Fault tree analysis and reliability block diagram for reliability evaluation using cost-based decision tree

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In the past few years a considerable amount of work has been devoted to improve the efficiency of methodologies applied to reliability and safety analyses of industrial plants. In particular, the need for a more detailed analysis of the system under study is growing, whereby the plants structures as well as its working conditions were taken into account. During the recent years, the requirement of modern technology, especially the complex systems used in the industry, leads to a growth in the amount of researches about the design for reliability. Avontuur and van der Werff (2001) and Avontuur (2000) emphasized the importance of reliability analysis in the conceptual design phase. It is demonstrated that it is possible to improve a design by applying reliability analysis techniques in the conceptual design phase. The aim is to quantify the cost of failure and unavailability and compare them with investment cost to improve the reliability (Abo Al-Kheer et al., 2011).

In following the increase of using automatic systems, the problem of performance reliability in such equipment and regarding to it, some indexes such accessibility, rate of fault and etc are suggested. Since the most automatic systems are designed for continuous missions and the destruction during the mission can make high expenses for utilizers, so evaluating the assurance on equipment must be considered in different steps and also in the phase of planning, to prevent such unwanted destructions (faults) during the work (Fiorenzo, 2008). In this field Kovarium and Iravani (2008) have promoted the reliability and improvement of robot 3P and robot 6R by tools FMEA and QFD.

Materials &As complex systems have become global and essential in today's society, their reliable design and the determination of their availability have turned into a very important task for managers and engineers. Industrial robots are examples of these complex systems that are being increasingly used for intelligent transportation, production and distribution of materials in warehouses and automated production lines. In this paper, a comprehensive fault tree analysis (FTA) on the critical components of industrial robots is conducted. This analysis is integrated with the reliability block diagram (RBD) approach in order to investigate the robot system reliability. For practical implementation, a particular robot system is first modeled. Then, FTA is adopted to model the causes of failures, enabling the probability of success to be determined. In addition, RBD is employed to simplify the complex system of the robot for reliability evaluation purpose. Finally, cost-based decision tree is configured to compute the cost of each component and the whole robot system. Methods

Pi= failure probability for component i; Ci= cost of failure for component i;

$K_{12}=P_{22}.C_{22}+P_{21}.C_{21}+P_{20}.C_{20}+P_{19}.C_{19}$

$G_{11}=\min\{K_{18},K_{17},K_{16}\}$ $K_{17}=P_{29}.C_{29}+P_{28}.C_{28}$

$K_{10}=P_{15}.C_{15}+P_{14}.C_{14}+K_{13}$

$G_3=\min\{K_{12},G_{11},K_{10}\}$ $K_{13}=P_{24}.C_{24}+P_{23}.C_{23}$

$K_7=P_8.C_8+P_9.C_9$

$K_6=P_6.C_6$

$K_5=P_5.C_5$ $G_2=\min\{K_7,K_6,K_5,K_4\}$

$K_4=P_4.C_4$

$Z=\min\{G_3,G_2\}$

In this paper, cost based decision tree was developed to evaluate reliability of a complex system including robots in a production system. The proposed model considered binary state robots that are functioning as material handling devices in a production system. In this approach, the reliability block diagram was presented, based on which the structure of robots were determined. Then, using a backward failure decision tree method the reliability of a complex system was computed.