Assessment of Capacity Degradation and RUL of Flexible Batteries in Wearable Electronics

Rahul Lall (Auburn High School)

Wearable electronics are finding new applications in everyday life. Future adoption of wearable electronics into applications such as medical diagnostics, identity protection, and asset situational awareness requires the development of form factors which are seamlessly integrated into wearable garments and on the surface of skin. Flexible wearable electronics are subjected to a greater deal of mechanical and environmental stresses while attempting to maintain functionality. Wearable applications need thin and flexible form factors for the energy storage to drive sensing, displays, control, and processing. Energy storage of these wearable applications most likely requires the ability to sustain use and recharge cycles. In this paper, the state of art flexible battery technologies commercially available have been studied for their survivability under exposure to environmental loads typical of wearable electronics applications (bending). The charging and discharging cycles were performed on the flexible battery with a custom designed test station. The test station included a linear actuator setup (programmable electronic load), microprocessor, and a data logger. All hardware was controlled using LabVIEW. Additionally, a method for prognosticating the capacity degradation and remaining useful life has been developed using Extended Kalman Filtering (EKF). It is expected that the developed system will expedite the use of flexible electronics and broaden their applications.

Foraging Efficiency and Learning in Capuchin Monkeys (*Cebus capucinus*)

Daniel Herrera (Augustana College)

Advisors: Grace Davis (UC Davis), Stephanie Fuhr (Augustana College)

Primates have relatively large brain to body ratios and spend a substantial period of their life in the juvenile development stage. Large brains suggest long juvenile stage, hypothesizing that primates require long juvenile periods to learn complicated foraging techniques. Critics of this hypotheses argue that foraging efficiency increases primarily as a function of increased muscle mass, not learning. We set out to determine if the juvenile period is in fact used to learn complicated foraging techniques by examining food preferencing behavior in white faced capuchin monkeys (*Cebus capuchinus*). Individuals of varying ages were observed as they selected fruits from attalea palm trees (*attalea butyracea*). Learning was tested by counting the number of times each individual touched, bit, or dropped individual fruits before eating them. We found that individuals tested fruits less as they aged, indicating that individuals learned how to distinguish a desirable fruit from a non-desirable fruit over time. These results support the previously stated hypothesis and justify the long juvenile period in primates, offering insight to the evolutionary drivers of primate ecology.

Creating a Statistically Characterized Reference Data Set to Test 2D Image Registration Algorithms for Testing Automated Portal Alignment for Patient Set-Up

Afua Dankwa (Oakland University), Edward Castillo (Beaumont Health), Gary McDonald (Oakland University) , Thomas Guerrero (Beaumont University)

Advisor: Thomas Guerrero (Beaumont Health)

Create and characterize a reference data set for testing image registration algorithms that transform megavoltage portal image (MVPI) to digitally reconstructed radiograph (DRR), which will be used in future, studies to test automated portal alignment for patient set-up. Six orthogonal image set anterior/posterior (AP) and lateral (LAT) of head and neck, abdomen and pelvis were selected. Computer assisted manual point selection tool (CAMPST), devoted software created in-house, was used to manually select landmark point pairs by an expert. 58 anatomic landmark points were manually paired between the six images for AP and 52 for the LAT. Approximation of inter- and -intra observer variation was determined by repeat measurement on both images by three other readers as a 2D Euclidean distance. The hypothesis that the mean difference between intra and inter observer registration error equal some critical value between 1mm and 7mm using the test statistic for paired data was tested. The registration error was generally high for the MVPI than the DRR due to the inherent poor quality of images acquired using megavoltage energies. Also the inter observer error was higher than the intra-observer error which is to be expected, as it is more likely for an individual to repeat their own point rather than someone else. The lower limit of the 95% confidence level was higher than 1mm and the upper limit higher 7mm. Our results agree with what has been reported in literature that the accuracies of 2D and 3D registration method fall between 1mm to 7mm.