

Project Title: Development of Diagnostics and Prognostics Methodology for Electronic System Health Monitoring

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Objectives: Develop a Methodology for Baseline Characterization of Electronic System. Perform experiment to establish baseline for electronic system under various environmental and usages conditions. Perform same set of experiment on a different system of same model to verify the repeatability of experiments conducted at earlier stage of work. Perform set of field experiments on same system model to validate the baseline established earlier. Perform set of field experiments on different system model to determine the applicability of baseline from previous study and characterize new system model based on earlier system model.

Introduction:

The desire and need for real predictive prognostics capabilities have been around for as long as man has operated complex and expensive systems. Real predictive prognostic capabilities are just one element among many interrelated and complementary functions in the playing field of Prognostic and Health Management (PHM). Any industry would like to have maximum operation availability, low warranty returns, very low Returned Tested OK (RTOK), low number of spares required and small logistics footprint, maximum life usage and no false alarms etc. One would like to be able to have the ability to accurately predict future health status, anticipate problems and should prepared ahead of being surprised by “hard downing (failure or recall)” events. Prognostic capabilities would let planner see ahead of both unplanned and even some necessary preventive events. Several challenges are involved with developing and implementing prognostic capabilities with new performance based logistic support concepts. Similarly, several technical issues are involved are consideration of dynamic operating environment, unknown material characteristics, unseen events, absence of unique mathematical technique which can address all kinds of fault and failure in various system and issues of uncertainty.

Electronics as a product and as an integral part of many system provides functionality and control for mechanical or electrical systems. Electronic products with a long life cycle ensure customer satisfaction. Increased warranties and severe liability with product failures forces manufacturers to analyze systems performance during their field operations and to determine their operational availability. This means electronic systems should be considered equal in comparison with any other systems for prognostics and health management.

Assessment of electronic systems performance will be more informed by considering information of its in-service use, operation, and environmental conditions. This raised interest in in-situ monitoring system health to predict failures and provide warnings in advance of failure. It can be argued that decision-making goals of diagnostics and prognostics are different but studying them separately is not feasible. Diagnostic results are utilized for maintenance purposes whereas prognostic results are used to prevent or avoid risk in terms of cost or life and to maximize the remaining life of replaceable components while minimizing operational risks. Combination of information from both the field provides better understanding of system that helps in improving system design that will not only improve system reliability but also reduce maintenance time.

The goal is to develop a methodology for baseline characterization of any given electronic systems with reasonable amount of experiments and data collection. Develop a diagnostic methodology that utilizes system baseline information and identify variations in system performance due to presence of any anomalies or system failure. Development of prognostic methodology based on features extracted from the data or critical parameters identified.

Approach:

This study characterizes environmental and usage parameters of notebook computer to build a healthy performance baseline. The baseline characterization includes identification of the range and distribution of

each performance parameters while computers are subject to changing environmental and operational conditions, as well as determination of relationships between multiple performance parameters.

Experiments were performed on ten identical notebook computers, representative of the state of the art in (2007) notebook computer performance and battery life (nearly three and half hours on a single battery). Notebook computers were exposed to a set of environmental conditions representative of the extremes in their life-cycle profiles. The performance parameters were monitored in-situ during the experiments. Operational and environmental ranges and profiles that constitute a “healthy” system were used to replicate the real-time usage of the computer. Data collection, software was developed to collect real-time performance parameter information on notebook computers and their battery performance without any user intervention. Software was installed on the computer. A set of user activities was defined and simulated by coding it into a script file. The same set of usage conditions were applied on all notebook computers to achieve time synchronization between the computer and the software application responses. Performance parameters were measured when system were subjected to different usages condition under various environmental conditions.

The correlations between different performance parameters were estimated by obtaining correlation coefficient between them. The variability of a performance parameter as function of other performance parameters was expressed in terms of an empirical relationship. Data features were calculated to define the baseline for healthy system. This baseline was used to detect anomalies and performance deviation.

Similar set of experiments performed earlier were conducted on a different computer to verify the repeatability of experiments. Performed set of field experiments on same computer model to validate the baseline obtained earlier. Perform set of field experiments on different computer model to determine the applicability of baseline from previous study and characterize this computer model based on earlier computer model’s model.

A test suite was developed; this should incorporate set of user activity and applications for system diagnostics. It is platform independent. It assist technical personnel to identify system problem(s). Develop a methodology to build baseline for a given system. Developed a set of rules to identify impending abnormal situation in online environment. Build fault library and performance parameters’ correlation to be used for anomaly detection. Develop system health scale that can be used for system diagnostics.

A multivariate prognostic methodology was developed for any electronic system. This methodology was able to detect anomalies and predict future health of electronic system. Set of anomaly were scaled on a feature scale so that those anomalies can be identified readily. The capability of the proposed methodology in real time system health monitoring by injecting an artificial fault into the system was demonstrated.

Deliverables:




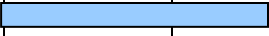


- Provide a methodology to construct a baseline for electronic system.
- Provide an approach to classify the healthy system from unhealthy based on MD value.
- Characterization of notebook computers’ performance parameter
- Characterization of feature scale based on faults identified in notebook computer.
- Illustrating the issues involved with battery health management in notebook computer.
- A prognostics and diagnostic methodology based on symbolic time series for electronic system
- Development of a deployable test suite for health monitoring in notebook computer

Project Status:

Experiments have been completed. Each performance characterization for baseline establishment was completed. Test suite for experiments was developed. A Non-parametric method is used for system diagnostics. Multivariate MD feature was used to baseline the system performance. Symbolic time series was used to develop diagnosis and prognosis methodology. Battery health management was studied.

Methodology for baseline characterization is being developed. Deployable test is also being developed. Feature scale for anomalies characterization will be performed.

Estimated Schedule:

Tasks	Oct-Dec 2007	Jan-Mar 2008	Apr-June 2008	July-Sept 2008	Oct 2008
Baseline Methodology					
Deployable Test					
Prognostic Methodology validation					
Feature scale characterization for anomalies					
Report and review					
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