DOWNLOAD PDF SYSTEMATIC FAULT DIAGNOSIS

Chapter 1 : FAULT DIAGNOSIS AND REPAIR OF CUTPOINT CELLULAR ARRAYS â€” Arizona State Un

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Governed by a range of regulatory standards, the verification of these systems, in general, must be proven to be as rigorous as possible. In addition, to guarantee the safe operation of these systems, safety mechanisms are integrated that ensure a reliable, deterministic reaction to random hardware failures when the device is operating in the field. These too must be verified to operate correctly and trap operational hardware faults. The automotive market, governed by the ISO standard, demands a particularly rigorous development methodology. This requires the use of specific verification techniques, as well as a well-defined, thorough verification process. The need for Formal Safety Verification It is hard to demonstrate that simulation-only verification solutions can provide the required degree of coverage necessary to guarantee safety. The exhaustive nature of formal verification solutions makes it a natural fit for these designs. However, additional capability must be included to prove design reliability and fail-safe operation. OneSpin provides a complete formal verification solution ranging from rigorous verification, and qualification of the verification environment, all the way to the verification of safety mechanisms and diagnostic coverage. Systematic and Random Errors The OneSpin Safety Critical Verification Solution encompasses a range of formal tools and techniques that provide a complete verification flow to test for the presence of any systematic faults and verify that a high proportion of random faults will be detected and handled by the device. The solution includes advanced coverage techniques, fault injection and qualification, as well as a broad formal verification solution. These gate level models can be complex and contain numerous possible fault scenarios. OneSpin provides a formal solution to target these problems in the form of three Apps. OneSpin Solutions meets or exceeds the requirements of functional safety standards. This conformance level enables OneSpin to provide certified formal verification solutions meeting tool qualification requirements set by functional safety standards for automotive and other applications ISO , IEC , and EN DO and DO Software tools applied in the development of airborne electronic hardware AEH must undergo tool assessment and qualification to comply with relevant functional safety standards. OneSpin provides expert support to reduce the qualification efforts for its family of formal tools. For engineering teams, this is a time-consuming task and, worryingly, one for which there are no mature solutions yet. Tool vendors may provide safety certificates or packages, in an attempt to support their customers with safety compliance. Strategies vary and so do the benefits to the user and project. In this paper, we review requirements on tool classification and qualification, present different safety compliance strategies, and explain their benefits to safety-critical hardware projects. Some RTL issues may only reveal themselves as bugs in the synthesis netlist. Additionally, synthesis tools manipulate the design to map it into the fixed FPGA structure. These complex transformations present a high risk of introducing bugs. Gate-level simulation and lab testing can only cover a tiny portion of the FPGA functionality and are likely to miss implementation bugs. Moreover, they are slow to run and challenging to debug. This white paper presents an implementation signoff flow proving that the final FPGA netlist is functionally equivalent to the RTL model. Based on FPGA-specific, mature formal verification technology, the solution is exhaustive and efficient, catching many issues before synthesis starts. These sophisticated features are made possible by increasingly complex electronic systemsâ€”systems that present countless new opportunities for things to go wrong. A defective headrest video screen may be an irritation to a young passenger in the back seat, but a malfunctioning corrective steering system could cost the occupants of the vehicle their lives. Adequate verification is essential. Our safety-critical white paper examines the ISO automotive standard and makes a case for its indispensability. Many engineers face the daunting task of having to examine countless faulty variants of their design in order to integrate and verify multiple safety mechanisms within complex Systems-on-Chip SoCs. This white paper examines key goals and challenges in fault-tolerant hardware verification, and presents formal solutions that ensure predictable hardware behavior under all relevant operating conditions and fault scenarios, while saving in engineering and computational resources. These solutions reduce the risk of undetected hardware issues, and enable a more predictable and efficient path to airworthiness certification. Want to get your monthly recap of relevant news? This approach uses so called operational properties to construct complete formal specifications and includes methods to verify specification completeness. The properties of auxiliary clusters are written in plain SystemVerilog assertions. Design verification and completeness checks are performed with OneSpin Design Verifier.

Chapter 2 : Practical Diagnostic Approach of Systematic Fault of AC Systems - PDF Free Download

Practical diagnostic approaches of systematic fault of AC systems with all the valuable real testing, theoretical and simulative works are noteworthy and necessary. Our work is an endeavor and primary step for this attempt.

Overview and Basic Terminology This guide to fault detection and fault diagnosis is a work in progress. It will evolve over time, especially based on input from the LinkedIn group Fault Detection and Diagnosis. Fault detection and diagnosis is a key component of many operations management automation systems. It might not be directly observable. A root cause is also generally associated with procedures for repair. A "fault" or "problem does not have to be the result of a complete failure of a piece of equipment, or even involve specific hardware. For instance, a problem might be defined as non-optimal operation or off-spec product. In a process plant, root causes of non-optimal operation might be hardware failures, but problems might also be caused by poor choice of operating targets, poor feedstock quality, poor controller tuning, partial loss of catalyst activity, buildup of coke, low steam system pressure, sensor calibration errors, or human error. A symptom is an observed event or variable value, needed to detect and isolate faults. If a symptom is the response to a question or an on-demand data request when actively testing a system instead of just passively monitoring it , it is referred to as a test or test result. Faults may be detected by a variety of quantitative or qualitative means. This includes many of the multivariable, model-based approaches discussed later. Fault diagnosis is pinpointing one or more root causes of problems, to the point where corrective action can be taken. Other elements of Operations Management Automation related to diagnosis include the associated system and user interfaces, and workflow procedural support to for the overall process. Workflow steps that might be manual or automated include notifications, online instructions, escalation procedures if problems are ignored, fault mitigation actions what to do while waiting for repairs , direct corrective actions, and steps to return to normal once repairs are complete. Automated fault detection and diagnosis depends heavily on input from sensors or derived measures of performance. In many applications, such as those in the process industries, sensor failures are among the most common equipment failures. So a major focus in those industries has to be on recognizing sensor problems as well as process problems. Distinguishing between sensor problems and process problems is a major issue in these applications. Our usage of the term "sensors" includes process monitoring instrumentation for flow, level, pressure, temperature, power, and so on. In the following material, we focus mainly on online monitoring systems, based on sensor or other automated inputs, but possibly including on some manual input from end users such as plant operators. However, we also consider a broader viewpoint of diagnosis not just as a technology, but also as part of the business process of fault management. It is also a natural fit for operations such as call centers for customer support, where a significant amount of diagnosis is done. Fault Management - the overall processes and life cycle of a fault An overview of different approaches to fault detection and diagnosis There are many different approaches to fault detection and isolation. Because each has their strengths and weaknesses, most practical applications combine multiple approaches. In this section, we highlight some of the major differentiating factors between the different techniques. When models of the observed system are used as a basis for fault detection and diagnosis, this is often referred to as "model based reasoning". Please go to the page Model Based Reasoning for fault detection and diagnosis Causal models. An important special case of model-based reasoning uses causal models. For a review of causal models, please go to the page: Causal Models In physical systems, causality in reality is associated with some time delay or lags between cause and effect. This has to happen because mass or energy has to move, overcoming resistance by inertial, thermal inertia, inductance, or other physical phenomena. This is discussed on the page Causal time delays and lags. Fault signatures, pattern recognition, and classifiers Pattern recognition is a general approach that directly uses the observed symptoms of a problem and compares them to a set of known symptoms for each possible problem, looking for the best match. Please go to the following page: They can be used as event detectors, detecting events and trends. They can also be used as diagnostic models in model-based reasoning, or used directly as classifiers for recognizing fault signatures. For more information, please see Neural Networks for fault detection and diagnosis. This is direct modeling of the decision process rather than modeling the system being diagnosed. Alarms are examples of events. Diagnostics involving events can be significantly different than diagnostics involving a fixed set of variables. Please go to the following page for a discussion of event-oriented diagnostics and event correlation: Event-oriented fault detection, diagnosis, and correlation Passive system monitoring vs. But many times, it is preferable to request non-routine tests. Diagnosis for maintenance purposes is based on testing. For a discussion on passive monitoring vs. Passive system monitoring vs. For a discussion on rule-based implementations, please see the following page: Rule-based approaches and implementations Hybrid approaches Pattern recognition by itself does not require a model. However, input for construction of the signatures for the known failures may be based on models; for instance, as residuals from models of normal behavior. This general technique applies to static or dynamic models. For dynamic models, the patterns can be based on predicted measurement values vs. Smartsignal offers products based on an empirical process model of normal operation used for fault detection, combined with other techniques for fault isolation. Pattern recognition can also be combined with models of abnormal behavior. But as part of the development process, this model was then used to automatically construct fault signatures - a form of compiled knowledge. At run time, diagnosis was based on matching observed data to the nearest fault signature. So the product at run time had the characteristics of a pattern matching solution. In some cases, a qualitative model really just exists inside the application developers head. That person directly constructs the signatures based on their knowledge. So, the overall methodology is often a combination of pattern recognition with a model-based method. Some tools such as GDA , are flexible enough to support multiple approaches to fault detection and diagnosis, and also support the upfront filtering and event generation as well. One conclusion was that most applications required a mix of techniques for success. Examples of hybrid approaches for pipeline monitoring An example of a hybrid approach that directly uses pattern recognition on the residuals from static numerical models of a liquid pipeline is given in the neural nets section of this site. An Approach And Demonstration outlines an approach to pipeline leak detection that combines causal models of abnormal behavior with both static algebraic models and dynamic models. Some issues in evaluating techniques and implementing them All solutions installed as software will have issues such as the user interfaces for end users and application developers, system integration, reliability, building generic libraries describing commonly repeated components, easy modification for maintenance, computing speed and storage requirements, and so on. But there are some unique issues associated with fault detection and diagnosis. Single fault assumption vs. This presents a problem for many diagnostic techniques. Please go the following page: Diagnosis of multiple faults Robustness: A system might be tuned to be very sensitive to detecting or recognizing particular problems. But then it is also likely to declare problems when none exist. There is a tradeoff in sensitivity vs. This is a generalization of the problem encountered when setting simple alarm thresholds. But, minor transient fluctuations will then result in false alarms. Filtering For systems using sensor data, noise is almost always an issue. The primary purpose of filtering is to reduce noise by combining multiple values of variables sampled over time so that at least some of the noise is canceled out. Filtering Robustness for sensor or model errors A major consideration when evaluating diagnostic techniques is robustness in the presence of errors in the sensors or the model. Any system that completely believes any symptom or test input will be sensitive to errors in that input. Similarly, any system that completely believes its own models will be sensitive to errors in that model. The result in either case can be conflicting data and incorrect conclusions. The errors might just be due to transient errors in timing, but could be longer lasting. Another way of looking at this is that most systems combine evidence. There will be some form of weighted averaging of the inputs when they are in conflict. Event orientation and scalable architecture for large systems Many model-based techniques require complex matrix calculations. This does not scale well for large systems. One approach is simply to break up the large diagnostic system into a set of smaller, independent ones. This results in diagnostic systems that might not account for all possible interactions in a complex system. However, as long as there are enough sensors, this might not be much of a problem. Another fundamental approach for large-scale systems is to focus on abnormal events, and reason over the events rather than all the underlying data at once. There is a separate event generation step that converts raw data such as temperature values into an event such as a high temperature alarm. Event generation could also be based on calculations using complex models of normal operation, signaling deviation of the data from expected behavior. In this way, models of normal behavior can be used to generate events for use in models of abnormal behavior. This combines the sensitivity of normal models for problem detection with fault isolation capabilities of models of abnormal operations. In the process industries, events such as simple alarms have always been generated. In recent years, alarm management systems have also looked at the implications of combinations of alarms. Each piece of equipment has an agent. Histories of numerical data used to generate events are mainly maintained locally by each agent. All of this was an attempt to deal with large numbers of events and problems.

Chapter 3 : Six-Step Approach to Fault Finding

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Model-based[edit] Example of model-based FDI logic for an actuator in an aircraft elevator control system [1] In model-based FDI techniques some model of the system is used to decide about the occurrence of fault. The system model may be mathematical or knowledge based. Some of the model-based FDI techniques include [2] observer-based approach, parity-space approach, and parameter identification based methods. There is another trend of model-based FDI schemes, which is called set-membership methods. These methods guarantee the detection of fault under certain conditions. The main difference is that instead of finding the most likely model, these techniques omit the models, which are not compatible with data. The truth table defines how the controller reacts to detected faults, and the state chart defines how the controller switches between the different modes of operation passive, active, standby, off, and isolated of each actuator. For example, if a fault is detected in hydraulic system 1, then the truth table sends an event to the state chart that the left inner actuator should be turned off. One of the benefits of this model-based FDI technique is that this reactive controller can also be connected to a continuous-time model of the actuator hydraulics, allowing the study of switching transients. Spread Spectrum Time Domain Reflectometry, for instance, involves sending down a spread spectrum signal down a wire line to detect wire faults. A particularly well developed part of it applies specifically to rotating machinery, one of the most common types encountered. To identify the most probable faults leading to failure, many methods are used for data collection, including vibration monitoring, thermal imaging , oil particle analysis, etc. Then these data are processed utilizing methods like spectral analysis , wavelet analysis , wavelet transform, short term Fourier transform, Gabor Expansion, Wigner-Ville distribution WVD , cepstrum, bispectrum, correlation method, high resolution spectral analysis, waveform analysis in the time domain, because spectral analysis usually concerns only frequency distribution and not phase information and others. The results of this analysis are used in a root cause failure analysis in order to determine the original cause of the fault. For example, if a bearing fault is diagnosed, then it is likely that the bearing was not itself damaged at installation, but rather as the consequence of another installation error e. The root cause needs to be identified and remedied. If this is not done, the replacement bearing will soon wear out for the same reason and the machine will suffer more damage, remaining dangerous. Of course, the cause may also be visible as a result of the spectral analysis undertaken at the data-collection stage, but this may not always be the case. The most common technique for detecting faults is the time-frequency analysis technique. For a rotating machine, the rotational speed of the machine often known as the RPM , is not a constant, especially not during the start-up and shutdown stages of the machine. Even if the machine is running in the steady state, the rotational speed will vary around a steady-state mean value, and this variation depends on load and other factors. Since sound and vibration signals obtained from a rotating machine which are strongly related to its rotational speed, it can be said that they are time-variant signals in nature. These time-variant features carry the machine fault signatures. Consequently, how these features are extracted and interpreted is important to research and industrial applications. The most common method used in signal analysis is the FFT , or Fourier transform. The Fourier transform and its inverse counterpart offer two perspectives to study a signal: The FFT -based spectrum of a time signal shows us the existence of its frequency contents. By studying these and their magnitude or phase relations, we can obtain various types of information, such as harmonics , sidebands , beat frequency , bearing fault frequency and so on. However, the FFT is only suitable for signals whose frequency contents do not change over time; however, as mentioned above, the frequency contents of the sound and vibration signals obtained from a rotating machine are very much time-dependent. For this reason, FFT -based spectra are unable to detect how the frequency contents develop over time. To be more specific, if the RPM of a machine is increasing or decreasing during its startup or shutdown period, its bandwidth in the FFT spectrum will become much wider than it would be simply for the steady state. Hence, in such a case, the harmonics are not so distinguishable in the spectrum. The time frequency approach for machine fault diagnosis can be divided into two broad categories: The difference is that linear transforms can be inverted to construct the time signal, thus, they are more suitable for signal processing, such as noise reduction and time-varying filtering. Although the quadratic method describes the energy distribution of a signal in the joint time frequency domain, which is useful for analysis, classification, and detection of signal features, phase information is lost in the quadratic time-frequency representation; also, the time histories cannot be reconstructed with this method. The short-term Fourier transform STFT and the Gabor transform are two algorithms commonly used as linear time-frequency methods. If we consider linear time-frequency analysis to be the evolution of the conventional FFT , then quadratic time frequency analysis would be the power spectrum counterpart. The main advantage of time frequency analysis is discovering the patterns of frequency changes, which usually represent the nature of the signal. As long as this pattern is identified the machine fault associated with this pattern can be identified. Another important use of time frequency analysis is the ability to filter out a particular frequency component using a time-varying filter. Robust fault diagnosis[edit] In practice, model uncertainties and measurement noise can complicate fault detection and isolation. This is the subject of maintenance, repair and operations ; the different strategies include:

Chapter 4 : Safety Critical Verification Solution â€“ OneSpin. Formal Verification.

Fault detection, isolation, and recovery (FDIR) is a subfield of control engineering which concerns itself with monitoring a system, identifying when a fault has occurred, and pinpointing the type of fault and its location.

Available online at www. Nowadays, for many reasons almost all the existing AC systems are in morbid operation, they all have little or large deviation from the optimal operation pattern. In this paper, a practical diagnostic approach of energy consumption and systematic fault of AC systems has been studied and presented. This approach is based on the comparison between theoretical hourly values and actual hourly values of each testing node, and can be used as a guidance of reasonable design, optimal operation and efficient maintenance of AC systems for improving the synthetic characteristics. Published by Elsevier Ltd. Introduction Nowadays, for many reasons, almost all the existing AC systems are in morbid operation, they all have little or large deviation from the optimal operation pattern. There are many reasons for this situation. First, AC systems should be designed and operated correspondingly according to the hourly building cooling load, but most of the AC systems are designed and operated based on the maximum hourly building cooling load. Lack of control characteristics and no optimal control scheme available for most AC systems is the vital reason for causing the systematic deviation from the optimal operation pattern and extra amount of energy consumption. In this situation, energy efficiency of the system may get even worse [1]. So, presenting optimal operation schemes and systematic fault diagnostic approaches and upgrading the control characteristics of AC systems are very important for reasonable design, optimal operation and efficient maintenance of AC systems for improving the synthetic characteristics. Up till now, many studies on this aspect have been done. Among these works, software simulation tools have played an important role. It calculates the load of the building in one year, and then calculates the energy consumption of the equipment of the AC system, finally gets the energy consumption of the whole AC system. So this kind of software is suitable for systematical energy consumption analysis. Based on EnergyPlus simulation, combining with some corresponding theoretical calculation, optimal values of testing nodes flow rate, temperature, pressure, etc. In order to well demonstrate the simulation and calculating value of each testing node and the operational state of the AC system, SCADA Supervisory Control and Data Acquisition system is employed in this paper for system control analysis and controller design. Methods Most of the air conditioning systems are in the state of static design, morbid operation, weak maintenance and management. And all these problems lead to the increase of the energy consumption. So, large amount of improving works needs us to accomplish, and the first step and the basis of these works is the AC diagnosis. AC diagnosis is recognized as an important process needed for design, construction, operation and maintenance of air conditioning systems. The judgment standard of AC system operation status.

Chapter 5 : Read Systematic Fault Diagnosis: Principles and Documentation (EEUA handbook) PDF - Blak

Why Do We Need Fault Diagnosis? As systems have become larger, more complex, and more integrated into our daily lives, it is imperative and obligatory that there exists systematic fault diagnosis.

To help technicians get to the cause of a fault faster, MCP has developed a course focusing on a logical approach to fault finding. Here are six key points to consider: Collect the Evidence All the evidence collected must be relevant to the problem in hand. If one is in doubt as to whether anything is relevant, then include it. Reject it afterwards at the first opportunity if it clearly is not relevant. The quantity of information collected is unimportant, what matters is that all information collected is relevant. Observe the system running, if you consider it safe to do so. Use all your senses: Refer to any relevant documentation. Analyse the Evidence Consider all the evidence collected and, if possible, reject any which after further careful consideration is not relevant. Study the hard core of relevant evidence and â€” through the process of careful, logical thinking â€”diagnose the likely fault or at least the area or region of the fault. The areas or regions are systematically reduced in size until a specific part can be identified as being faulty. For example, if a door bell does not ring when it should, it is only by means of a systematic approach that one determines that the bell itself is faulty. Determination and Removal of the Cause If the cause of a fault is not removed, the fault will recur even though the fault has been rectified. For instance, a flat bicycle tyre might be the result of a puncture the fault in the inner tube. If the puncture is repaired i. The cause of the puncture may be a nail which has penetrated the outer cover. This must be removed. Rectification of the Fault This may be a simple task, as in the case referred to above, or it may be a much bigger one. Whatever is the case, it is a specific task based on earlier findings. Check the System It is important to ensure that the machine, equipment or system is functioning normally after the cause of the fault and the fault itself has been dealt with. In the case of the puncture, it is easy to confirm that the cause of the fault â€” and the fault itself â€” has indeed been dealt with satisfactorily, assuming that the tyre remains inflated.

Chapter 6 : A Guide to Fault Detection and Diagnosis

The energy consumption and fault diagnosis are very important on reducing energy consumption and improving the efficiency of energy utilization of AC (Air Conditioning) systems.

At this point we have nearly billion unit operating hours of data. This is probably the largest process industry data set in the world. The objective in all this research is to generate predictive failure data that is the most realistic in the world. I have a theory that the main reason is the definition of random versus systematic. So exida did a survey using 16 failure examples. For each example, the person answering the survey would enter a failure classification from three choices: The results confirm the theory. Fifty four 54 people entered their opinions. Disagreement occurred in all sixteen examples. Not one had complete agreement as to the category! So it is no wonder that failure rate studies give different failure rates. He explained that a set of procedures would be written to significantly reduce systematic failures if these procedures were followed. He also explained that all understood that even rigorous procedures could not eliminate all failures. These were called random failures. A probabilistic method would be used to create designs with sufficient redundancy and design strength to reduce random failures to a tolerable level. The intent was to reduce both kinds of failures to tolerable levels. But not everyone agrees, so we need to work on that. Before going too much further we need to answer some questions. Who wants this data? What is the purpose of this data? I submit that the data is for the owner-operators of an industrial process so they can use the methods of IEC and IEC to reduce their risk to tolerable levels. If you agree it is clear that the data should be as realistic as possible. The purpose of the data is not to blame someone for each failure. Think about these questionsâ€¦.

Chapter 7 : Fault detection and isolation - Wikipedia

The building energy use accounts for a large portion of energy end use of commercial sectors. The performance of HVAC systems is very important in terms of energy saving and energy efficiency. However, the HVAC systems may suffer various faults, such as fouling, pipe clog and improper control, etc. However, few researchers paid attention to the system-level FDD and the comprehensive structure of the building system diagnosis strategy. The building-level diagnosis scheme adopts a simplified building load estimation model as the benchmark to characterize the overall performance of the entire building system. The building envelopes including exterior walls and roofs are represented by a thermal network model with three resistances and two capacitances. The internal mass is represented by a thermal network model with two resistances and two capacitances. The building load estimation scheme using monitoring weather information e. The building load forecast scheme using the weather forecast information from the observatory as the input of the building thermal network model is applied in the optimal control strategies. In the forecast scheme, two weather prediction modules are incorporated into the thermal network model. The other is the solar radiation prediction module based on the cloud amount and temperature forecast from the observatory. The first step is to detect, diagnose the sensor, and to estimate the fault i. The second step is to diagnose the system i. Using the normal or corrected sensor measurements, one or more performance indices Pis are obtained to characterize the performance of the HVAC systems. An on-line adaptive threshold of the PI residuals, determined by the training data and measured data, is used to define the normal range. As chillers take the largest part of the power consumption in HVAC systems, the component-level FDD scheme for the chiller is developed using fuzzy modeling and artificial neural network ANN. Based on the sensitivity analysis tests, performance indices PI are selected to characterize the health status of the chiller. SQP is very effective to distinguish the faults, even to the faults having the same qualitative rule patterns. The three-level building HVAC system diagnosis strategy is developed into a software package implemented on IBmanager, which is an open integration and management platform for intelligent building systems based on the middleware technologies. As a function module of IBmanager, the software package of the building HVAC system diagnosis strategy is supposed to report alarms, generate the diagnosis results and recommend improvements through an Intelligent Control and Diagnosis System for a commercial building. This system is a platform working in the foreground of the working station as an interface between IBmanager and end-users. PolyU Library Call No.:

Chapter 8 : Random vs. Systematic? | exida

The first step is to detect, diagnose the sensor, and to estimate the fault (i.e. sensor fault detection, diagnosis and bias estimation (FDD&E)) prior to the use of the system FDD method. The second step is to diagnose the system (i.e., system FDD) by using the sensor FDD&E as the guarantee of measurement health.