Implementation of a diagnosis architecture for a networked mobile robot

Key words: diagnosis, prognosis, Bayesian Network, network communication Wifi , Networked control systems, implementation on a mobile robot.
Development environment: Linux.
Implementation tools: C/C++.
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Description:

Nowadays, networked systems are found in a large number of applications such as energy, transport, environment… The networks of communicating mobile vehicles (including autonomous), possibly collaborative (flying or submarine drones, robots, automobile and rail vehicles, domestic help), are a subclass of networked systems characterized by wireless communications and mobile nodes. They are distributed systems where the actuators, sensors and the controllers are connected through a communication network. However, the integration of a network in the control loop, given the stochastic aspects of wireless networks, and mobility of its communicating entities generate problems that affect the system performance. Several parameters, which represent the Quality of Service (QoS) of the network have an impact on the performance of the networked control system and on its Quality of Control (QoC): packet loss, delay, jitter and throughput. As a result there is a clear need for a diagnosis method to localize faults and to make the right decisions to improve the system performance. A Bayesian network (BN) for diagnosis has thus been proposed [3]. The BN [2] is a relevant tool to model and evaluate systems integrating a probabilistic dimension. It is a good formalism to model under uncertainty. Another advantage is the possibility of representing the dependencies between failures.

Our diagnosis method will be tested on a system composed of a mobile robot (Khepera III) controlled via a wireless network by a remote station as shown in Figure 1. The robot main task is reaching the target while avoiding obstacles. Mechraoui [1] designed both an embedded control and a remote control over wireless network. The robot can be autonomous (when outside the station coverage area) and in this case all calculations are performed on its onboard microcontroller. Otherwise, the robot is connected to a remote station (computer) and in this case most of the computations are performed on the station.

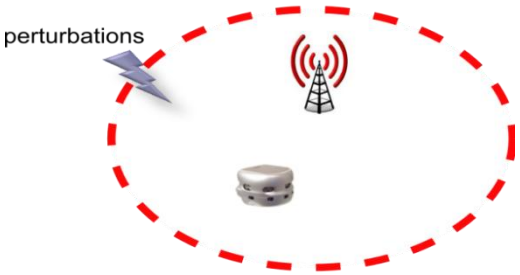

Figure 1 : robot Khepera III controlled by a remote station

The objective of the internship is to implement the robot control architecture via the network and the proposed diagnosis method. For the implementation of the diagnosis method, the network parameters and the internal state of the robot must be supervised. BN receives these

observations in order to determine the cause of the malfunction using the inference algorithm. The trainee will have to :

- implement the distributed Bayesian Network for diagnosis on the robot (Khepera III) and on a machine that will control it via a wireless network.
- make a bibliography study about prognostic policies to predict failures before occurrence.

The trainee must have skills in C / C ++ and programming in Linux, some knowledge of control systems and ideally wireless communication networks and network monitoring tools. Knowledge of BN and inference algorithms will be a plus.

A thesis will be possibly proposed following the internship.

References:

[1] A. Mechraoui, *Co-conception d'un système commandé en réseau sans fil à l'aide de réseaux bayésiens distribués*, thèse de doctorat, Université de Grenoble, Institut Polytechnique de Grenoble, 2010.

[2] P. Naïm, P. H. Wuillemin, P. Leray, O. Pourret et A. Becker, *Réseaux bayésiens,* 3ème édition, Eyrolles, 2007.

[3] Sassi, I., Gouin, A. and Thiriet, JM., *A Bayesian network for diagnosis of networked mobile robots.* In European Safety and Reliability Conference 2016.