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A MULTIDISCIPLINARY CLIENT-SERVER PLATFORM

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Abstract

The academic syllabus of the Electrical Engineering and industrial data processing taught inside the french Institutes of Technology offers a course called Industrial Ethernet and remote control with the internet. The aim of this module consists in making students more sensitive to the use of ethernet as an industrial communication solution. In firms, the students will have to maintain equipments such that packaging machines, collective boilers or water treatment plant.

As a pedagogical support, the Spykee robot platform is used for two main reasons. First, its possibilities are matching the previous objectives. Then, as it is a regional product, that implies the maintenance and improvements can be effective with a short delay. The robot can be used at different levels of applications with respect to the user's basic knowledge.

The paper deals with the main applications done with the multidisciplinary platform. One application is based on the DARE method, acronym for Discovering, Applying and REsolving which has been used for ten years in the Electrical Engineering department. A second example presents an international robotics competition with academic partners. During this one week competition, groups of European students share their skills and know-how with our students. The paper ends with a short presentation of a humanoid robot that offers a large amount of possibilities and triggers imagination for new pedagogical applications.

Keywords:

Multidisciplinary, technological platform, partnership with companies, robotics

1. INTRODUCTION

The academic syllabus of the Electrical Engineering and industrial data processing taught inside the french Institutes of Technology proposes a course called Industrial Ethernet and remote control with the internet [1]. The aim of this module consists in making students more sensitive to the use of ethernet as an industrial communication solution. In firms students will have to maintain equipments such that packaging machines, collective boilers or water treatment plant. The use of internet offers a way for students to carry out some operations on industrial programmable automation systems. The purposes of the taught knowledge aims the student to be able to configure a system of computers either for companies or box offices by the use of the transmission control protocol known as TCP/IP. The section 2 presents the didactic platform *Spykee* from the specifications to its applications in projects. The section 3 shows an example of the platform in a friendly and international contest. In particular, the DARE method used since ten years in mathematical background is now applied to this contest. The section 4 draws conclusion and further developments.

2. THE DIDACTIC PLATFORM SPYKEE

This section presents the didactic platform *spykee* or how to turn a toy into a teaching tool. Some internet context definitions are proposed to the reader in order to identify the further required students skills. Then, the specifications of the didactic platform *Spykee* are given with the reasons justifying the financial choice of the platform.

2.1 Internet protocol

In the framework of computers networks, the term protocol denotes a set of communication rules. The Transmission Control Protocol/ Internet Protocol, TCP/IP in short, is one of the most useful and

wellknown protocol. The letters IP for Internet Protocol indicate that the protocol TCP/IP obeys to the Internet communication rules. Internet means Inter Networks. The protocol IP offers to connected computers in local area networks to communicate with others worldwide networks. Each computer in the world gets an identification address from the IP protocol designed as the IP address. The IP address is a unique address used to locate and identify a device over a network. Thanks to the IP address a message, also called a set of data, can be sent to another identified computer. The IP structure is composed of 4 numbers of 8 digits each. The first byte is called the network identifier . The three next bytes are the host identifier. The protocol TCP/IP needs a router called UDP for User Datagram Protocol in order to send the data. Thus the UDP/IP protocol allows for a given application running on a computer A to send data to another application running on a computer B. In that framework, each application needs to be identified by a number called the communication port. The association of the IP and of of the port constitutes a socket. Additional rules installed in the TCP/IP protocol guarantee the reliability of transmission.

2.2 The didactic platform Spykee

For industrial management, the communication is based on an architecture called Client-Server. An application running on a computer A called the client is communicating with an application running on a computer B called the server. The client is sending queries or orders to the server. Generally, the server are computers with bigger capacities than a personal computer in terms of memory access and storage size, computing power and numbers of input/output. In order to teach the basic knowledges of industrial management, the robot *Spykee* of ®Meccano company [2] (Fig. 1) is used as a client-server platform. This didactic platform is turning as a multidisciplinary platform. Thus, such domains as applied mathematics, computer sciences, automation, control system, image processing, sound processing can lay on the same tool. Actors of the education world are now using this platform in order to refresh the motivation of youngs for technology and science. The ®Meccano challenge based on *Spykee* for secondary scholl pupils of the Academy of Lille tries to turn their mind more positive to the sciences.

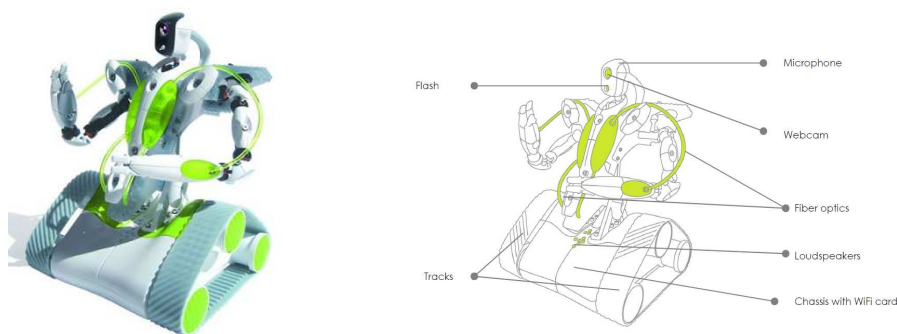


Figure 1. left : the spykee robot ; right : its elements.

The challenge is organised since 2010 by an organism UIMM (in french Union des Industries et des Métiers de la Métallurgie) in the background of MECANOV a mechanical regional pole of excellence. The sector of mechanics involves 45000 employees in the Nord Pas de Calais region. It is important for the companies in this sector to recrute youngs well prepared to their future jobs. Numerous opportunities are proposed to youngs issued from vocational schools, institutes of technology, universities and engineer schools.

2.3 Specifications and operating modes of Spykee

Spykee is a toy produced by the ®Meccano (Fig.2) firm. Frank Hornby in 1898 at Liverpool founded a model construction system. The system comprises re-usable metal strips, plates, wheels, axles and gears with nuts and bolts to connect the pieces. It enables the building of working models and mechanical devices. The ®Meccano firm was established in the Nord Pas de Calais region since 1959 with its head office located in Calais. After several years of lower activities, the recovery was pushed up by the Ingberg family since 2000. The sets of model construction system has been spread with plastics parts equipped with electrical or electronical functions as the *Spykee* robot.



Figure 2. The meccano system in the sixties

A wifi board, a webcam, a mp3 reader, one mike and its speaker make Spykee a singular toy. Spykee is an embedded system under Linux with a microprocessor CPU ARM9 at 200 Mhz with 32 Mo for SDRAM and 4Mo as NOR Flash. It possesses a WIFI 802.11 b/g link, a video camera QVGA CMOS (320x480). It contains a server application with a socket communication. Thank to this equipment, Spykee can be driven with a computer from any part of the world. It is able to move, hear, talk, take shots, make videos. Spykee also offers the VoIP – voice over IP- for voice communication or multimedia streams on IP compatible networks, that is *Spykee* can be used as a phone. As *Spykee* includes a system for detecting people and another one able to charge itself its batteries, it can be considered as a survey video camera.



Figure 3. The Spykee console display

The *Spykee console* software (Fig. 3) provided by ®Meccano once installed on a client like computer completes the platform client-server (Fig. 4). Three operating modes can be used : beginner, enlightened and expert. In the beginner mode, the robot is piloted through a direct wifi connexion between the computer and spykee.

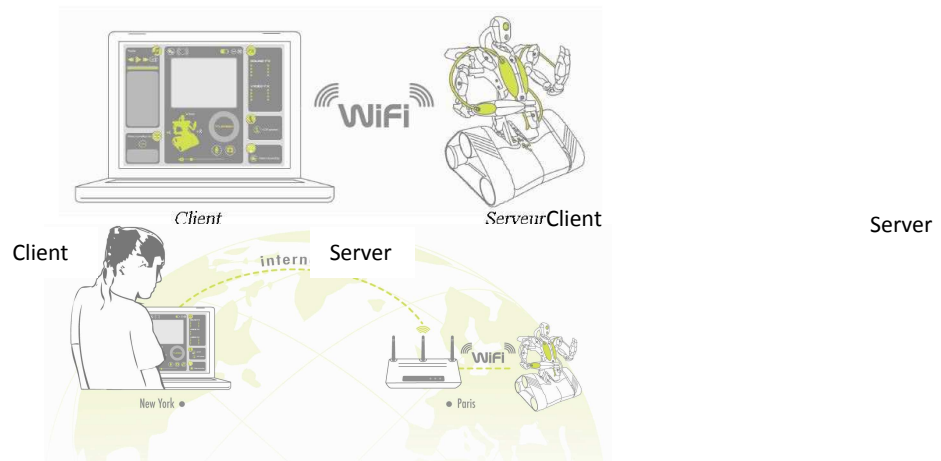


Figure 4. left :the client-server beginner mode ; right the expert mode

In the enlightened mode, the robot command is carried out by a router. In that mode, the connexions are effective once the robot is switched on. In the expert mode, the robot can be piloted from any part of the world by a web connected computer. The connection starts from a client to the server once IP address and communication ports are known. The set IP address and port number is called a socket. All data sets exchanged between the client and the server are based on the TCP/IP and OSI – models (see on Fig.6). The OSI model - Open System Interconnexion- created in 1984 includes seven layers. It offers more details than the TCP/IP model created in 1976.

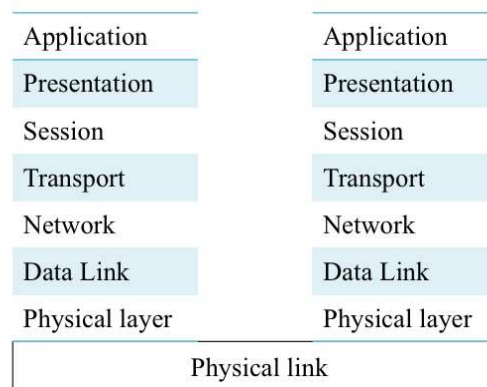


Figure 6. The seven layers of Open System Interconnexion model

The next section highlights the discovery of an application of the *Spykee* platform with French students then European students issued mainly of a bachelor of technology course in the electrical engineering domain. In that last case, a friendly robotic competition starts up the motivation of all students. A method called the DARE method is used in filigrane of the contest.

3. USING THE MULTIDISCIPLINARY PLATFORM

3.1 The student work

The students' work is organised within projects [3] as defined in the academic course and named supervised projects. These projects take 300 hours of personal work during the whole course of 4 semesters. The aim of a project is to lead the student to an autonomous situation. In that framework, the student is learning the methology to deal with projects. To work inside a team, to manage the workload,

to observe deadlines and to write a specification chart are the main skills expected from the student. The student must be also able to search and filter mainly on the internet the right documentation. He can propose new solutions or improvements and finally must write a technical report on his work. Furthermore, the student will also discover the self-reliance and multidisciplinary.

3.2 An international week devoted to robotics

In the framework of supervised projects, a week of international robotic challenge was organised in 2009. Small groups of French, Dutch and Irish students has been enrolled during that week. Six multinational teams each composed by two French students were on apprenticeship plus three European students coming from the Dublin Institute of Technology in Ireland and from Hogeschool Zeeland a polytechnic school at Vlissingen, Netherlands. The subject was how to pilot a *Spykee* robot in a maze. (fig. 7 left)



Figure 7. left : the maze structure ; right : a shot from *Spykee*

The maze is composed by a 4x4 meters square carpet stucked on the ground and divided in 40x40 cm square cells. Those cells are delimited by white strips that form the grid pattern (Fig 7. right). Different robot lanes may be designed using removable sides. The *Spykee* inner camera is detecting in real time the white strip to be followed, the intersection of strips to choose a new direction, the obstacles as walls or other robots to start a new moving strategy. The contest provides to the english teachers of the electrical engineering department a good opportunity to check and improve their students skills in a real mainly technical situation.

3.3 The DARE method

All projects have been supervised using a method invented by a team of teachers. The DARE method is an acronym for Discovering, Applying and Resolving [4,5]. This teaching method is split into three parts.

The first part of any project is a discovery part. It is equivalent to a reverse engineering process. For instance, the study focuses on information running from client and server by the use of the spykee console software. A programming language in ASCII format allows the client to order the motors. The server acquires images in JPEG format. The client application decodes all data to rebuild the transmitted images. The work done in that background matches the syllabus in the network course by applications of protocols and multiplexing.

The second part of the project is an application part. The students must create their own app to be applied on a smartphone or a pad as a client. The development software in that case is WinDev® of PCSoft. It brings a way to design an application oriented on data management. The native and pseudo language like is called Wlanguage. WinDev® can be defined as a software engineering toolkit to design data bases management sytems. While developping a WinDev® program it is necessary to focus on sockets statements as SocketConnect , SocketWrite, SocketRead, SocketClose. In that situation, the work is thus a computing science work or a programming language application.

The last part of the DARE method consists in resolving problems. As an example, the problem can be set as the definition of a tracking line robot in the *Spykee* environment (fig7). The students will rely on the knowledge in automation. They can install a Proportional Integral-Derivative controller. The mathematics course with the image processing lessons in particular will also help the students. Thus, a client application with images structures as input and proper orders to the robot as output can be designed.

The three parts rhythm of the DARE method sounds as the Latin teaching method from last century. That is, translation from mother tongue, the translation and finally the dissertation. The authors have been using the DARE method for ten years in automation course, in applied maths course with a computer algebraic software as Maple® and now in electronic design software beginners course. One main effect of the method validating its use since a decade is that no student is passive. This is due to the way to write the easy starts of a practical work. But, the clever students find in the last part a way to prove and to apply their skills.

4. CONCLUSION

The paper presents a didactic platform used to teach the Internet protocol by the mean of a sophisticated toy. All teachings, mainly projects lay on the *Spykee* robot platform. In particular one international and friendly contest takes this platform for a multidisciplinary use. A method called the DARE method minds the students up to easy comprehension and positive behavior. In filigrane, the teachers also improve their communication skills.

Robotically speaking, the Electrical engineering department spreads its views and know-how to new platforms. Thus, the NAO humanoid robot from company Aldébaran Robotics and the drone Parrot are the last two robotics platforms that are starting, maintaining and improving the motivation of students for sciences, technology and their applications to human beings. The high level of the lectures in term of robotics and automation evolves the electrical engineering department to launch of a new bachelor of technology course entitled Engineering for the autonomy of person. The subject will prepare the students to learn how to turn disabled persons more secure, healthy, mobile and comfortable thank to the new technologies.

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