Discovery Space
Newsletter
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Dear DSpacers,

The DSpace service will add its contribution to the development of a new generation of citizens who are scientifically literate and thus better prepared to function in a world that is increasingly influenced by science and technology. The project's ambition is to inspire and motivate young people to pursue careers in science on one hand and to engage the young participants in sharing the experience of exploration and discovery on the other. It envisions to enhance awareness and understanding of the scientific and technological advances of our times, and to link them to the history and evolution of the human mind and society (scientific, historical and cultural basis for modern astronomy).

Dr. Elias Vagenas,
Editor of the DSpace Newsletter

1. Projects and Robotic Telescopes

During the last years several projects have been developed and some of them are still running in the field of science teaching employing robotic telescopes. Bellow we provide a short description of four (4) of the most known such projects.

1.1. The EUDOXOS project (Greece, Spain, Italy, Austria)

The aim of the EUDOXOS project is to utilize the "Andreas Michalitsianos" (AM) telescope, a 60cm Cassegrain type remotely controlled robotic telescope with large-format CCD camera and the "Apollon" solar telescope, in order to develop the adequate framework to teach science subjects to High School students in the basis of an interdisciplinary approach. The robotic telescopes are installed in the National Observatory of Education EUDOXOS on the Ainos mountain of Kefallinia Island (Ionian Sea), Greece. These scientific instruments have been developed with funds from the Greek Government. The EUDOXOS project is a collaboration of the Institute of Nuclear Physics at the National Centre for Science Research "Demokritos", Ellinogermaniki Agogi, the Greek Naval Academy, The Pedagogical Institute and the Prefecture of Kefallinia and Ithaki, to be used for educational and research purposes as a working example for Distance Learning and Research .

The robotic telescopes were installed in August 2001 and they are operational now. One is able to remotely request a specific observation schedule and subsequently receive the resulting photographs via the Internet, to be used for educational purposes or for scientific analysis. OTE is currently collaborating with EA and RFK in order to create an advanced communication system (including satellite link through DVB-RCS platform utilization) for the EUDOXOS observatory.

A User friendly Interface has been developed to be an adding tool that bridges science teaching and technology. This educational software supports teachers and students in an innovative learning environment while at the same time is compatible with graphics and analysis software components, so that students can easily investigate trends and patterns of the data they collect by using the telescope. The EUDOXOS platform gives students around Europe the opportunity to use remotely controlled telescopes in a real-time, hands-on, interactive environment. In this way it enables students to increase their knowledge on astronomy, astrophysics, mathematics and other science subjects and improve their computer literacy while strengthening their critical thinking skills. Students are able to graphically view all quantities under study and the data correlations through a scatter diagram on the computer screen.

More information can be found in http://www.ellinogermaniki.gr/ep/eudoxos/.

1.2 The Schools Observatory project (UK, Japan)

The International Schools observatory (ISO) is a web-based observatory that provides schools around the world with access to professional robotic telescopes. Students can access and control the telescopes through the Internet. Provided by Liverpool John Moores University and the Japan Spaceguard Association, the ISO allows students or schoolchildren from different countries to work together on science projects, make new friends and experience the excitement of science observation and discovery in exactly the same way as professional astronomers. Two telescopic centres make up the ISO.

Liverpool John Moores University provides access to a world-class astronomical telescope. The Liverpool Telescope is the largest robotic telescope in the world and is located on the island of La Palma in the Canaries. The Bisei Spaceguard Centre in Japan has telescopes that enable students to view all-sky image data, perfect for searching for asteroids. Observing time has been specially reserved on these professional instruments for schools. Working with the resources developed by the Schools' Observatory, students can prepare and carry out their own astronomical research and share in the excitement of

discovery. Using the full power of the Internet, the Schools' Observatory brings cutting-edge science and technology into the classroom.
More information can be found in http://www.schoolsobservatory.org.uk

1.3 The Faulkes Telescopes project (UK)

The aim of the Faulkes Telescopes Project is to promote science, mathematics and technology to schools. Thanks to generous donations from the project founder, Dr Martin "Dill" Faulkes and other agencies, the project has the tools and the staff to do so.

The project owns two research quality telescopes. One

is located on Maui, Hawaii (Faulkes Telescope North) and the other is located in Siding Spring, Australia (Faulkes Telescope South). Each telescope stands 8 metres tall and has a 2 metre diameter primary mirror and a field of view up to 30 arcminutes in diameter.

The whole telescope system is designed to operate automatically so that the telescopes run as robots. All that is needed to control one of the telescope is a computer (Windows or Apple Macintosh) and an Internet connection. A control centre in the UK (and others in Hawaii and Australia) will send instructions from the user via the Internet on which observations are to be carried out. The telescope control system then decides if the weather is good enough to open the enclosure, point the telescope and take the images requested. At the end of night, or if the

weather deteriorates, the enclosure be closes. The robotic nature of the telescopes means that excellent images of stars and galaxies are sent within minutes to the classroom computer via the Internet.
More information can be found in http://www.faulkes-telescope.com.

1.4 Telescopes in Education project (USA)

The Telescopes in Education (TIE) project began in 1992 with NASA funding. The first telescope to participate in the TIE project was the 24-inch at the Mount Wilson Observatory, coming online in 1993, and since that time, students from hundreds of schools in the US, Australia, Canada, England, and Japan have remotely controlled the telescope from their classrooms. To help teachers and students understand what they are doing and how to do it, the TIE project and members of the growing TIE community have developed a suite of guidebooks, sample projects and lesson plans (see http://tie.jpl.

nasa.gov).
TIE has been tremendously successful as a pioneer in robotic observatory technology, as demonstrated by the many awards it has won over the years for its activities using the Mount Wilson Observatory. TIE program brings the opportunity to use a remotely controlled telescope and charge-coupled device (CCD) camera in a real-time, hands-on, interactive environment to students around the world. TIE enables students to increase their knowledge of astronomy, astrophysics, and mathematics; improve their computer literacy; and strengthen their critical thinking skills. The TIE program currently utilizes a science-grade 24-inch reflecting telescope located at the Mount Wilson Observatory, high above the Los Angeles basin in the San Gabriel Mountains of Southern California. The telescope has been used by students in grades K-12 to observe galaxies, nebulae, variable stars, eclipsing binaries, and perform other ambitious projects and experiments. Hundreds of schools in the US and around the world (including Australia, Canada, England, and Japan) have successfully used the prototype telescope on Mount Wilson. Through TIE, students have rediscovered and catalogued a variable star and assisted the Pluto Express project at NASA's Jet Propulsion Laboratory to revise the ephemeris (orbital location) for the planet Pluto. The telescope and CCD camera located at the Mount Wilson Observatory can be operated remotely by educators and students from the convenience of computers in their classrooms via modem and special astronomy software. Images can be downloaded to a remote user of the telescope in five minutes or less (the time depends upon the speed of the user's modem). These images can be stored in the user's computer for later image processing and study. The software also serves as an excellent stand-alone, educational astronomy program. Educators and students can reserve observation time on the Mount Wilson telescope for any evening of the week. Observation sessions can last from one hour to an entire night. Arrangements can be made for projects requiring special observation times or long-term, repetitive observing runs.
More information can be found in http://www.telescopesineducation.com/program.html.

2. DSpace Service

Except the above mentioned cases there are other similar approaches across the world. In all cases data can provide evidence that the idea of using robotic telescopes for educational purposes is experiencing significant growth. Over the past few years about 30 observatories have been outfitted with specific software and hardware interfaces in order to be used remotely. Currently these telescopes operate as independent observatories with little leverage of resources, communication and coordination. Through the DSpace project the consortium aims to investigate the business case of using robotic telescopes for educational purposes by taking advantage of the tremendous synergistic potential of an international network of professional-grade, remotely accessible observatories.
The DSpace service integrates robotic telescopes seamlessly into one virtual observatory and provides the services required to operate this facility, including a scheduling service, tools for data manipulation and access to related educational materials provided

by the currently running projects and networks. Additionally the DSpace service will facilitate the usage of broadband communication channels as a means of interaction and data transfer mechanism between the telescopes and the remotely located users around the world. In this way the effective and fast response of the service is safeguarded. The DSpace will become a distributed network of science centres and robotic telescopes accessed by students, educators, researchers and the wider public (e.g. visitors of science parks) via Internet. A network of robotic telescopes (has several advantages. Weather is less likely to cancel or delay an observing session if automated telescopes are available in widely different geographical locations. More telescopes will serve more users with fewer delays and on the preferred schedules. The DSpace project will bring out the business case of the use of a network of robotic telescopes for educational and research purposes. The DSpace services portfolio consists of:

- on-line access to the network of the robotic telescopes (on-line or scheduled requests)
- access to scientific data and resource archives

(data and images)
- access to a central data archive, making use of a common archive and distribution system
- access to educational material and interactive tools (allow for data representation and analysis)
- access to teacher resources (e.g. professional development materials, lesson plans)
- student-centred materials (e.g. data library, communication area, student's magazines)
- on-line training courses at different levels (for school students, for university students, for the wider public)
- participation contests (the contests will cover the levels of all targeted groups of users, e.g. scientific contests, best science project contests for students, best photo contest for the wider public)
- participation to conferences, workshops and summer schools (the users of the service will have the opportunity to visit the observatories during different events)
- information on specific events (e.g. transit of Mercury or Venus)

Potential users of the DSpace service

The proposed services address:
1) Educational Institutions, e.g. primary and secondary education schools, Universities
2) Research Institutes
3) Scientific museums, Science centers and Science Parks
4) The wider public

Services and Benefits for the users of the DSpace Service

There are several benefits for the users of the DSpace service:
Operation from multiple locations around the world. The DSpace service will operate from multiple locations around the world which has a number of advantages:

1) Observing conditions at any one site become less of a factor and less of an impediment to a successful observing experience.

2) The ability to observe at different latitudes opens up much larger parts of the sky to the observer.

3) The ability to observe from different longitudes makes night-time observations possible from classrooms during their school day

4) Telescopes can be assigned based on observing requirements such as duration of observation, visibility of the target body, required angular resolution, type of observation (image, spectra, photometry).

5) Coordinated observations among observatories can provide long baseline temporal coverage.

A significant add-on to the current status will be the ability to select observing sites in an automated fashion based on user-supplied requirements. This permits an elevated level of coordination, which can be particularly useful when used to adapt to real-time requirements (e.g. weather or technical difficulties).

The main benefits for the DSpace users will be:

Ubiquitous Broadband Access to Resources.

A significant overhead is involved in the individual development of software, hardware and training programs. The DSpace service proposes to offer an economy of scale to the organisations involved. Through the formalism of a distributed data system, resources such as these will be developed once and used by all network members. The DSpace service provides a central data archive, making use of a common archive and distribution system, ensuring the integrity and accessibility of DSpace observations at minimum cost. In addition to data, analysis tools, instructional materials and guidelines will be made available on line for use by all network members. Additionally the utilization of broadband communication channel (both wired and wireless) will improve significantly the communication between the telescopes and the remotely located users. The DSpace service aims to support the exploitation of the broadband networks across as it demonstrates the effective usage of the new generation of high speed transmission services.

Unification of the existing tools and on-line materials.

A common user interface based on the already in use EUDOXOS platform will be the main portal to the DSpace service. The open architecture of the EUDOXOS platform allows for easy adaptations and additions. This ensures that every observatory in the network will feel comfortable and familiar to the end user. Similarly, a single “home” DSpace web site will be developed providing access to the resources of each observatory. The home site will contain materials and information common to all DSpace observatory programs, such as access to data and tools, teacher resources (e.g. professional development materials, lesson plans), student-centred materials (e.g. data library, communication area, student’s magazines), applications for observing time and collaborative activities. Many of these resources already exist; we are proposing value-added services to increase the utility of existing programs through integration, coordination and where appropriate, archiving.

Understanding opportunities of e-learning methods, contents and resources.

Using the DSpace services students and teachers will be able to directly apply the theories learned and taught in the classroom to real, interactive research. They will personally experience the procedures involved in an authentic research project and thereby gain a far better understanding of science and engineering. It is hoped that the DSpace service will provide more students and teachers with a valuable and unique perspective as they become adults and embark on careers as business persons, lawyers, judges, politicians, and others who will lead society through the 21st century on a solid foundation of knowledge, new technology, and the cultural diversity of the new world economy. Although the DSpace service is based on front-end technological applications, the aim is not to test this technology but to focus on the results and the changes concerning the qualitative upgrade that can be produced in the teaching procedure and to measure the cost effectiveness of the proposed methodology. The DSpace project challenges the most difficult objective of the development of a better understanding of the opportunities, which are associated with e-learning methods, contents and resources as well as their impact in education in terms of organisation and management. The partnership believes that the new systems and educational tools have to start from the user. They have to be so transparent that the user can understand them and be in control of what she or he is doing. Recent studies1 normally describe science lessons by means of negative indicators. Students behave passively and their learning outcome is mostly not seen as a basis for the acquisition of new knowledge and for further activities in the area. Students seem to be far away from skills proposed by “scientific literacy” to become reasonable and responsible acting citizens, meaning in short they are far away from presenting, discussing and criticising science related topics of society. In this way their “classroom” is transformed into a scientific laboratory.

3. Using the DSpace service

The DSpace service will focus on three main application areas:

3.1 Formal Education: An Experimental Laboratory for All

One of the main purposes of the service is to improve science (physics, astronomy, mathematics,

and computer) instruction. It is indeed ideally suited to help young people (and in particular women)

learn to use the Internet and computers in a scientific environment and is designed to promote independent and creative activity. The participating classes will be able either to control the telescopes ``live'' over the Internet or the students will prepare and ``order'' their own observations via the Internet and have the robotic telescopes perform them at the next possible date. The images which are finally delivered will be calibrated and analyzed by the students using simple image-processing software, offered the service.

- Elementary and Secondary Education:
  School teachers could develop creative, hands-on interactive astronomy lessons over the internet using our network's robotic telescopes, to meet the needs of school curricula. These would be suitable for small-group collaborations and would include automated image acquisition service and/or observatory control as required to complete the lessons, plus the use of copyright material on our project's web site.

- University Education:
  The telescope network will be used to improve the quality of science instruction at the university level, while offering to the students the opportunity to realize their own projects and to gain experience in carrying out independent scientific research. Astronomy (or other closely related fields) students and faculty can use our service for teaching practical astronomy laboratory techniques and research astronomy courses (that is, a minimum of related theoretical background is required). Essentially (due to the nature of telescopes) optical observational techniques can be taught.

- On-line Courses:
  The DSpace service will offer astronomy on-line courses to users (individuals or groups). The theoretical background of such courses could be covered through lecture notes that professional astronomers collaborating with the consortium would create and assign readings of textbooks in libraries or on the Web (the readings could be required before the observing sessions are taking place or/and for after-observing and data manipulating and interpreting activities). For all the different levels of courses and applications, some essential computer literacy will be assumed or taught as an independent course (e.g. at a minimum data analysis techniques, plotting programs, and at a more advances level basis statistical analysis techniques, fitting simple functions to the data and estimating uncertainties of the quoted results). The courses could be organized on a weekly basis, and in twice-a-year cycles, always keeping in mind that we need to emphasize the hands-on aspect of the course and keep the lectures to the minimum that is required so as for the students to understand and get familiarized with the observing techniques and the scientific inquiry and hands-on experience of real astronomy. The students would be required to keep logbooks with their notes on the observations and experimental setups performed, the data obtained and the preliminary reduction and analysis (plots, calculations, etc) they might have performed. There might be provision for grading the completed projects and subsequently reward the best projects within each course cycle. Such rewards could include a free observing night session with one of the robotic telescopes of the network, a fully paid visit to one of the sites of the network, free posters of some of the best night-sky "shots" of the course cycle, etc.

3.2 Informal Education: Self-Directed Interactive Astronomy for All

The service will offer to users all over the world the unique opportunity to control professional astronomical observatories in real-time for self-directed astronomy studies or personal enjoyment.

Using the Internet, private users can gain full control of our virtual observatory, commanding its robotic telescopes and cameras to capture images of the sun, moon, planets, galaxies and other deep sky

celestial objects in real-time much like a professional astronomer. Images can also be obtained using automated requests, without having to control the telescopes directly, which is a convenient way to acquire multiple images during late night hours. In this way, the requested data will be taken on the next clear evening/day and returned via email. The private users will have to first sign-up with our service for a fee (per hour or per night) in order to control the various (one or more) telescopes, or in order to request specific object images. Once they have purchased the credits, they will be able to book observing time or make specific image requests. Upon agreement, there will also be provision for refunding if the requested observing cannot be performed on time (e.g. due to instrument problems or unfavourable weather conditions.

3.3 Acquisition of Professional Scientific Data

Scientifically, the network of robotic telescopes will open totally new horizons and possibilities for obtaining critical scientific data that could not be obtained otherwise. Indeed, because they can obtain measurements automatically, it will become possible to perform time-intensive projects which otherwise would require enormous efforts from the professional astronomy community, both in terms of personnel and money.

The DSpace service will be presented in the following events:

4th Science Centre World Congress, Rio de Janeiro 10-14 April 2005, Brasil

International Astronomical Summer School, Rozhen 22-31 July 2005, Bulgaria

e Learning Conference, Brussels 19-20 May 2005

4th National Conference of Astronomy, Athens 9-11 September 2005, Greece

4. Edition

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