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AZ EMBER-ROBOTOK EGYÜTTMŰKÖDÉSÉT SZERVEZŐ RENDSZEREK MULTI-ÁGENSŰ KÖRNYEZETBEN

COOPERATION ORGANIZATION IN HUMAN / MULTI-ROBOT INTERACTION

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Abstract

Human - robot interaction design falls at the confluence of several research areas including autonomous systems, human factors, intelligent user interfaces and task analysis. Communication between robots and people significantly increased over last years. The main reason is a huge progress in artificial intelligence. Human - robot interaction is based on the study of functionality and usability of performing some tasks that involve humans. In this paper we will discuss team organization conditions. The aim of this paper is to make literature overview and define which teamwork organization is better due to the reducing of workload and increasing performance.

Keywords: *teamwork, cooperation, MRS, Human – robot interaction, team organization*

Összefoglalás

Az ember-gép kapcsolat nagyon sok kutatási témában szerepel napjainkban és egyre időszerűbb, és egyre nagyobb teret foglal el a hétköznapi életben is. Az ember-gép kommunikáció is egyre gyakoribb lesz az életünkben. Ennek fő oka az intelligens rendszerek egyre szélesebb körben való elterjedése. Ebben a cikkben egy összefoglaló tanulmányt mutatunk be az ember-gép kapcsolatok fejlődéséről, feltételeiről, és egy jövőbeli kitekintést adunk az önszerveződő rendszerekkel kapcsolatban. Vizsgáljuk továbbá az ember-robotok közti csoportmunka lehetőségeit kutatva, ennek előnyeit, hátrányait.

Kulcsszavak: *csoportmunka, együttműködés, MRS, ember–gép kapcsolat, csoportszervezés*

1. Introduction

Enhanced autonomy makes it possible for one operator to control multiple robots. It releases an operator from manually controlling each robot and makes it possible to do tasks requiring monitoring, coordination, and complex decision-making [2]. Human - robot interaction is used when the completion of the task is too risky for people or cannot be achieved by people. Moreover, even when a single robot can achieve the given task, group of robots is used in order to achieve better performance and increase overall of the system [8]. The software techniques developed for the robotic applications take advantage of the hardware improvements and provide complex and reliable solutions for the basic tasks that a robot should be able to perform, while acting in real world environments: localization, path planning, object transportation, object recognition and tracking, etc. [8].

A Multi-Robot System can be characterized as a set of robots operating in the same environment [8]. However, robotic systems may range from simple sensors, acquiring and processing data, to complex human-like machines, able to interact with the environment in fairly complex [8]. Effective teamwork in highly dynamic environments requires a delicate balance between giving agents the autonomy to act and react on their own and restricting that autonomy so that the agents do not work at cross purposes [9]. Although there are a lot of advantages of using MRS (Multi-Robot Systems), system can fail. It is well known that many well-constructed teams never reach their full potential. In order to avoid system fails we have to create outstanding taxonomy. Factors that can lead to system fails are the following: poor combination of individual efforts, a breakdown in internal team processes, and improper use of available information [1]. In addition, when people collaborate with autonomous systems, system complexity inevitably increases, and automation can change the way people coordinate with each other [3]. It follows that in multi-robot systems one of the central issues is the study of how groups work in order to avoid fail of the system. A paradigmatic example of joint activity is teamwork, in which a group of autonomous agents choose to work together, both in advancement of their own individual goals and the good of the system as a whole [4].

2. Teamwork organization

Controlling multiple autonomous robots is a complex process. The main elements of teamwork are leadership, mutual performing, backup behaviour and team orientation. It is important to make a distinction between team performance and team effectiveness [7]. Team performance accounts for the outcomes of the team's actions regardless of how the team may have accomplished the task [7]. Conversely, team effectiveness takes a more holistic perspective in considering not only whether the team performed but also how the team interacted to achieve the team outcome [7]. This is an important differentiation because many factors external to the team may contribute to the success (or failure) of the team, and therefore in some cases team performance measures may be deficient in understanding the team [7].

2.1 Work organization between robots

We can assume that there are 2 types of work organization between robots: Distributed and Centralized.

Centralized system has an agent (leader) that is in charge of organizing the work of the other agents; the leader is involved in the decision process for the whole team, while the other members can act only according to the directions of the leader [8]. The classification of centralized systems can be further refined depending on the way the leadership of the group is played [8]. Specifically, Strong centralization is used to characterize a system in which decisions are taken by the same pre-defined leader agent during the entire mission duration, while in a weakly centralized system more than one agent is allowed to take the role of the leader during the mission [8].

A Distributed system is composed of agents, which are completely autonomous in the decision process with respect to each other; in this class of systems a leader does not exist [8].

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2.2 Team structure

Team structure is an important factor that affects to the effectiveness for the search and rescue setting team. Team structure can be described as the work assignment and communication architecture. Work assignment is the "manner in which the task components are distributed among team members" [5]. Team structured is closely related to communication, coordination and team performance.

For a team of operators working together with multiple homogeneous unmanned vehicles, two possible ways to organize the vehicles are as Sectors or as a Shared Pool [6]. In the Sector condition, each operator controls a part of all the vehicles. In the Shared Pool condition, operators share the control of all the robots and service them as needed.

Sector assignment can reduce the number of robots the operator must monitor and control [2]. However, the Shared Pool condition offers a more flexible scheduling advantage of load balancing since any operator in the team can service any robot as needed [2]. Although there was no significant difference on performance, teams that shared the control of all robots were found to have slightly lower workload [1]. In the Shared pool condition second operator may detect problems that were missed by the first operator. It also leads to excessive observation advantage.

In the pool condition members communicate more than in sector and share the workload between the operators and perform more teamwork behaviours. It was investigated that teams with shared control are more wanted to work with team members in future projects.

Team members also employed certain team strategies to cope with the increased coordination cost. In the experiment, it was observed that some operators in Pool teams would pre-plan on which robots to control via verbal communication, even if the plan changed during the task execution [1]. In addition, reduced individual level of effort is easier in Pool teams than in Sector teams. With reduced individual level of effort, the advantage of Pool teams is diminished [1]. Teams that have developed shared mental model have more accurate expectations for the needs of the team and the teammates during periods of stress [7].

3. Conclusion

The effectiveness of the team increases during the process as team members learn how to work with each other and become increasingly proficient in their task work. Operators are suggested to start with simple tasks where they can learn their tasks, roles, performance, progress and the then undertake more complex tasks. It's better to plan some strategies before the process starts.

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