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Development of Pulau Kapas Driving Cycle for PHERB Powertrain

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ABSTRACT

Background: This paper presents the results of the development of Pulau Kapas (PK) driving cycle for Plug-in Hybrid Electric Recreational Boat (PHERB) powertrain. The real world data are obtained using on-board measurement techniques, which is Global Positioning System to collect boat speed-time data along the selected route. Route selection was based on the records of average daily traffic of the Pulau Kapas tourist boat. Various variables were used in the characterization of Pulau Kapas driving cycle development for PHERB powertrain. The developed driving cycle contains a 656 s speed time series, with a distance of 5.24 km, and an average and a maximum speed of 28.77 km/h and 49.26 km/h, respectively. The characteristics of Pulau Kapas driving cycle are compared with existing standard drive cycles. The results obtained from this analysis are within reasonable range and satisfactory.

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INTRODUCTION

For pioneering vehicle emission models and powertrain input, driving cycle is an important (Amirjamshidi, *et al*., 2013). Besides that, to provide a long term basis for design, tooling and marketing, vehicles manufactures need these cycle (Tong *et al*., 1999). A driving cycle for a vehicle is a representation of a speed-time data profile for a particular area or city. It is widely used to estimate transport air pollutant emissions and determining fuel consumption pattern for a vehicle in specific place. Consequently, development of speed-time data and obtain real time data of a vehicle is important. This will give a better observation and understanding of the speed-time data and pollutants that are released in the traffic situation. (Pathak, *et al*., 2010). The driving cycle in Pulau Kapas (PK) is not exists, so the objective of this study is to obtain a better understanding of driving characteristics in Pulau Kapas such as average speed, running speed, acceleration, deceleration, mean length, time proportion of idling, cruise, acceleration and deceleration, root mean square of acceleration and deceleration, and acceleration energy per kilometer. To develop a driving cycle data, few steps are involves, which are route selection, data collection and drive cycle construction (Hung, *et al*., 2007). PHERB is kind of boat, which apply more than two kinds of propulsion. This paper explain a step and methodology of construct Pulau Kapas driving cycle for Universiti Malaysia Terengganu plug-in hybrid electric recreational boat (UMT PHERB). Figure 1 represent a schematic diagram of the PHERB powertrain. It consist one electric machine (EM) which bring as either a motor or generator at the time and energize by batteries and ultracapacitors packs.

Driving Cycle Development:

Basically, developing a driving cycle consist of recording the driving condition which are usually driven for normal purposes. In order to develop a driving cycle data, there are three steps involves, which are route selection methodology, data collection methodology and drive cycle construction methodology. For PK driving cycle, the selected route is the shortest route and is often used by tour companies to send tourists to Pulau Kapas. The selected route for PK driving cycle are shown in Figures 2 In this research, on-board measurement techniques will be apply to collect vehicle speed-time data. By using Global Positioning system (GPS), the data can be produced by using previous techniques in order to collect boat speed-time data along designated interested route. This technique involves recording a set or real world speed-time data. This process will be repeated to obtain large amount of data. The data will be analyze and characterize after it is collected, and it will show the situation and condition of that route. The flowchart for PK driving cycle is displayed in Figure 3. The 12 sets of significant variable parameters were used in the

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development of a PK driving cycle construction. Table 1 lists the variable used in a PK driving cycle development.

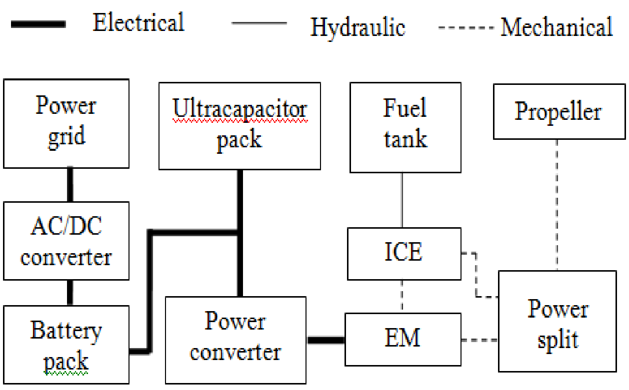

Fig. 1: A schematic illustration of the proposed series-parallel PHERB powertrain.

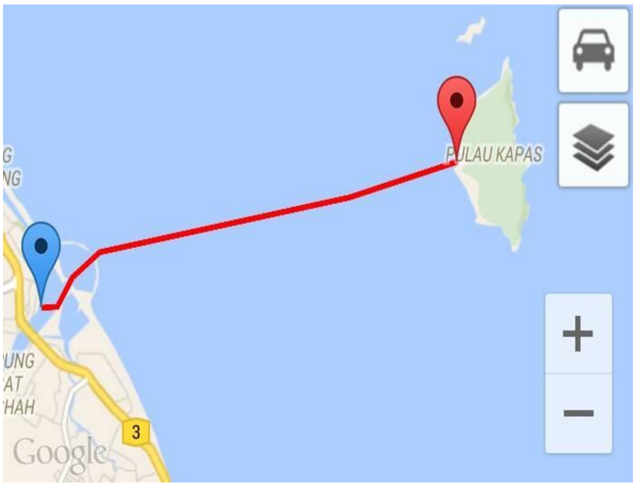

Fig. 2: Selected route at Pulau Kapas.

Table 1: Variables used in PK driving cycle construction.

No	Variable	Unit	Formula
1	Average speed ,	km/h	$v\_avg = 3.6\dfrac{dist}{T_{total}}$
2	Average running speed, v_2	km/h	$v\_run = 3.6\dfrac{dist}{T_{drive}}$
3	Average acceleration of all acceleration phases, a	m/s^2	$a\_avg = \left(\sum_{i=1}^{n}\begin{cases}1\,(a_i>0)\\0\,(\text{else})\end{cases}\right)^{-1}\sum_{i=1}^{n}\begin{cases}1 & (a_i>0)\\0 & (\text{else})\end{cases}$
4	Average deceleration of all deceleration phases, d	m/s^2	$d\_avg = \left(\sum_{i=1}^{n}\begin{cases}1\,(a_i<0)\\0\,(\text{else})\end{cases}\right)^{-1}\sum_{i=1}^{n}\begin{cases}1 & (a_i<0)\\0 & (\text{else})\end{cases}$
5	Mean length of a driving period, c	s	-
6	Time proportion of idling, P_i	%	$\%drive = \dfrac{T_{drive}}{T_{total}}$
7	Time proportion of	%	$\%acc = \dfrac{T_{acc}}{T_{total}}$

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	acceleration, P_a		
8	Time proportion of cruise, P_c	%	$\%cruise = \frac{T_{cruise}}{T_{total}}$
9	Time proportion of deceleration, P_d	%	$\%dec = \frac{T_{dec}}{T_{total}}$
10	Average number of acceleration-deceleration changes within one driving period, M		-
11	Root mean square of acceleration, RMS	m/s^2	$RMS = \sqrt{\frac{1}{T_{total}}\sum_{i=1}^{n} a_i^2}$
12	Acceleration energy per kilometer, PKE	m/s^2	$PKE = \frac{1}{dist}\sum_{i=2}^{n}\begin{cases} v_i^2 - v_{i-1}^2 & (v_i > v_{i-1}) \\ & (else) \end{cases}$

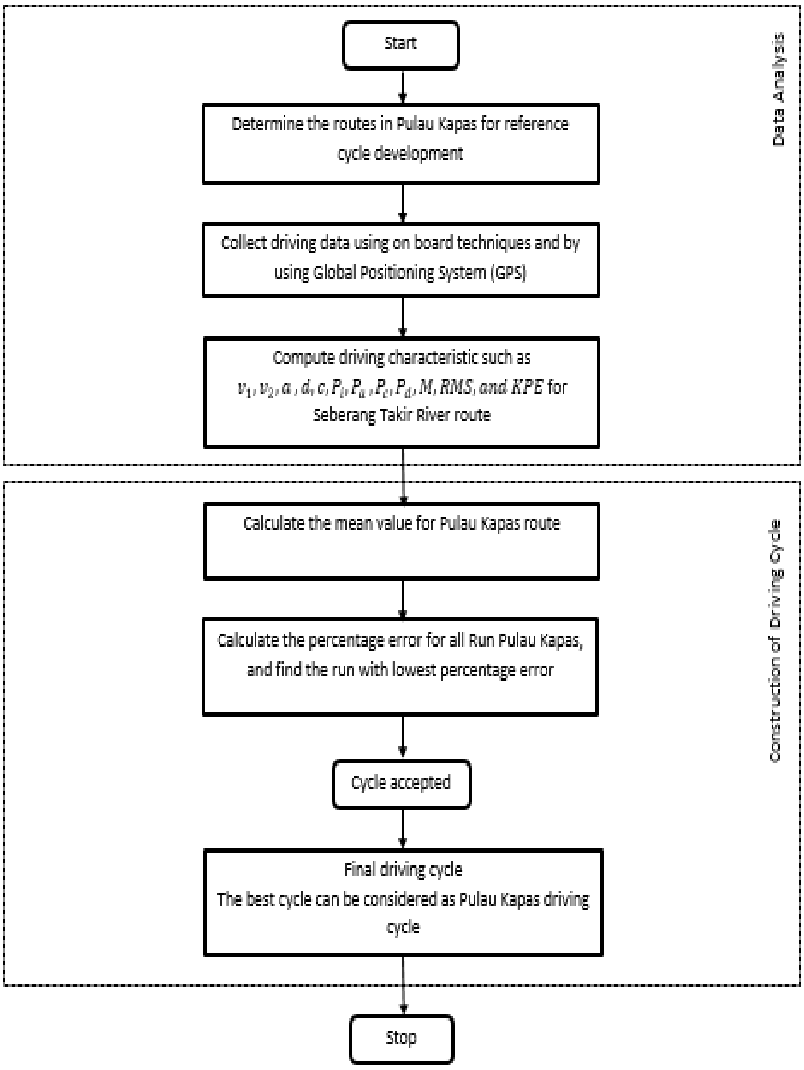

Fig. 3: Flowchart for PK driving cycle development.

RESULTS AND DISCUSSIONS

In this research, Speed-Time data is collected by using Global Positioning System along the selected route starting from Marang jetty up to Pulau Kapas. This research took only 20 days for collecting data where one data is collected every day. The data is obtained throughout the period of 10:00-12.00p.m for 20 days on March 2015. This period of time is selected because it is a peak hour for tourist to go to Pulau Kapas. The assessment of 12 data variables are shown in Table 2. The mean values in Table 3 are acquired from Table 2. The percentage error for all run is calculated after the mean value is gained, Run 3 is the most significant choice to represent Pulau Kapas driving cycle because it has the lowest percentage error. From the data collected at Pulau Kapas, the average speed for Pulau Kapas driving cycle is 28.77 km/h and the average running speed is 29.26 km/h. Based on the results, it shows that the speed is moderate. The four vehicle operating modes is calculated during the test run, The time spent by boat in different operating mode, it was observed that 1.68% for the time proportion of idling, 0.15%, 49.47% time proportion of acceleration and 49.16% time proportion of deceleration. The rate for acceleration and deceleration is 0.55. The value of mean length of driving period is 656s. The mean length of driving period is high, it indicates that the path is good and clear without any obstacles. The Root Mean Square for this run is 0.81 and the Acceleration Energy per Kilometer is 0.61. The best Pulau Kapas driving cycle is constructed as presented in Fig. 5.

Table 2: ST River Driving Cycle Data Analysis

Criterion	v_1 (km/h)	v_2 (km/h)	a (m/s^2)	d (m/s^2)	c (s)	P_i (%)	P_c (%)	p_a (%)	P_d (%)	M	RMS (m/s^2)	KPE (m/s^2)
j	1	2	3	4	5	6	7	8	9	10	11	12
Run 1	29.81	30.24	0.57	0.59	631	1.43	0.16	50.63	48.25	0.99	0.87	0.55
Run 2	30.60	31.10	0.25	0.27	737	1.63	0.14	50.68	47.96	0.99	0.32	0.26
Run 3	28.77	29.26	0.55	0.55	656	1.68	0.15	49.47	49.16	0.98	0.81	0.61
Run 4	29.34	29.95	0.58	0.58	640	2.03	0.16	49.14	49.14	0.98	0.91	0.56
Run 5	30.96	31.52	0.29	0.27	727	1.79	0.14	48.07	50.41	0.98	0.35	0.28
Run ..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..
Run ..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..
Run 16	30.47	30.93	0.28	0.27	740	1.49	0.14	48.71	50.07	0.99	0.35	0.28
Run 17	29.92	30.45	0.59	0.58	626	1.76	0.16	49.12	49.44	0.98	0.93	0.56
Run 18	30.72	31.10	0.26	0.27	734	1.23	0.14	50.89	48.16	0.99	0.32	0.26
Run 19	30.84	31.26	0.29	0.27	731	1.37	0.14	47.53	51.37	0.99	0.36	0.27
Run 20	29.38	29.90	0.59	0.57	641	1.72	0.16	48.44	50.16	0.98	0.90	0.56

Table 3: Mean Values of the Assessment Parameters of Runs.

Criterion	v_1 (km/h)	v_2 (km/h)	a (m/s^2)	d (m/s^2)	c (s)	P_i (%)	P_c (%)	p_a (%)	P_d (%)	M	RMS (m/s^2)	KPE (m/s^2)
j	1	2	3	4	5	6	7	8	9	10	11	12
Mean Value (run 1 – run 20)	29.99	30.50	0.42	0.42	688.20	1.66	0.15	49.44	49.18	0.98	0.61	0.42

Table 4: Percentage Difference Relative to Target Summary Statistics

Criterion	v_1 (km/h)	v_2 (km/h)	a (m/s^2)	d (m/s^2)	c (s)	P_i (%)	P_c (%)	p_a (%)	P_d (%)	M	RMS (m/s^2)	KPE (m/s^2)	Total Error (%)
J	1	2	3	4	5	6	7	8	9	10	11	12	
Mean Value	29.99	30.50	0.42	0.42	688.20	1.66	0.15	49.44	49.18	0.98	0.61	0.42	29.99
Run 1	0.60	0.85	35.71	40.48	8.31	13.86	6.67	2.41	1.89	1.02	42.62	30.95	185.37
Run 2	2.03	1.97	40.48	35.71	7.09	1.81	6.67	2.51	2.48	1.02	47.54	38.10	187.41
Run 3	4.07	4.07	30.95	30.95	4.68	1.20	0	0.06	0.04	0	32.79	45.24	154.05
Run 4	2.17	1.80	38.10	38.10	7.00	22.29	6.67	0.61	0.08	0	49.18	33.33	199.33
Run 5	3.23	3.34	30.95	35.71	5.64	7.83	6.67	2.77	2.50	0	42.62	33.33	174.59
Run …..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..
Run …..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..
Run 16	1.60	1.41	33.33	35.71	7.53	10.24	6.67	1.48	1.81	1.02	42.62	33.33	176.75
Run 17	0.23	0.16	40.48	38.10	9.04	6.02	6.67	0.65	0.53	0	52.46	33.33	187.67
Run 18	2.43	1.97	38.10	35.71	6.66	25.90	6.67	2.93	2.07	1.02	47.54	38.10	209.1
Run 19	2.83	2.49	30.95	35.71	6.22	17.47	6.67	3.86	4.45	1.02	40.98	35.71	188.36
Run 20	2.03	1.97	40.48	35.71	6.86	3.61	6.67	2.02	1.99	0	47.54	33.33	182.21

Table 5: Minimum Percentage Error of the Assessment Parameters of Grouped Runs

Criterion	v_1 (km/h)	v_2 (km/h)	a (m/s^2)	d (m/s^2)	c (s)	P_i (%)	P_c (%)	p_a (%)	P_d (%)	M	RMS (m/s^2)	KPE (m/s^2)	Total Error (%)
J	1	2	3	4	5	6	7	8	9	10	11	12	
Run 3	4.07	4.07	30.95	30.95	4.68	1.20	0	0.06	0.04	0	32.79	45.24	154.05

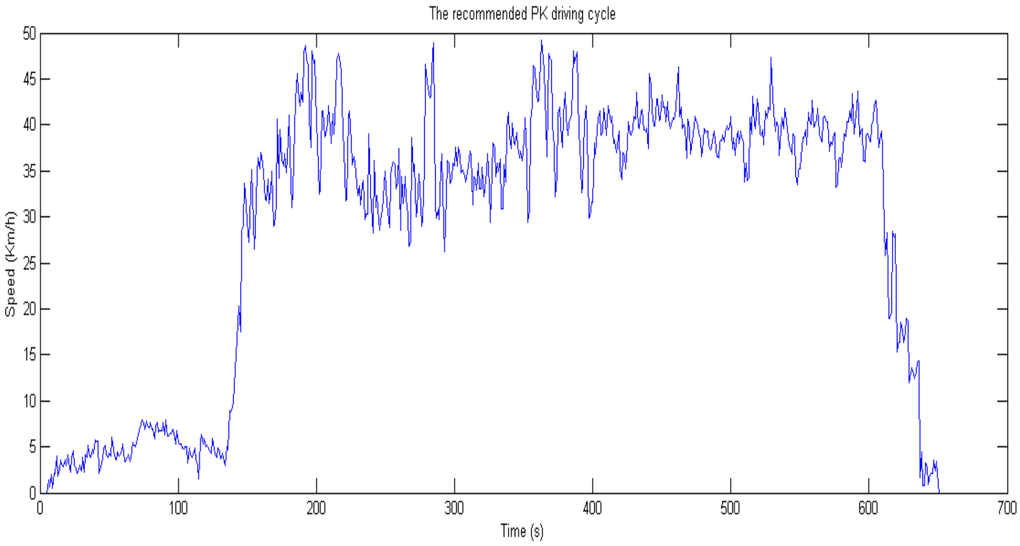

Fig. 4: The PK river driving cycle.

Conclusions:

Based on the results of this study, it can be concluded that the proposed method is possible to generate a recommended PK driving cycle that can be used for UMT PHERB powertrain, in order to measure fuel economy and emissions and it was proved by the tabulate data above.

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REFERENCES

Amirjamshidi, G. and M.J. Roonda, 2012. Development of simulated driving cycles: case study of the Toronto Waterfront Area. TRB 2013 Annual Meeting.

Hung, W.T., H.Y. Tong, C.P. Lee, K. Ha, L.Y. Pao, 2007. Development of a practical driving cycle construction methodology: A case study in Hong Kong. Transportation Research Part *D*, pp: 132-140.

Pathak, S.K., A.K. Aigal, V. Sood and S.K. Singal, 2010. Development of real-world driving cycle for a passenger car for the city of Dehradun. Petrotech-2010, New Delhi, India.

Tong, H.Y., W.T. Hung and C.S. Cheung, 1999. Development of driving cycle for Hong Kong. Atmospheric Envoirement, 33: 2323-2335.