EXTENDING THE LIFE OF ROBOTICS THROUGH THE USE OF A PEMFC

Kenneth Nagle, Breanna Sanchez, Anthony Jimenez

Coastal Bend College, Beeville, knagle@coastalbend.edu, sanchez6456@study.coastalbend.edu, zenemijar@yahoo.com

ABSTRACT

Portable automated technology is currently limited by the life of batteries. A promising method to increase the life of batteries is the use of a Proton Exchange Membrane fuel cell (PEMFC). Much of the research reviewed for this project focused on fuel cell performance while operating in a relatively steady state for long periods of time. In reality, fuel cells are subject to a variety of load requirements. The feasibility and dynamic behavior of a PEM fuel cell and its application in automated technology is the focus of this research project. The research project involved the application of a PEMFC system and its actual performance in the operation of a robotic buggy in a variety of settings and terrains. The goal was to increase the battery life 300% in actual application.

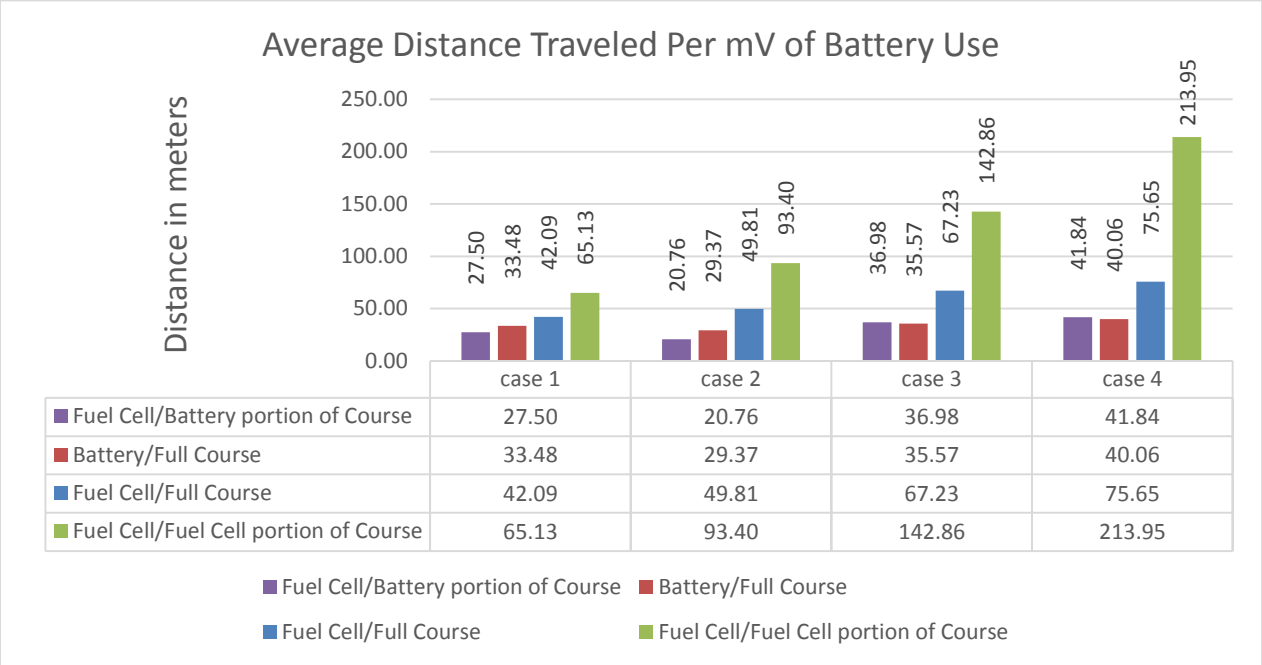
The Project utilized the Wild Thumper chassis from www.sparkfun.com as the robotic buggy, powered by a 5400mAh Lithium Polymer 2-Cell/2S battery and the H-Cell 2.0 PEMFC from Horizon Fuel Cell Technologies. The buggy was operated by the researchers using a DX3C DSM 3-Channel Surface Radio, and put through four case studies:

Case 1. Surface type: Linoleum, Topology: Flat Distance per lap: 58.93m
Case 2. Surface type: Grass, Topology: sloping, Distance per lap: 103.78m
Case 3. Surface type: Concrete, Topology: sloping, Distance per lap: 117.65m
Case 4. Surface type: Linoleum, Topology: Flat Distance per lap: 235.353m

Each case was performed twice, the first iteration was with just the battery to establish a base from which to compare the second iteration to, which utilized the H-cell 2.0 as an augmentation to the battery, it was supplied with 20 L hydrogen. During the iterations of each case, the initial voltage reading of the battery was noted. The researchers, then drove the buggy around each course, until the system voltage was at 7.70V or the next lap would take the voltage well below 7.70V. At the conclusion of each lap the system voltage and elapsed time were recorded.

Many studies have been performed in regards to PEMFC performance, often pertaining to long duration missions. Such as, one where the robot traversed the Boston marathon route at a total distance of 85.4 km, using a battery capable of completing one lap, with the addition of a PEM fuel cell system 16 laps were completed, this study maintained a constant speed of 3.6 km/h (Thangavelautham, 2012). Another example, a system that was studied for exploration of planetary bodies with low gravity. Used micro PEM fuel cells, to produce low amounts of energy and store it over a period of time, to later use in a short bursts of movement. Resulting in a hypothetical mission lasting a total of 7 days and covering a distance of 1.5 kilometer (Kesner, 2007). These studies show the potential of fuel cells in extreme cases, this study, however, focused on a readily available PEM fuel cell system, and used in everyday situations. While the manufacturer of the H-cell 2.0 states that the system can extend battery life up to 400% (horizionfuelcell, n.d.). It was assumed that this value was obtained by operating at a constant power draw and nonstop travel. This study, however, utilized courses that require frequent and consistent stops. The results of this study are shown in Figure 1, as the, “Average

Distance Traveled Per mV of Battery Use", for each case. It was anticipated that as the frequency of stops are extended the performance of the PEMFC will increase.



	case 1	case 2	case 3	case 4
Fuel Cell/Battery portion of Course	27.50	20.76	36.98	41.84
Battery/Full Course	33.48	29.37	35.57	40.06
Fuel Cell/Full Course	42.09	49.81	67.23	75.65
Fuel Cell/Fuel Cell portion of Course	65.13	93.40	142.86	213.95

Figure 1. Average Distance Traveled Per mV of Battery Use

The results in Figure 1, as expected show an increase in fuel cell performance as the distance between stops is increased. Furthermore, it suggests that terrain may be a contributing factor in fuel cell performance. Additionally, it indicates that if the fuel storage is not of a sufficient capacity, the benefits of the fuel cell are dramatically reduced. However, it should be noted that the methodology of this study involved the significant potential for human error, future research should use methods that eliminate most, if not all human error, moreover, multiple iteration of each case would produce more exact results.

Keywords: PEMFC, robotics, batteries

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