

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



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3-23-2017

Hypothesis

Theoretically, both motor speed and torque have a linear relationship to current when either is held constant. Thus, experimental data should ideally show an array of linear relationships as shown in figure 1 and 2 for the case of changing power¹.

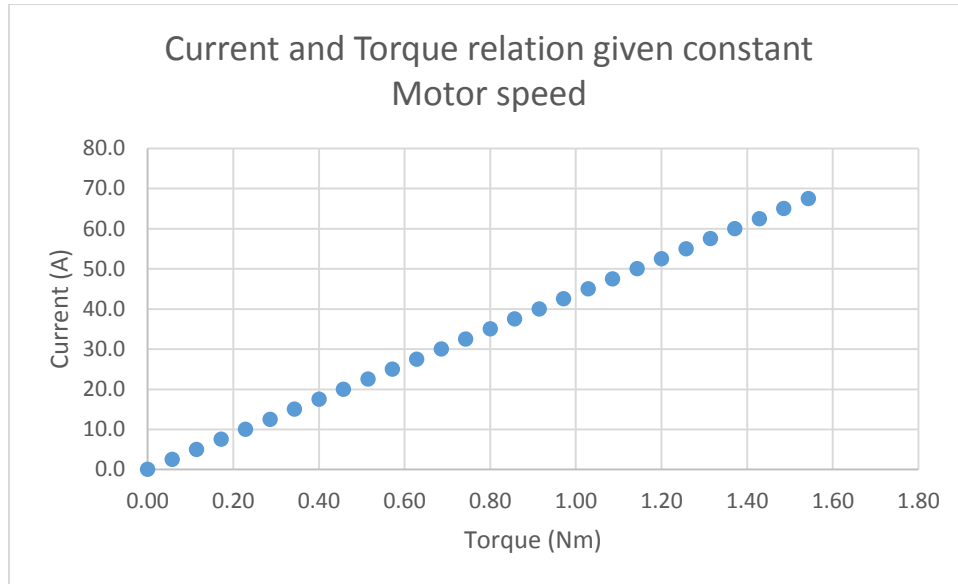


Figure 1 Torque and current relation at constant RPM

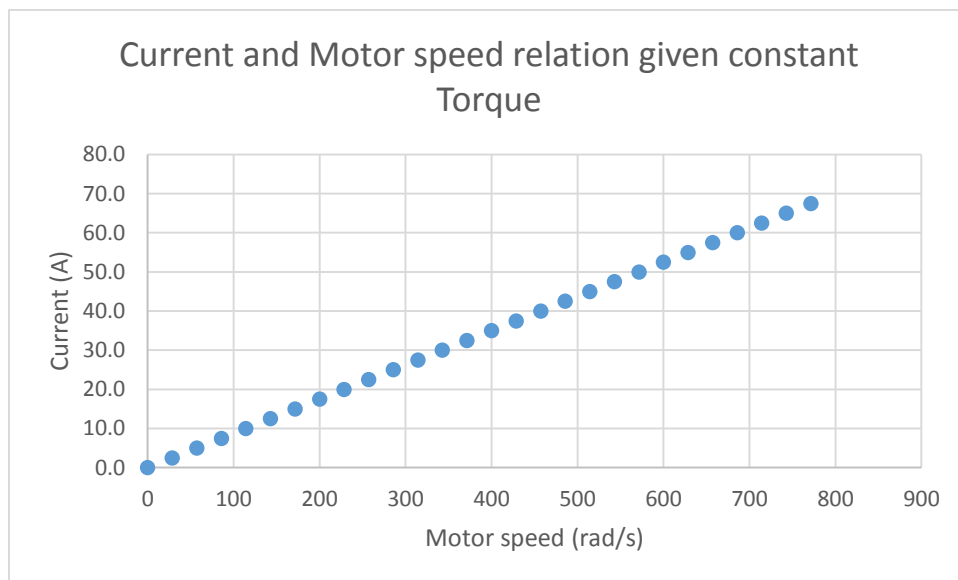


Figure 2 RPM and current relation at constant torque

Method

Raw data collected from the dynamometer was analyzed using Origin. The original data was extrapolated, specifically 1863 columns and 39 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 current and torque relation when the contour plot is cut at constant values of motor speed.

Result

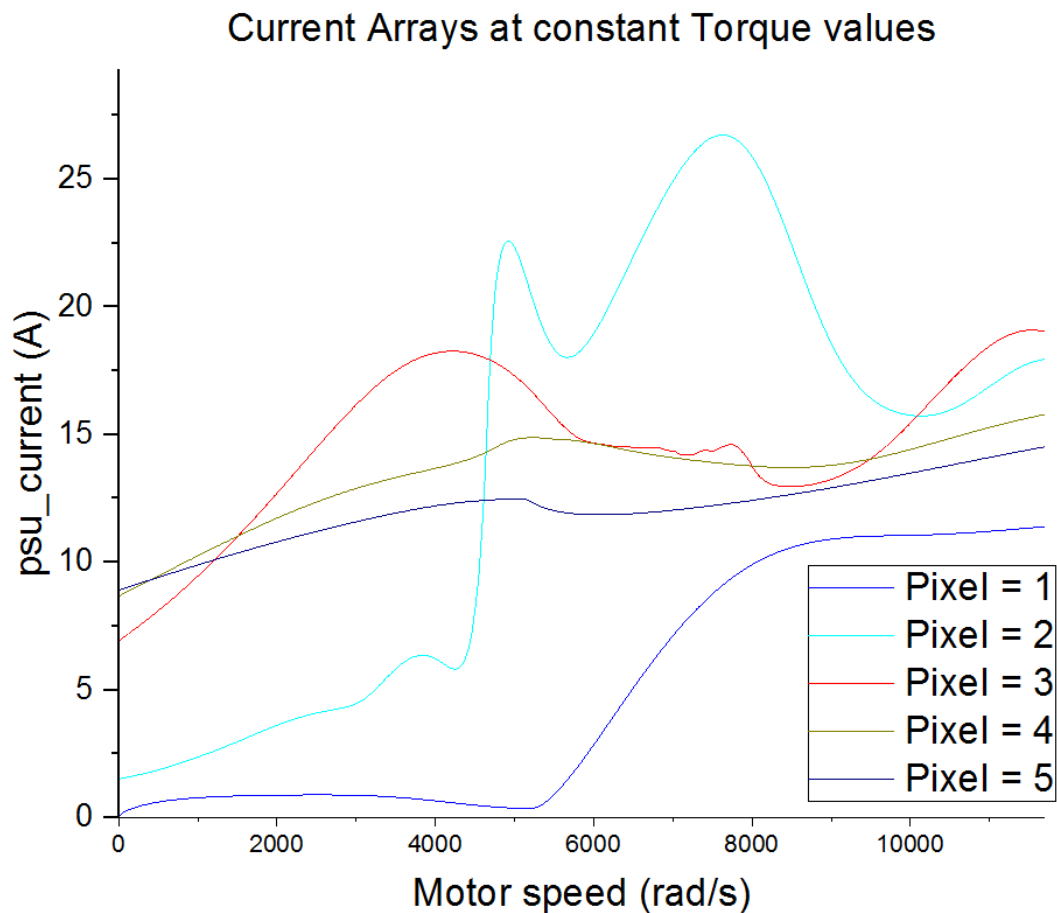


Figure 3 Current and motor speed at constant values of torque

Table 1

Current at Constant Torque values		
	Actual Torque (Nm)	Approximate Torque (Nm)
Pixel 1	19.93	20
Pixel 2	14.98	15
Pixel 3	10.02	10
Pixel 4	5.014	5
Pixel 5	0.01191	0

Figure 3² shows a current array that is not consistent with the expected linear array. 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.

The working range of our motor is a maximum of 200A current and 4500 rad/s motor speed, for that region except for plot at torque of 20 Nm, the rest of the plots depict some increase in current with increase in motor speed. The intersecting of some plots is not consistent with the expected single current and motor speed for a given torque.

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.

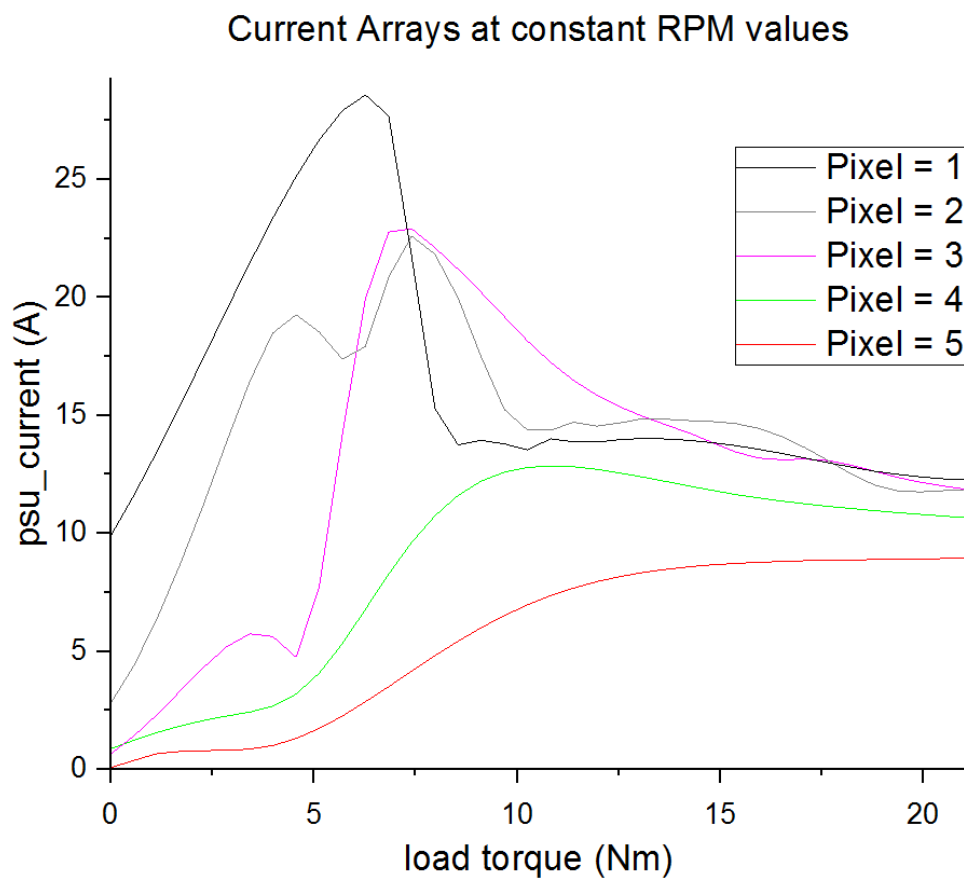


Figure 4 Current and torque at constant values of motor speed

Table 2

Current at Constant RPM values		
	Actual RPM (rad/s)	Approximate RPM (rad/s)
Pixel 1	12.57	0
Pixel 2	2012	2000
Pixel 3	4004	4000
Pixel 4	5993	6000
Pixel 5	7999	8000

Figure 4² shows a current array that is not consistent with the expected linear array. The initial values of torque seem to have some linear relation with current but seem to reach an optimum level before decreasing. 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>