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

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Hypothesis

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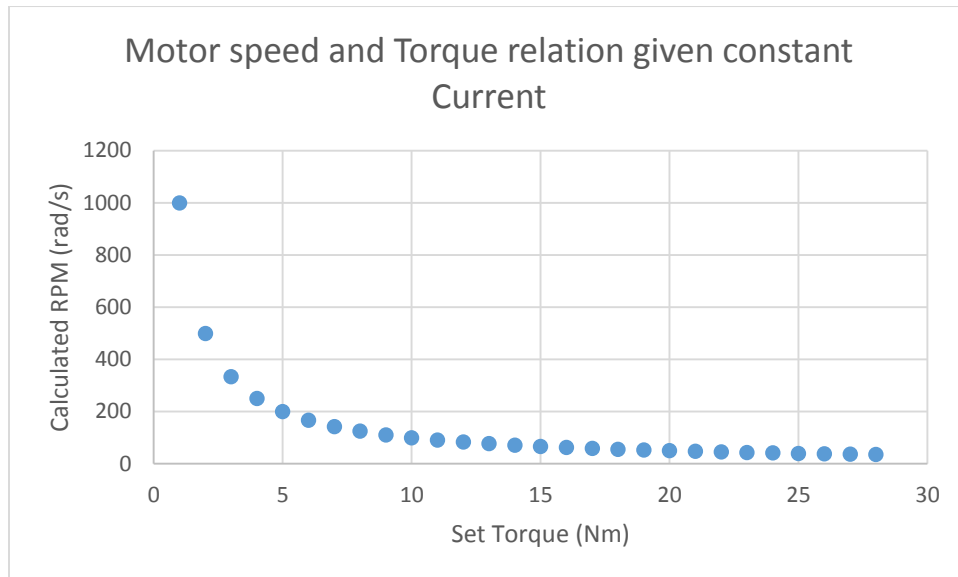

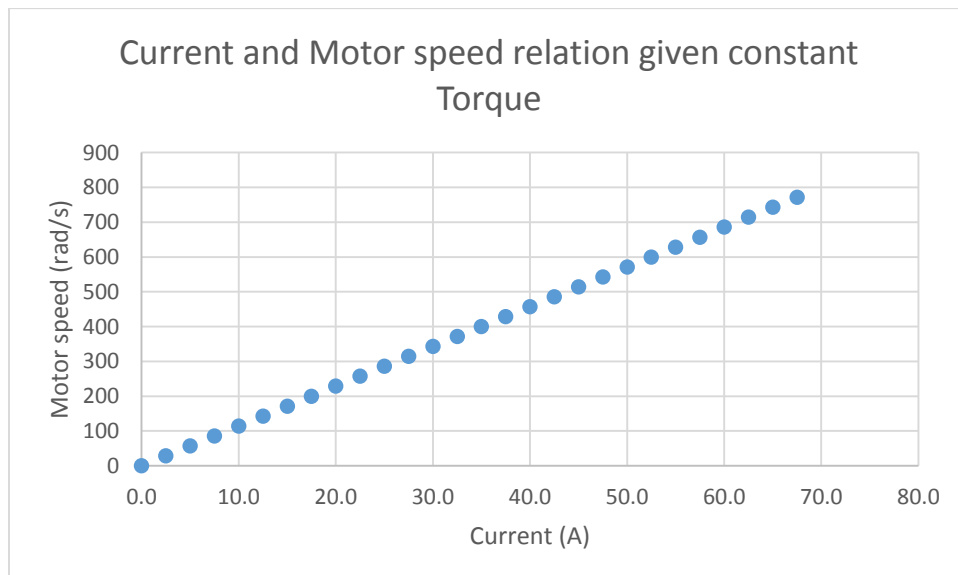*Figure 1 Torque and rpm relation with constant current*

Figure 2 Current and rpm relation given constant torque

Method

Raw data collected from the dynamometer was analyzed using Origin. The original data was extrapolated, specifically 224 columns and 22 rows to form a matrix used to generate a contour 3D plot. Figure 3 shows current and motor speed relation when the contour plot is cut at constant values of torque. Figure 4 shows motor speed and torque relation when the contour plot is cut at constant values of current.
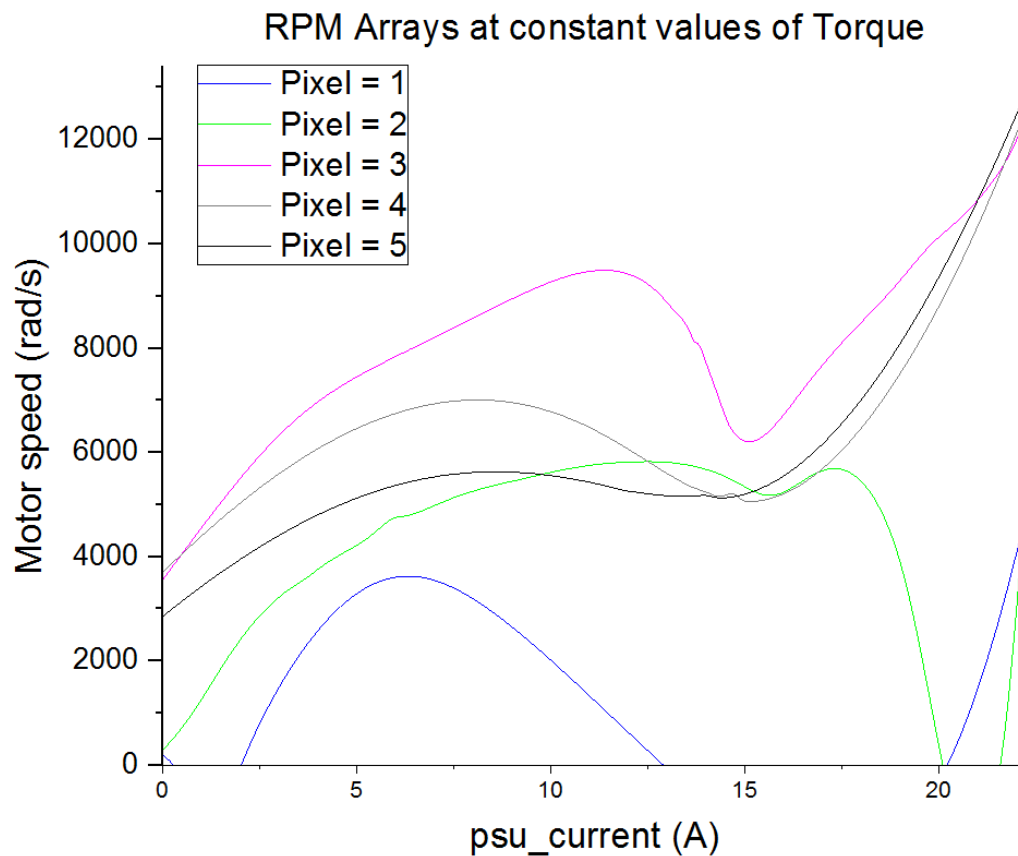
Result

Figure 3 RPM Arrays at constant Torque

Table 1

RPM at Constant Torque values		
	Actual Torque (Nm)	Approximate Torque (Nm)
Pixel 1	0.01191	0
Pixel 2	5.014	5
Pixel 3	9.976	10
Pixel 4	14.98	15
Pixel 5	19	20

Figure 3[2] 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.
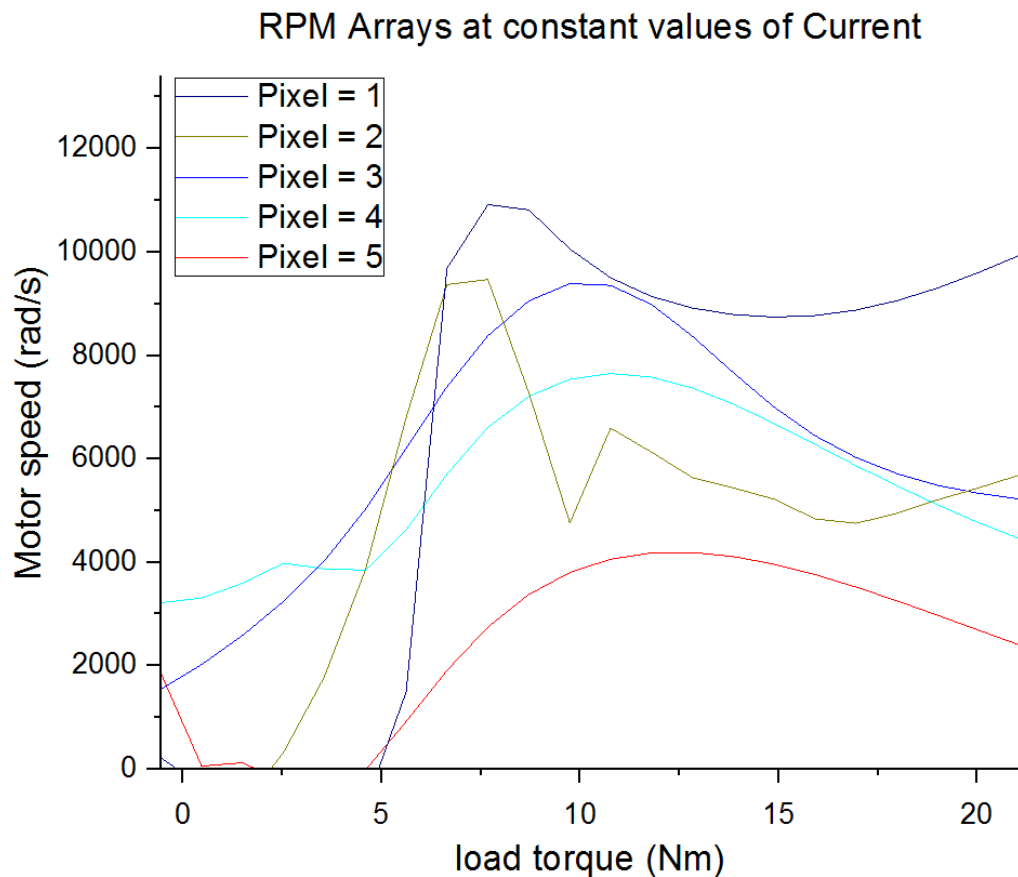
RPM Arrays at constant values of Current

Figure 4 RPM arrays at constant Current

Table 2

RPM at Constant Current values		
	Actual Current (A)	Approximate Current (A)
Pixel 1	20	20
Pixel 2	15.01	15
Pixel 3	9.982	10
Pixel 4	5.031	5
Pixel 5	0.2	0

Figure 4[2] 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:

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

[2]Plotting 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