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IFAC-PapersOnLine 48-24 (2015) 089–094

Cultural aspects of computer networks in tennis

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Abstract: The paper describes an approach to designing and developing computer networks intended for application in sport, in particular, in tennis. This includes input from an expert end-user (tennis player). The objective function maximises service quality for all users. The optimum network topology proposed is a three part butterfly topology. The design model involves multiple threads with each thread connecting a user to applications and the approach aims to develop the first thread as a template for subsequent threads. The paper also discusses the potential impacts of the increasing use of computers in sport and how to maximise positive and reduce negative impacts.

Keywords: Computer network, goal, criterion, topology, performance, robustness, tennis.

1. Introduction

This paper presents a computer network for supporting tennis players. This is being developed by the Working Group 03 Nota (Non-technological aspects of ICT (Information and Communication Theory) and automation), which works on wider applications of ICT and automation systems and networks. Consideration of the ethical, social, political and cultural aspects of these systems and networks is very important for understanding their applications, ensuring they perform effectively and are implemented in ways that are culturally appropriate and encourage rather than discourage ethical behaviour. These factors should also be considered in the evaluation of system performance. The work presented here is one of a series of five papers on the cultural and ethical aspects of the applications of computer networks in sport, music, the performing arts and politics. These applications are generally complex and involve large scale systems.

The use of computers in sport in general and tennis in particular is by no means new. However, their use has not yet become general practice. A number of different computerised approaches have been used to support training, both in tennis and other sports. Applications of virtual reality and simulation have been considered by a number of authors including (Bideau et al., 2010; French and Ferguson, 2000ab; Ji et al., 2003; Miles et al., 2012; Morizono et al., 1997; Noser and Thalman, 1998; Tsuji et al., 2001; Yokokohji et al., 1996). Other approaches include (interactive) video mirrors (Hämäläinen, 2004); computer controlled ball throwing machines (Crews and Richings, 2000; Kovacs et al., 1992); sports computers with various facilities including GPS receivers and tracking devices (Edgecomb and Norton, 2006; Fry, 1999, 2002); GPS systems (Larsson, 2003; Lee et al., 2005); and rapid feedback systems (Baca et al., 2006). While some of the rapid feedback systems have been proposed for 'elite' sports training, if low cost versions can be developed, there is no reason they cannot be used in sports training at all levels. Other uses of computers include real time tracking for improving tennis broadcasts (Pingali et al., 2000) and the use of micro-computers for making automatic line call decisions in tennis (Supran, 1984).

However, though the examples mentioned above are very interesting and sometimes useful for tennis players, they only support the solution of individual, separate, technical problems. However, tennis players and organisers require a complex tool which is able to provide support to them in several different domains in addition to the technical ones. There are also benefits in a single multi-function tennis support tool which provides a range of functions, including those discussed above, and uses a special purpose computer network to do this.

2. End-User Involvement

End-user involvement is always very important for the effective development of technical systems. This includes specifying end-user requirements which can then be used to draw up technical specifications and monitoring and critiquing the design process and its implementation. This is particularly relevant when the characteristics of end-users are very different from those of the developers, which is

Peer review under responsibility of International Federation of Automatic Control.
10.1016/j.ifacol.2015.12.062

generally the case, and/or the system is complex. There are a number of different approaches to end-user involvement. However, it is important that end-users are involved from the start and throughout the design process, as changes introduced at a later stage are generally more expensive (Hersh, 2010) and may also be less effective. While there are advantages in involving a wide range of different types of end-users in the design process, this may not always be feasible. The alternatives include the use of either typical or expert end-users. Typical end-users are able to present the perspective and issues which affect the majority of end-users. Expert end-users have a greater understanding of the domain of activity. Co-operation between end-users and ICT developers also requires a willingness to work together and try to harmonise different approaches and expectations between end-users and developers. There will also generally be a need to develop a common language and to both reduce the use of jargon and to explain any necessary technical or domain specific terms.

Some examples of end-user involvement in the Polish context, but the very different application areas of the ICT and automation industries are presented in Lewoc et al. (2015). The paper authors also have experience of both the value and the necessity of end-user involvement in a number of different types of application, including in the design of power distribution systems (Lewoc et al., 2015) and assistive devices (Hersh and Johnson, 2010).

In this case the design involves a single expert end-user, the Polish female tennis player Agnieszka Radwańska who has been in the first ten of the World Tennis Association ranking. She is considered to have a particularly reflective approach to the game. Her end-user requirements are presented as short extracts from an interview with her carried out by the first author.

‘Tennis combines the heart, the head, when and where I need be on the court, and the rest of my body and spirit. … Do I need a computer network? Sure, I do, an efficient, reliable, and – most important, a robust one. So that I can resist any shot from the girl on the opposite site of the net who, most probably, thinks about me and tries to work hard with her head and her force, her arms and body.’

‘My head does not help me enough, so I need help from the people who support me, in the audience and in my team. … I need information about their tricks on the court, their strongest and weak points, … . I do not need information about their training, their staff … . I only need to know how they behave on the court in various situations. … I need a good, i.e. efficient, effective, reliable and robust computer network.’

3. The Computer Network

The tennis playing and support system of interest can be modelled as a number of threads, with each thread linking a user with the application serving the user. The first thread therefore involves the first user and should, as far as possible, be designed to be used as a template to support the implementation of subsequent threads. This requires the use of general solutions, methods and standards, as far as possible.

The computer network to support tennis players is designed to support a one to one mapping to this system, but with the possibility of time delays. The computer network is based on a topology. As shown in figure 1, the two main options are the star and ring topologies. In order to function effectively in the presence of disturbances, the topology should be highly robust and reliable in a variety of conditions. Doyle’s (1982) μ function is used as the measure of robustness. The calculation of μ values for different topologies can be used to investigate their robustness. For instance, the Star topology has been shown to be much more robust than the Ring topology (Izworski et al, 2003).

It should be noted here that the application of the μ function to robustness investigation of general automatic control systems is not easy, as calculating the μ value may require calculation of the eigenvalues for a matrix consisting of transmittances and disturbances. In the case of a general automatic control system, this is rather difficult and cumbersome.

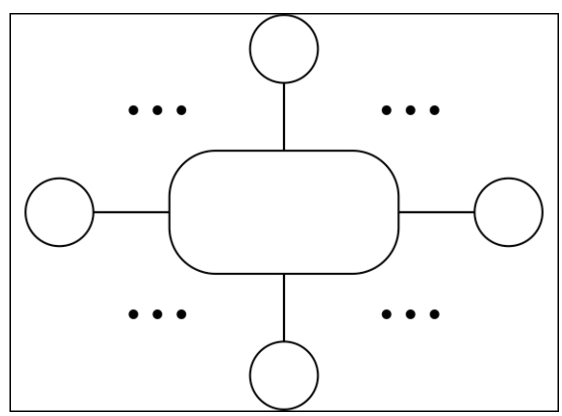

Figure 1a, Ring topology for tennis applications

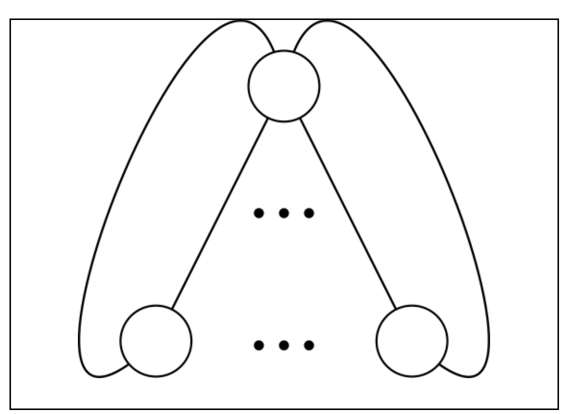

Figure 1b: Star topology for tennis applications