



New Trends and Issues Proceedings on Humanities and Social Sciences



Issue 5 (2017) 98-104

ISSN: 2547-8818

www.prosoc.eu

Selected Paper of 7th World Conference on Educational Technology Researches (WCETR-2017) 20 – 22 April 2017 AAB
College, Pristina, Republic of Kosovo

Remote radio astronomy in distance learning

M.M. Montoya^{a*}, Facultad de Ciencias, Universidad Nacional de Educacion a Distancia (UNED), Senda del Rey 9/ Madrid, E-28040, Spain

J.A. Vaquerizo^b, Centro de Astrobiologia, Madrid, 28850, Spain

A. Williard^c, Facultad de Ciencias, Universidad Nacional de Educacion a Distancia (UNED), Senda del Rey 9/ Madrid, E-28040, Spain

E. Martinez^d, Facultad de Ciencias, Universidad Nacional de Educacion a Distancia (UNED), Senda del Rey 9/ Madrid, E-28040, Spain

Suggested Citation:

Montoya, M.M., Vaquerizo, J.A., Williard, A. & Martinez, E. (2017). Remote radio astronomy in distance learning. *New Trends and Issues Proceedings on Humanities and Social Sciences*. [Online]. 05, pp 98-104. Available from: www.prosoc.eu

Selection and peer review under responsibility of Prof. Dr. Huseyin Uzunboylu, Near East University, Cyprus & Prof. Dr. Shemsedin Vehapi, Vice Rector for Academic Issues, AAB College, Republic of Kosovo

©2017 SciencePark Research, Organization & Counseling. All rights reserved.

Abstract

National Distance Education University (UNED) is a Spanish University whose methodology is based on the principles of Distance Learning. UNED has the largest student population in Spain and is one of the largest universities in Europe. PARTNeR (Proyecto Académico con el Radio Telescopio de NASA en Robledo, Educational Project with NASA's Radio Telescope at Robledo) is an educational project that allows students to remotely operate a 34-meter parabolic antenna located at the NASA's Madrid Deep Space Communications Complex. UNED science students perform real-time remote radio astronomical observations controlling PARTNeR radio telescope through Internet from their classroom. Students that cannot attend the observation on-site because of geographical dispersion or occupational tasks can join it on-line using the AVIP classroom, a virtual classroom based on IP technology. The main educational objective of UNED-PARTNeR collaboration is to learn the basics of general astronomy and radio astronomy and to understand the fundamentals of radio telescope operation. The technical objective of UNED-PARTNeR collaboration poses a double challenge: on the one hand, to remotely operate a first-rate scientific instrumentation using AVIP classroom and, on the other hand, to carry out a real scientific research using distance learning methodology.

Keywords: Distance learning; Remote radio astronomy; Virtual classroom; Practical Astrophysics

* ADDRESS FOR CORRESPONDENCE: **M.M. Montoya**, Facultad de Ciencias, Universidad Nacional de Educacion a Distancia (UNED), Senda del Rey 9/ Madrid, E-28040, Spain

E-mail address: e-mail: mmontoya@ccia.uned.es Tel.: (+34) 91 398 7180

1. Introduction

1.1. PARTNeR Project

PARTNeR project is an educational program that uses a 34-meter parabolic dish antenna located at NASA's Madrid Deep Space Communications Complex (MDSCC) as educational tool to perform remote Radio Astronomical observations from the classroom using Internet (Vaquerizo, Perez & Cabezas, 2011).

The project is a joint collaboration between NASA and the Spanish National Institute of Aerospace Technology, INTA. Both institutions signed a Joint Statement in 2001 to carry out the PARTNeR Project.

The main objective of the project is introduced to High School and undergraduate students to the procedures and techniques of Science. Students learn about radio astronomy fundamentals, control remotely a huge antenna and collect scientific data from astronomical sources in the universe.

Teachers are trained and also provided with support materials for classroom implementation. Students are actively involved in handling data by doing real science as an ongoing and teamwork process.

As technical requirements, Internet is used to connect students to the Remote-Control Center and the antenna. Figure 1 shows the general connection diagram between an Educational Center and the PARTNeR Control Center.

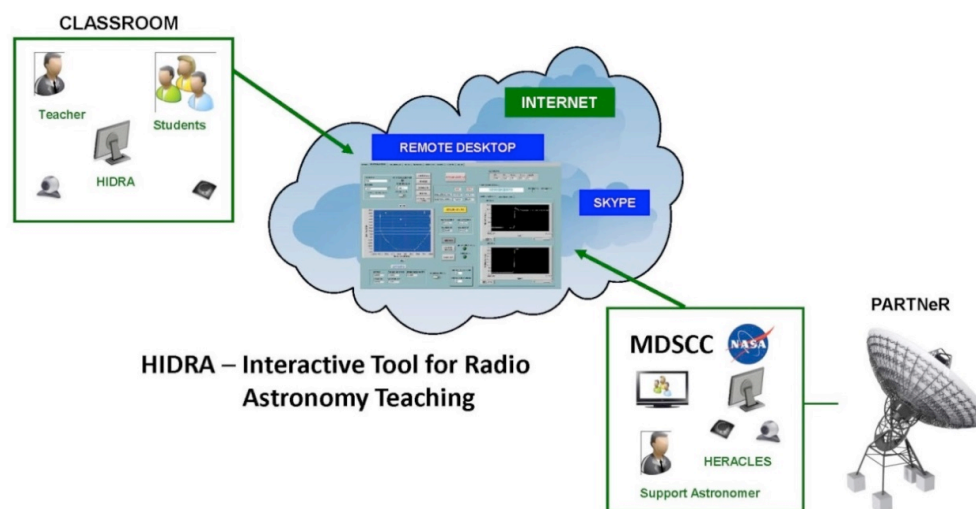


Figure 1. General Connection Diagram - PARTNeR Control Center

Within the project the appropriate software has been developed for both antenna control and observations. This has been done using a graphical programming language that is widely used today, LabVIEW (<http://partner.cab.inta-csic.es/>).

This software is responsible for controlling, through a very simple graphic interface, the radio astronomical data collection during the observations, as well as the movements and all the communications made with the antenna. In addition, it allows remote support, which is very useful for this project, since such software will be used by students from their universities, to remotely control the antenna over the Internet.

Actually two different applications have been developed, one of user and one of superuser or local control. The first is the one students use during remote observations (see figure 2), while the second is the application of local control, which allows access to all available elements and devices and control

over all of them. The superuser application is called **HERACLES** (**HER**ramienta de **AN**alisis y **CO**ntról **LO**cal en **EN**torno **SU**perusuario, analysis tool and local control in superuser environment). While the user application is called **HIDRA** (**H**erramienta **I**nteractiva para la **DO**cencia de la **RA**dio **AS**tronomía, interactive tool for teaching radio astronomy). The user application is similar to the one of control, but it is limited in the access to the instruments, being the graphic interface simpler than the one of superuser.

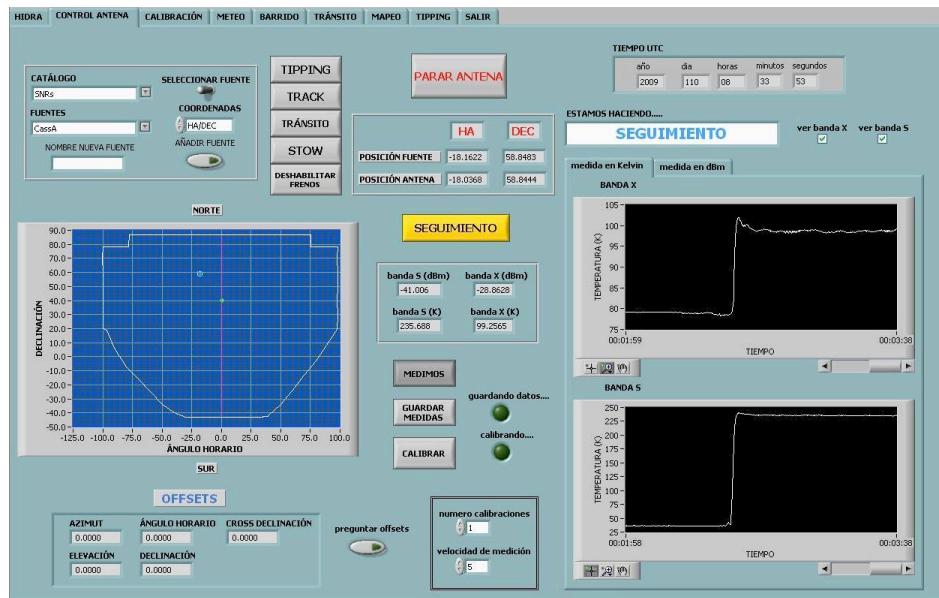


Figure 2. HIDRA interface

1.2. National Distance Education University (UNED)

The National Distance Education University (UNED) is a Spanish University that has as its mission the public service of higher education through the modality of distance education (<http://www.uned.es>).

Some Facts and data about UNED:

With more than 205 000 students, UNED has the largest student population in Spain and is one of the largest universities in Europe.

Since 1972, UNED has sought to translate into action the principle of equal opportunity in access to higher education through a methodology based on the principles of distance learning and focused on the needs of the student.

UNED is the leader in the implementation of cutting edge technologies applied to learning, with the largest offer of virtual courses in Spain.

Official degrees offered:

- 27 bachelors' degrees adapted to the European Higher Education Area (EHEA)
- 76 official university master's degrees adapted to the EHEA.
- 19 doctoral programs adapted to the EHEA.

2. UNED-PARTNeR collaboration

General Astrophysics is an optional subject within the study programmes of both UNED Physics and Mathematics Bachelor degrees. Due to the experimental character of the subject, students have to do

online practices as part of the training activities. One of these online practices, spectral index measurement of a radio source, is currently possible thanks to the collaboration of UNED with the PARTNeR project. This collaboration also allows students in the final year of Physics degree to choose Radio Astronomy as a topic to complete their mandatory Final Year Undergraduate Project.

As mentioned above, Partner project allows students to access to a 34-meter parabolic antenna and perform radio astronomical measurements in real time through a remote desktop. The main problem in implementing this practice is that the majority of UNED students, being a distance learning University, cannot attend on-site the remote observations from UNED Headquarters. So, the technological challenge is to remotely operate the radio telescope from the UNED Headquarters, allowing all students to join the radio astronomical observation using a virtual classroom.

2.1. AVIP: Virtual Classroom based on IP Technology

AVIP classroom is an audiovisual platform based on IP technology that provides "virtual presence". Virtual presence means that students can attend a class taught in a classroom at UNED headquarters from any point with Internet connection, as if they were there.

AVIP classroom hardware consists of a computer with Internet connection, a webcam, an environmental microphone and an interactive whiteboard. AVIP classroom software, named On Line Lecture and developed by the University's technological support service, interconnects the teacher who is in the classroom with the students who connect through the Internet, in real time. On Line Lecture software has the following elements: whiteboard, drawing tools, chat window, recording tools and the ability to share desktop (<http://www.intecca.uned.es>). Figure 3 shows the AVIP classroom diagram.

Three different user profiles are available in AVIP classroom: guest, speaker and moderator profile. The teacher moderates the session and the student attends the class as guest, with more restricted permissions, but with the possibility to actively participate (with video, audio and permissions to use the whiteboard), turning their profile into a speaker one.

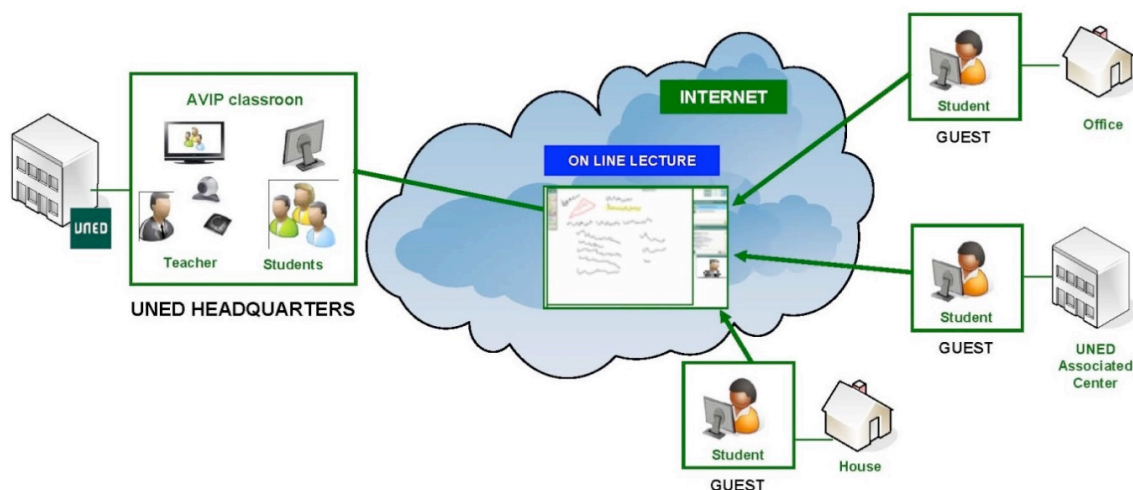


Figure 3. AVIP: Virtual Classroom based on IP Technology

3. Methodology

The combination of the procedure used by PARTNeR with UNED virtual classroom has allowed all the students enrolled in General Astrophysics to join a radio astronomical observation, in real time. Figure 4 shows the AVIP-PARTNeR connection.

Firstly, the teacher connects to HYDRA interface with the remote desktop connection tool, to be able to control the antenna from the headquarters of the UNED; Secondly, the astronomer joins the AVIP classroom, from the MDSCC, with the speaker profile. Thus, he can give explanations on the use of the antenna and guide the students during the measurement.

The teacher then activates the Share Desktop option in the AVIP classroom so that students who have joined the session via the Internet can participate in the observation, as if they were there.

Students in the classroom at the UNED headquarters take remote control of the antenna and collect data from the radio source with the help of both, the teacher in the classroom and the astronomer in the PARTNeR Control Center.

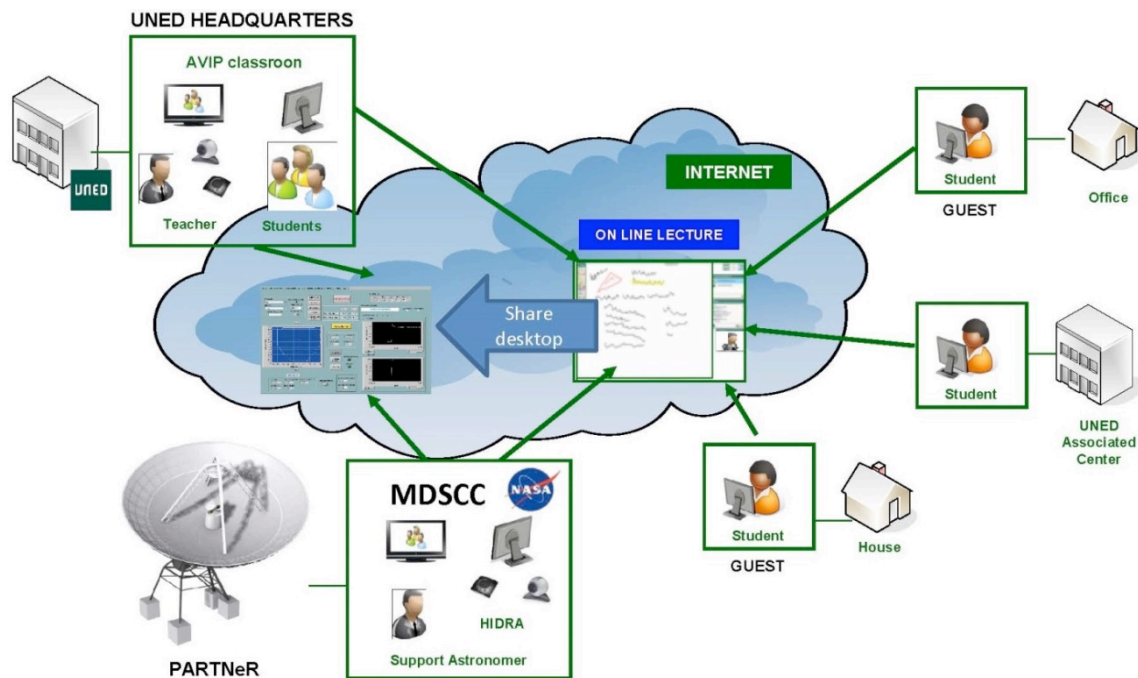


Figure 4. Connection AVIP-PARTNeR

4. Results

Since the UNED's participation in the project began in 2012, several remote sessions of radio astronomy have been held with the students of the subject "General Astrophysics". With the obtained data the students have had to calculate the spectral index of the observed astronomical object, with this it can be deduced if the emission of the stellar object has thermal origin or not.

Prior to the participation of the students in the observation and data collection, during the academic year 2012/13, it was necessary to carry out many tests to set up the connection method between AVIP classroom and the remote desktop to control the antenna. It was the first time that the

project involved a distance learning university and that posed some challenges to do the connections properly.

The following list indicates the observation sessions carried out in different academic years. In the figure 5, it can be seen a graph developed by one of the students to calculate the spectral index with the data taken in the observation.

Academic year 2013/2014

- 1st observation session – Crab nebula
- 2nd session – Perseus A
- 3rd session– Cygnus A

Academic year 2014/2015

- 1th observation session – Crab nebula
- 2nd observation session – Crab nebula

Academic year 2015/2016

- 1th observation session – Crab nebula
- 2nd observation session – Crab nebula

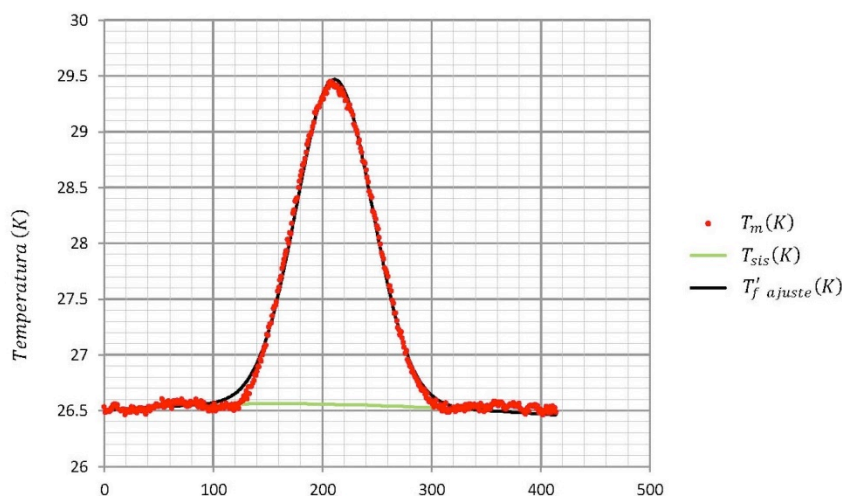


Figure 5. Result example: source temperature fit

In addition, during these courses, 5 students have done their final year undergraduate projects. They were able to carry out the observation sessions from their homes, without having to go to the observatory and taking data remotely. In the following list indicates the projects carried out in different academic years. Some of its results are shown in figures 6 y 7.

- Academic year 2013/14
 - Study of the Jupiter magnetosphere – 1 project
- Academic year 2014/15
 - Getting a radio map of the Rossete nebula– 2 projects
- Academic year 2015/16
 - Study of the Jupiter magnetosphere – 1 project
- Academic year 2016/17
 - Getting a radio map of the Rossete nebula– 1 project

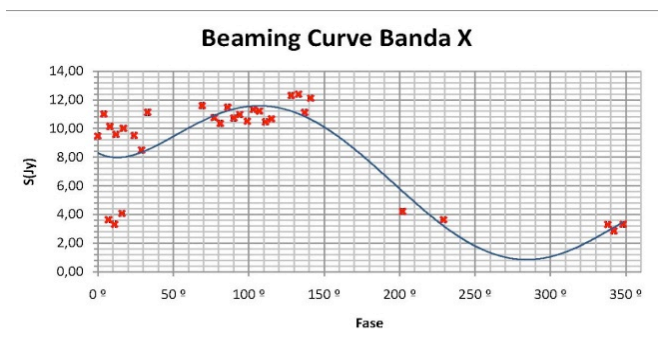


Figure 6. Jupiter magnetosphere Beaming curve

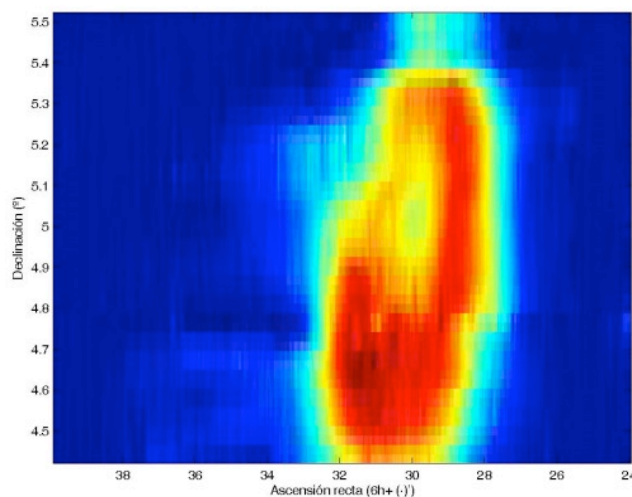


Figure 7. Radio map of Rosette Nebula

5. Conclusions

UNED collaboration in the PARTNeR project allows UNED students to practice Radio Astronomy in real time with a professional Radio Telescope.

The realization of these practices makes possible the evaluation of some learning outcomes in Astronomy and Astrophysics and contributes to the acquisition of specific competences of the degree.

This collaboration also allows the UNED Physics Degree to offer an experimental line of final year undergraduate project dedicated to Radio Astronomy.

References

Vaquerizo, J.A., Perez, J.S. & Cabezas, D. (2011), Abstracts book of XXXIII Reunion Bienal de Real Sociedad Espanola de Fisica (pp. 149-150)

<http://partner.cab.inta-csic.es/>

<http://www.uned.es>

<http://www.intecca.uned.es>