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Fault Tree Analysis as a Reliability Management Technique in Autonomous Robots

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Abstract
Fault tree analysis has been used for decades in aeronautics, automotive, nuclear power, chemical processing industries, but it has seen limited use in mobile systems. The automotive industry has used the technique successfully but not dynamically. I propose the use of fault tree analysis as a dynamic technique that can allow an autonomous robot to properly evaluate its situation in the case of a fault. The utilization of fault tree analysis is a top down analysis technique that refers to aposteriori evaluations of undesired effects regarding the functioning of a system. This paper deals with the use of fault trees specifically constructed for each functional assembly/subassembly of an autonomous robot. These trees are stored in the system and subsequently used as a pattern for the automatic analysis of defects, faulty components and the probable causes of these faults. The results of these analyses are then used to evaluate the functioning capacity of the robot and (if possible) to attempt corrective actions in order to ensure continued functioning and mission completion. While the use of fault trees implies a large volume of work related to modelling the fault trees of each component of the robot, the autonomy the robot gains represents a major improvement on previous reliability management techniques. The system also permits the use of fault trees provided by manufacturers for their components with minimal adaptation. Furthermore, if the several robot models use the same components they can share the fault trees for those specific components by simply copying them reducing the volume of work even more. This makes the technique versatile in the long run allowing extremely complex robots to manage their own faults.

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