	662	81.1	37.4	300.4	20.1	664	19.3	34.4	-0.02	17.8	23	never	59
132	16.9	533	668	81.2	37.6	301.6	19.8	656	19.1	34.4	-0.01	17.5	23	never	59
144	16.6	527	675	81.2	37.7	302.9	19.5	649	18.8	34.5	-0.01	17.2	24	never	58

8. POWER VALIDATION AND FUTURE WORK

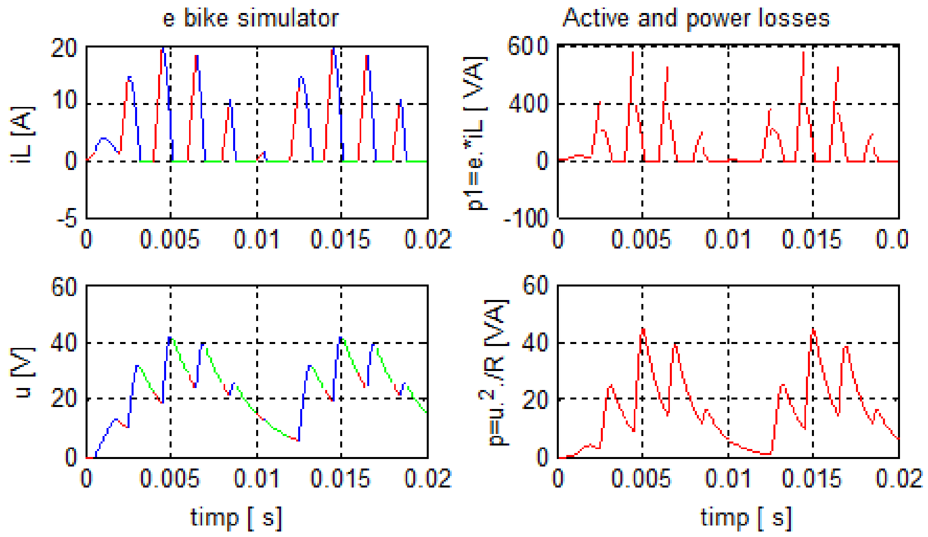

Fig. 12. Power estimator as function of speed and load

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Thank you for the kind attention!