Chapter 27
Implementation of the Communication Network for the Multi-Agent Robotic Systems

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ABSTRACT

The paper proposes a structure of self-organizing communication networks of the multi-robot system. The considered networks are organized on the basis of two radio channels: to transmit control (telemetry data) and to transmit data (video flow), which have the higher bandwidth requirements. The algorithm of self-organizing network is designed and presented based on the wideband channel quality control: data of the received signal strength indicator (RSSI), the capacity and the packet error ratio (PER).

1. INTRODUCTION

The communication networks between the agents of multi-agent systems (robots) are designed to provide exchange of control and information messages between elements of the system in order to solve the tasks of agents' management and delivery of the data, which is obtained with the help of video cameras and other sensors that the agents are equipped with. Since the system components are mobile, and the communication conditions between them are dynamically changeable, the main goal of the network

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self-organization is to ensure stable network performance of its basic functions (Koucheryavy, 2010; Koucheryavy, 2011; Attarzadeh, 2011; Koucheryavy, 2013). Therefore, the main tasks of the networks' self-organization are:

- to provide the network connectivity (liaison between the network nodes);
- to provide the Quality of Service (QoS) traffic (maintaining the required quality of service traffic) (Koucheryavy, 2009).

There are some well-known routing protocols for self-organizing networks which provide logical structure organization using the information about the state of channels between nodes and any additional information. Usually that protocols use one common channel to path control traffic and useful information data. Amount of the control traffic depends on the protocol type, traffic characteristics, and the network stability. The network stability is the most important factor for the mobile network. Motion of the nodes impacts on the radio signal propagation conditions between them due to the variation of distance, obstacles between the nodes, and the interference with the reflected signals. Therefore, the mobility may cause the network structure instability and results in the control traffic growth. Frequent switching of the network structure leads to the degradation of the useful traffic service quality.

Usually nodes of the self-organization network use one specific frequency channel. If there are any interference signals or any other devices use the same channel, the quality of service may decrease rapidly. To solve this problem it is necessary to find the reason of quality degradation and adjust all the network nodes. Therefore, it is required to have possibility of the monitoring of existing frequency channels and possibility to send control commands to all nodes to select the other channel.

In the field of the robotic systems implementation the communication network between elements of the system must provide delivery of the management traffic and any additional traffic. The management traffic is used to control robotic devices. Usually the rate of management traffic is relatively low but requirements to communications reliability are very high. On other hand the additional traffic is usually a video traffic with a relatively high bitrate. The quality of video traffic service impacts on the quality of experience but don't directly impact on the possibility of the system in general. In fact, the quality of video traffic service must have to be as high as possible, but it should not affect the quality of traffic management service. Considering requirements to the management and video traffic service we can conclude that it makes sense to organize hardware independent channels (Kirichek, 2016a).

There are some approaches to setup network configuration to improve stability. Some methods are based on active probe methods, for example (Wang, 2015; do Carmo, 2014). Some methods are oriented on maximization of the network coverage, such as (Kantaros, 2014). There are methods developed for simplification of the network configuration algorithms (Shinnoh, 2015), or supporting of high mobility (Tardioli, 2014). So, we can conclude that necessary method dependents on the application of the network. In the paper, we present a method that provides a compromise between the software and the hardware components.

In this paper, we consider the self-organizing network formed by using of two different radio transceivers in different frequency bands and different physical level realization. One of them designed for the payload traffic and the other one for control traffic transmitting. Us of two different transceivers complicates the device, but increases the stability of the network and quality of service. This complication can be justified if we consider the fact that the network must provide control of the mechanical devices.