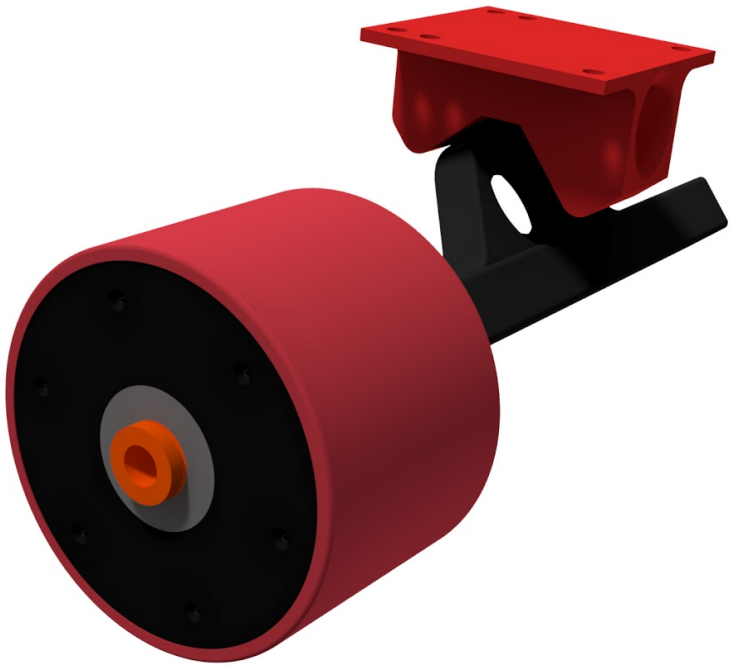
Arthur Zhang **Fall 2018**

In Hub Motor Electric Longboard (In Progress)



I'm designing and manufacturing an electric longboard, opting to increase the complexity by designing an in hub motor. The main challenges for this project are cost-effectively sourcing the materials used and performing calculations on optimizing motor performance. After testing the motor design, I plan on designing a custom battery management system and speed controllers as well (the current electrical system consists of store bought speed controllers and battery system). CAD renders of the current hub motor design are available below.

Stator Specs				
	Stator OD	53	mm	
	Stator Radius (R)	26.5	mm	
	Stator ID	20	mm	
	Stator Height (L)	35	mm	
	# Slot Teeth	12	ul	
Magnet Specs				
	Length	40	mm	
	Width	12	mm	
	Thickness	1.5	mm	
	N52 Flux Density (B_0)	1.45	Tesla	From K and J Magnetics
	Air Gap	0.4	mm	
	Number of Full Loops	30	ul	
Magnet Fill Percentage (28 magnets)				
	Magnet Width	6	mm	Taken From CAD Model
	Number of Magnets	14	ul	
	Rotor Diameter	54	mm	Taken From Above
	k (magnet multiplier)	2	mm	
	Fill Percentage	0.9903		
Torque Requirements				
	Passenger Mass	82	kg	
	Hill Inclination	20	degrees	
	Force Gravity	274.847	N	
	Target Speed	5.00	m/s	
	Mechanical Power	1374.237	W	
	Available Electrical Power	1776.000	W	
	Required Current (I)	**34.36**	A	
	Required Torque	69.077	Nm	
	Magnetic Flux Density	1.145	T	
	Complete Wire Loops (N)	103.56	ul	

$K_m - torque\ produced\ per \frac{Nm}{A}$

$N - complete\ wire\ loops\ with\ magnetic\ field$

$B - permanent\ magnetic\ field\ strength\ (note\ good\ magnets\ will\ have\ a\ strength\ of\ about\ 1)$

$L - length\ of\ magnets$

$R - radius\ of\ motor\ armature$

$$K_m = 2 * N * B * L * R$$

BLDC Torque Production

$T - torque\ of\ one\ BLDC\ motor\ phase$

$i - motor\ current\ currently\ flowing$

$m - \#\ of\ stator\ teeth\ divided\ by\ 3$

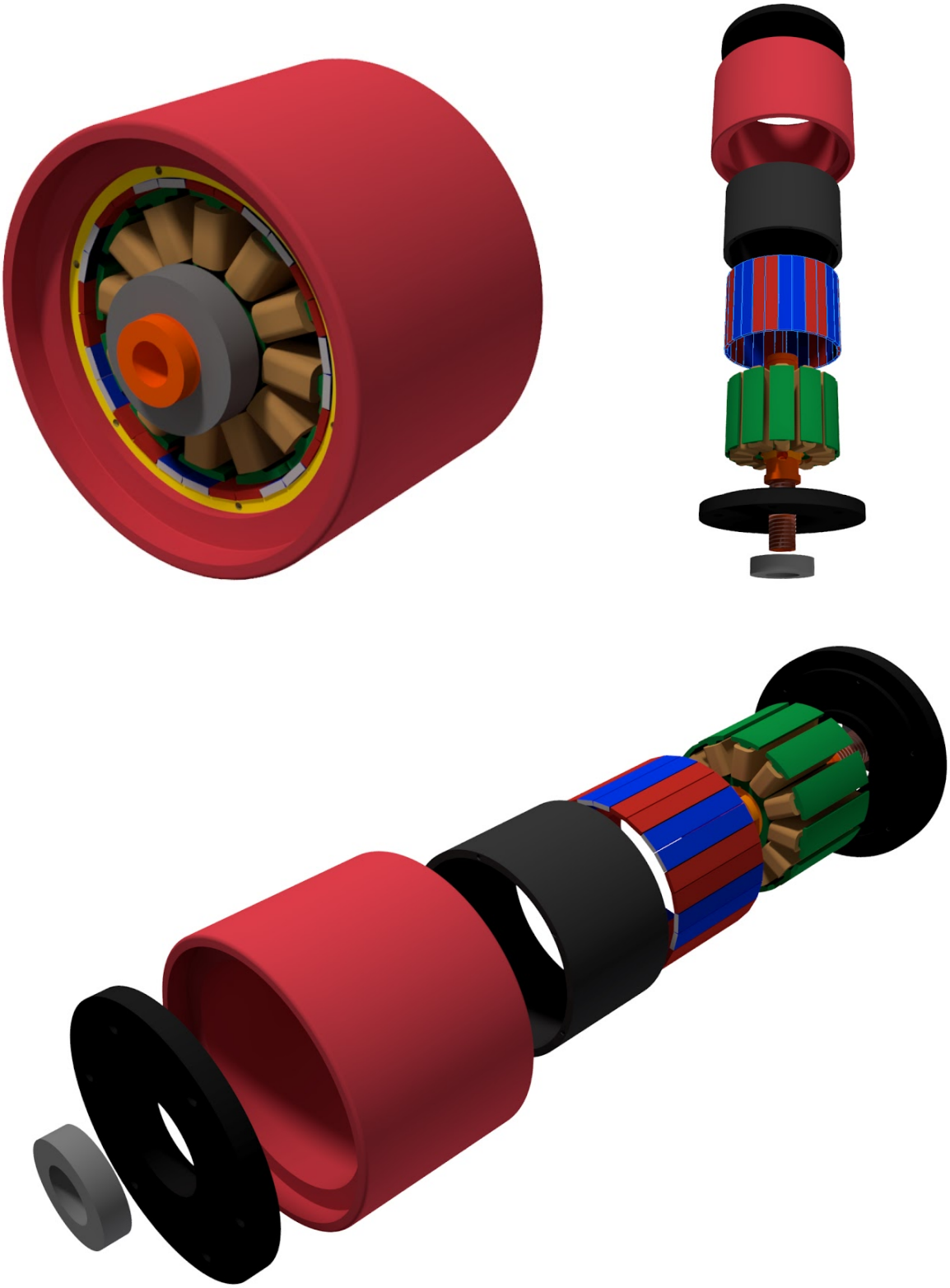
$$T = 4 * m * N * B * L * R * i$$

$$T = 4 \times m \times N \times B_a \times L \times R$$

$$B_a = B_0 \times \left(\frac{t}{t+g}\right)$$

T - Torque (Nm)
m - # of stator teeth divided by 3
N - number of complete magnetic wire loops
B_a - flux density (T)
B_0 - permanent magnet field strength
t - thickness of the magnet
g - radial thickness of the magnet
L - length of magnet
R - radius of stator

Comparison of predicted hub motor torque and torque/speed requirements for climbing hills



View of motor assembly inside wheel (top left), exploded vertical view of assembly (top right), exploded horizontal view of assembly (bottom)

Note: I'm manufacturing the hub motor parts by writing CAM for a CNC I have access to at the University of Michigan. The deadline to have the electrical system and motor assembly tested and debugged by is the end of May 2019. If you would like to inquire about the status of the project, feel free to contact me by email at: arthurzh@umich.edu