

Experimental result of the Formula Electric
Car Physical Parameters:
Torque Array Plots from Dyno Data
(Spring '16)



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Hypothesis

Theoretically, current has a linear relationship to torque when motor speed is held constant as in figure 1, while torque has a hyperbolic relationship to motor speed when current is constant in figure 2. Thus, experimental data should ideally show an array of relationships as shown in figure 1 and 2¹.

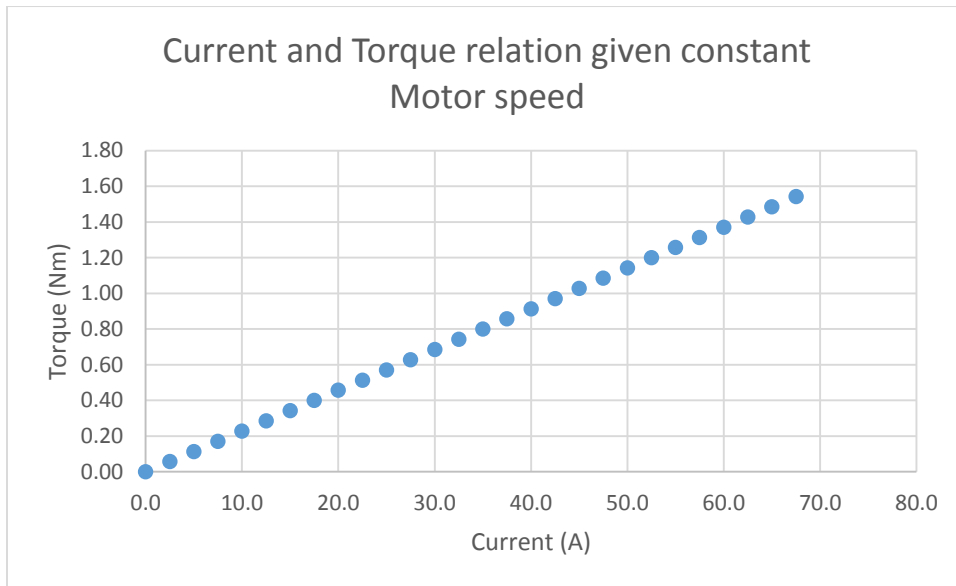


Figure 1 Current and torque relation at constant motor speed

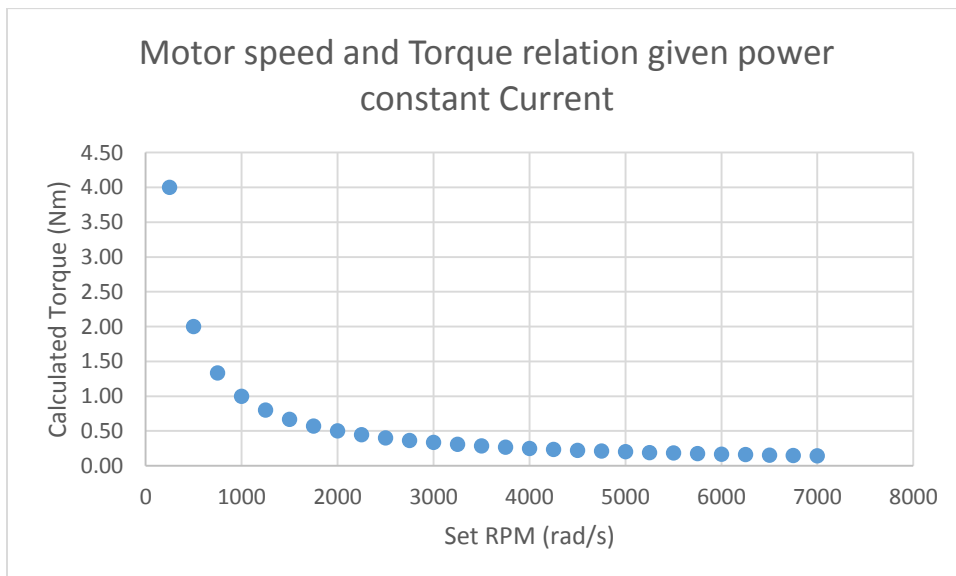


Figure 2 Motor speed and torque relation with constant current

Method

Raw data collected from the dynamometer was analyzed using Origin. The original data was extrapolated, specifically 1863 columns and 224 rows to form a matrix used to generate a contour 3D plot. Figure 3 shows current and torque relation when the contour plot is cut at constant values of motor speed. Figure 4 shows motor speed and torque relation when the contour plot is cut at constant values of current.

Result

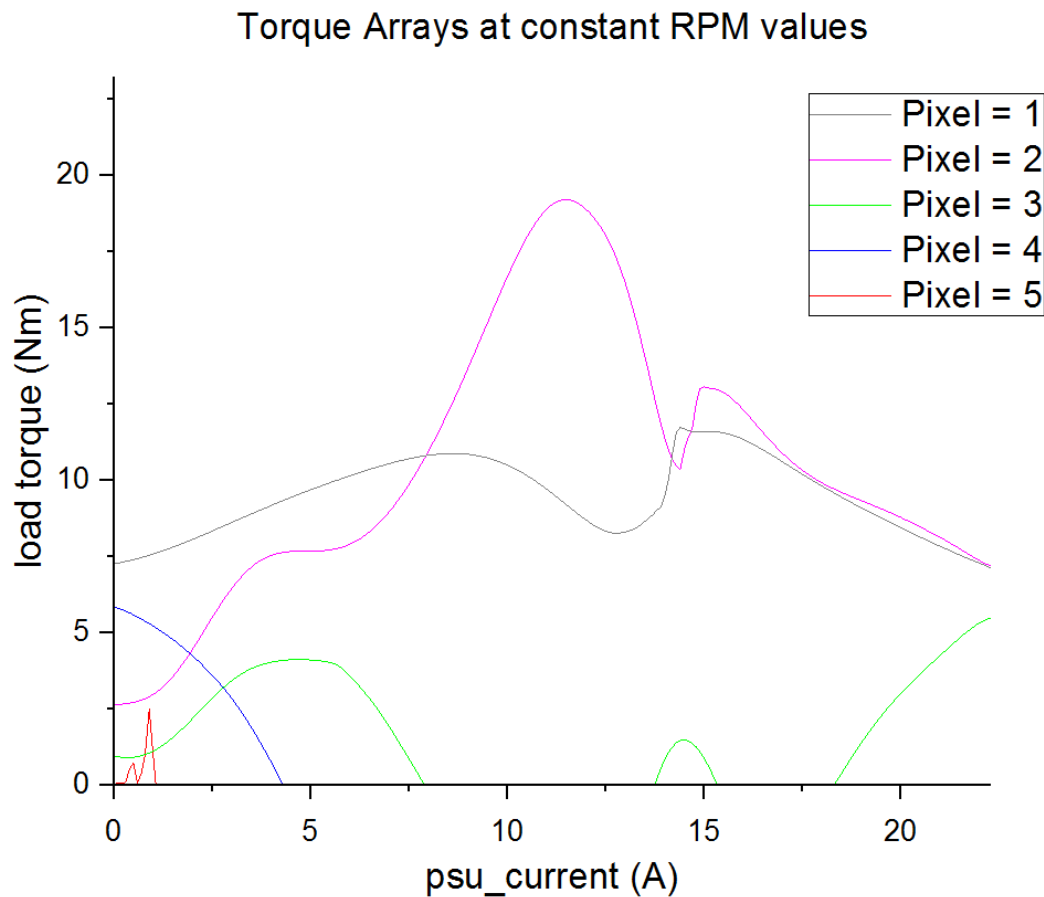


Figure 3 Torque Arrays at constant RPM

Table 1

Torque at Constant RPM values		
	Actual RPM (rad/s)	Approximate RPM (rad/s)
Pixel 1	8005	8000
Pixel 2	6000	6000
Pixel 3	4005	4000
Pixel 4	2017	2000
Pixel 5	12.57	0

Figure 3² shows more of a transient behavior than the expected linear relationship. The range of current is 0 – 22A, which may not be sufficient to characterize a motor and motor controller system that goes to a max of 200A.

A wider range of measurement would be the next step to realistically characterize the entire motor and motor controller system, and eliminate the suspicion of the current data depicting a transient behavior, rather than a steady state one.

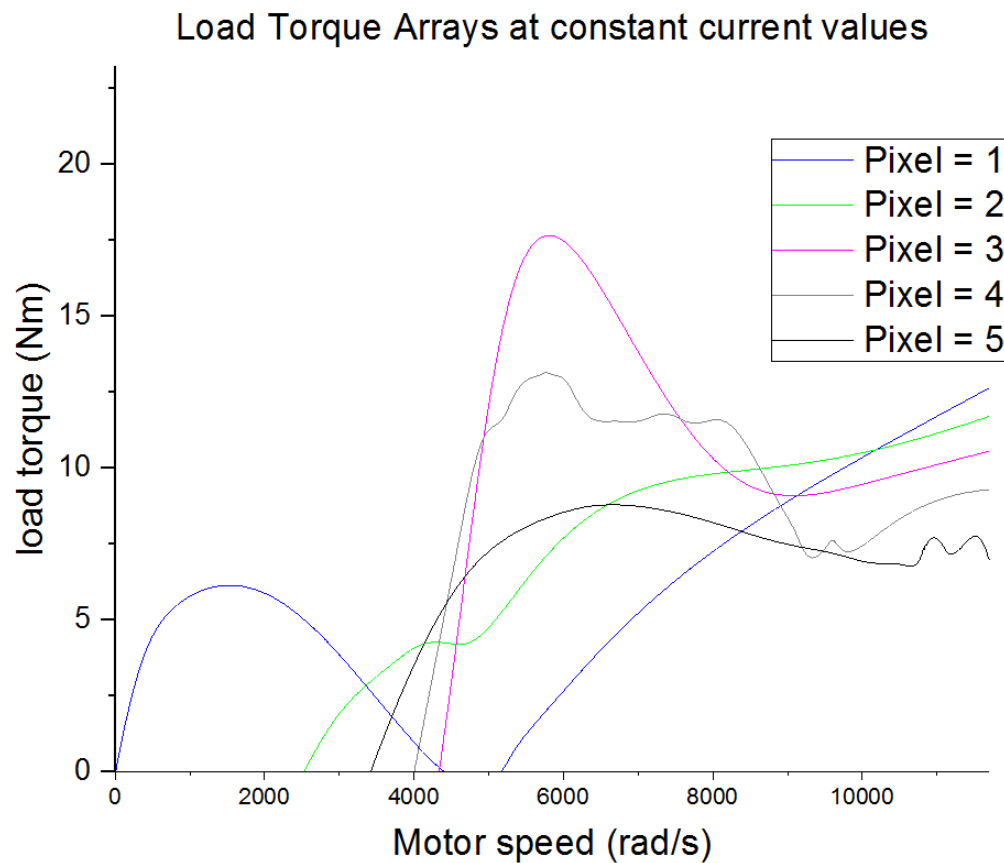


Figure 4 Torque arrays at constant Current

Table 2

Torque at Constant Current values		
	Actual Current (A)	Approximate Current (A)
Pixel 1	0.01246	0
Pixel 2	4.969	5
Pixel 3	9.992	10
Pixel 4	15.01	15
Pixel 5	20.02	20

Figure 4² shows a motor speed array that is not depicting a hyperbolic relationship between motor speed and load torque. The range of current is 0 – 22A, which may not be sufficient to characterize a motor and motor controller system that goes to a max of 200A. Behavior under 1000 rad/s are transient as well.

A wider range of measurement would be the next step to realistically characterize the entire motor and motor controller system, and eliminate the suspicion of the current data depicting a transient behavior, rather than a steady state one.

References:

¹Theoretical relation of the formula Electric Car Physical Parameters of Load Torque, Supply Current and Motor Speed.

²Plotting 3D surfaces in Origin:

http://wiki.originlab.com/~originla/howto/index.php?title=Tutorial:3D_Plotting

<http://www.originlab.com/index.aspx?go=Products/Origin/Graphing>