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Remote access astronomy

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Abstract

There is still nothing to beat the excitement and fulfilment that you can get from observing celestial bodies on a clear dark night, in a remote location away from the seemingly ever increasing light pollution from cities. However, it is also the specific requirements for good observing that can sometimes prevent teachers from offering this opportunity to their students. Compromises for a town-based school or college might be to view only bright objects such as planets, or stars of magnitude 4 or brighter because of light pollution, but you would still require a knowledgeable teacher or astronomer and equipment to take outside with the students. Remote access astronomy using robotic telescopes can partly provide a solution to these problems and also opens up the doors to exciting projects that may otherwise be inaccessible to schools and colleges.

Photons from afar

Looking through the eyepiece of a telescope at distant stars and galaxies, knowing that the photons you are seeing have travelled for many hundreds, thousands or millions of years to reach your eye is a fascinating activity. It doesn't matter how else you do astronomy, nothing can take away the feeling you get when you first see the rings of Saturn, and Jupiter and its moons for yourself with only the aid of a telescope to magnify the image. If you do it the hard way you can get a lot of satisfaction from finding the objects you want to observe yourself on a chart and then identifying them in the sky. You then point your telescope at the body in question and observe it, making sketches of what you see.

This of course is a partly romantic view of astronomy, but still it is true to say that many people would not be involved in astronomy were it not for the feelings and emotions that observing in the way described above can produce in an individual.

But what of the teacher in the classroom or laboratory? Never trained in astronomy at university and perhaps not even a physics specialist, when are they going to get the opportunity to take students on an observing trip where they will be able to see all of the things that will make their experience of astronomy complete? The answer for most teachers is never! As a consequence the students miss out on something they may never get to do after their formal education is complete. There is no immediate way around this problem. It requires a dedicated and knowledgeable teacher with access to appropriate equipment to set up an observing session in a suitable location. This is just too many variables for most 'science' teachers to bring together at the same time with the limited amount of time they have available to achieve this. In most cases it would usually be an after-school activity anyway and would be in addition to lessons in the classroom or laboratory. This is where remote access astronomy may come in. It does not

 0031-9120/03/030232+05$30.00

substitute for observing with your own telescope but it does eliminate the need to achieve some of the conditions identified above and can in fact provide a better alternative to some of them. It also opens up doors to a whole new area of astronomy that even the most dedicated and knowledgeable teacher would not usually be able to offer.

Remote access astronomy is accessing a telescope remotely, controlling it either live or in some sort of off-line mode (where requests are processed according to a priority system) in order to obtain images that you can use for analysis. This is by no means a new idea but until recently you would have still required a fairly good knowledge of astronomy and a bit of specialist equipment (such as an ISDN telephone line in some cases) to connect to the telescope you wish to control. This is beginning to change. A number of important projects are now underway to provide access to telescopes for teachers and their students with no specialist equipment needed (except for a computer connected to the Internet) and little or no prior knowledge of astronomy needed either. These projects aim to provide teachers with easy access to high quality telescopes and to provide as much or as little help as is required for the teacher to use these telescopes with students in the classroom or laboratory. Some of the projects we shall detail below also overcome the need to observe at night-time.

Robotic telescopes

Robotic telescopes operate unattended, working from a list of targets provided by a large number of astronomers, but autonomously adjusting the schedule to adapt to changes in the weather or new discoveries. This allows regular monitoring on almost any timescale and very rapid reaction to sudden events—a satellite discovering a new Gamma-Ray Burst, for example, can communicate directly with the telescope, which can then be observing the new source within a minute.

The Liverpool Telescope

Such telescopes present considerable technical challenges and have only become possible because of recent advances in computer technology and communications, particularly the Internet. However, their potential is such that ten years ago, Professor Mike Bode at Liverpool John Moores University (JMU) started a project to create a company that would manufacture such telescopes. That company, Telescope Technologies Limited, is now completing the first of its telescopes, led by the Liverpool Telescope (LT, figure 1) sited on La Palma in the Canary Islands—one of the best observing sites in the world.

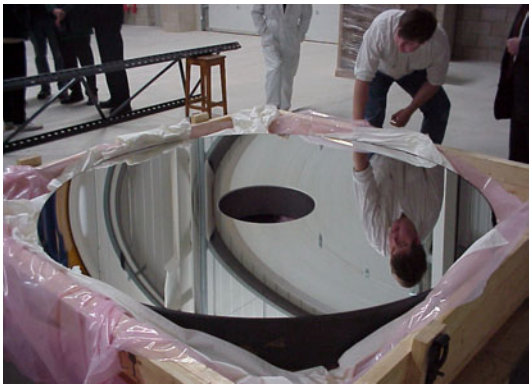

Figure 1. The Liverpool Telescope Primary Mirror.

Schools access

The LT, with its 2 metre diameter primary mirror, is the largest robotic telescope in the world and provides the first opportunity for astronomers to really get to grips with the dynamic nature of the universe. This type of telescope is of research-class quality. However, its importance does not stop there. From the start, those involved in the project have wanted to bring the advantages of robotic technology to a wider audience, and so some of the time of the LT has been set aside for schools to use. Observations for students can be placed in the schedule alongside those for professional astronomers, and the resultant observations downloaded via the Internet and analysed—for the first time making practical, experimental astronomy possible in the classroom using the highest quality apparatus. Access to the LT observing program is through the National Schools Observatory (NSO). The aim of the NSO is to enable any UK school to enhance its teaching through the use of telescopes such as the LT while simultaneously promoting the excitement of the science and technology that make the whole thing possible.

The NSO website is the main portal for the observatory—promoting the use of appropriate

Figure 2. A visit to the telescope factory.

technology—and is written for students, although there is a separate Staff Room section for teachers. As well as providing the tools that are needed to request observations (including tools to help students and teachers decide what they want to observe!) there are many other aspects to the site that will stimulate learning and bring the world of astronomy and space science to life in the minds of young people.

The Faulkes Telescopes

The Faulkes Telescope (FT) Project differs in a number of respects from the NSO/LT. The two telescopes in the Faulkes stable are also manufactured by Telescope Technologies Limited and are identical in specification to the LT mentioned above. There are, however, three notable differences in how they will be used. One of the telescopes is located in Hawaii and the other will be located in Australia. This gives the FT project coverage in both the northern and southern hemispheres. Because of their location (and therefore time zone differences) they are able to offer remote live observing during what would be daytime in most of Europe. Most access to the telescopes will be made available to UK schools, colleges and amateur groups, and as such the time zone difference immediately opens up the opportunity to do live observing during school hours. Access to the telescopes will also be made available to educational establishments in Hawaii and Australia. Other international projects may develop over time. The other notable difference is that all of the time of both FTs is dedicated to educational purposes.

Real telescopes, real astronomers, real science

The LT will also be used by professional astronomers; this provides the opportunity for astronomers and students to share observations and data. With the FTs, research astronomers are working closely with school teachers to develop both short and longer research projects that schools can take part in that will provide useful and valuable data for professional astronomers as well as for the schools themselves. Typical projects that will be available to schools on the FT project are:

- Near-Earth asteroids (NEAs): detailed follow-up observations to determine orbits, rotation rates and/or colours, working closely with a global network of astronomers.
- Observations of open clusters to determine stellar ages, masses, types, and search for ‘unusual’ and exciting massive stars.
- Galaxy imaging: to determine Hubble class, measure spiral arms etc, and generate a large online catalogue.
- Planetary nebulae: probing the chemistry, structure and evolution of these beautiful stellar remnants.
- Gamma-ray bursts: rapid follow-up observations linked to the NASA Swift mission, working at the cutting edge of astrophysics in the chase to capture the earliest observations of these incredible objects.

In particular the NEAs project might be of interest to schools as this is a hot topic both scientifically and politically. The educational development team on the FT project are working closely with Spaceguard UK to develop an observing program where schools can do follow-up observations of newly discovered NEAs. They would then submit their observations to the Minor Planet Center, which operates at the Smithsonian Astrophysical Observatory. These observations would be used along with those from other observers around the world to accurately calculate the orbit of the newly discovered NEA. It is even possible that schools might discover new main-belt asteroids as well and be able to name them.

Curriculum links

Both the LT and FT projects will provide the opportunity for teachers to link astronomy to their curriculum. This is very important. Whether you agree with the highly structured curriculum that is taught in many schools or not, teachers have little time for diverting students' attentions to the exciting but not curriculum/test oriented topics in astronomy. Teachers in this position should be able to easily find topics and projects that will link directly to the curriculum they are teaching at any level from primary, secondary and college education. Clear guidance will be provided as to which project and topics fit where in the curriculum. In time the FT project in particular will also cater for community groups such as clubs and amateur astronomical societies.

Coursework

As an example of how curriculum topics will link with these projects it is worth looking at how a robotic telescope may provide an opportunity for pre-university physics students (such as A-level students) in the UK. If carefully planned, investigations using robotic telescopes should be able to meet the practical assessment requirements of many specifications (typically: planning, implementing, analysing evidence and drawing conclusions, evaluating evidence and procedures).

The FT project is actively developing what it calls 'education/research projects' for students in the 16 to 19 age range as well as younger and older students. These are projects which originate with ideas from professional astronomers in universities and which are then developed with the needs of school students in mind—in other words, they have to be relevant to course content or be appropriate for assessed coursework or both. Already well developed are projects on measuring galaxies (surface brightness profiles and spiral arms) and projects on near-Earth objects and asteroids in general (e.g. making precise orbit measurements, observing their light curves as they rotate). Other projects in course of development involve variable stars of different types, nebulae of different varieties, comets, interacting galaxies and measuring the ages of star clusters.

A spreadsheet is available in the online version of this journal that highlights the obvious and perhaps not so obvious curriculum links that robotic telescopes might have.

Allaying the fears of beginners

Not all science teachers/educators are blessed with an in-depth knowledge of astronomy. This also has been taken into account with these projects. Both the FT and NSO/LT projects will offer guides to using the respective facilities at beginner through to advanced level. At its simplest the FT project in real-time (live observing) mode will offer a point-and-click solution to obtaining your own images. You will be able to select the object you require an image of and you will see the telescope moving and obtaining your image. The LT project will also offer a similar facility and then your request for an observation will be queued along with other requests to be done in off-line mode. The image can then be collected later or perhaps e-mailed to the user.

And the cost is?

Well, it varies. The NSO/LT project currently charges an annual subscription of £45 to schools and this allows access to the telescopes and the software needed. The subscription, though, does not start until the LT is available for use. The FT project has not yet set a firm charging structure but it looks likely that the cost will be in the region of £120–£150 per annum, which will include several hours of live time plus a substantial amount of off-line time (off-line time being similar to how the NSO/LT will work). Both facilities have either developed their own software or have obtained licenses from other developers to enable schools to participate in the respective projects without having to purchase additional software.

Other similar resources

So far we have focused on two large-scale projects (in terms of telescope size at least) with large research-class telescopes. The reason for doing this is that both of these projects are specifically designed for schools and colleges to use. They are also both based in the UK but with some international focus as well. These two projects have also been collaborating closely in order to provide complementary facilities for users. It would not be fair, though, to end this article without at least a look at some other remote access astronomy projects.

Bradford Robotic Telescopes

This Tenerife-based telescope is being fully refurbished and completely robotized. The telescope will be installed as soon as the dome is complete.

The objective of the system is to provide astronomy experiences to support the national curriculum in England for all students at Key Stages 2, 3 and 4. There will be modules for teachers to use in the classroom and full teacher support for the astronomy and the administration of the lessons.

It is expected that the educational material will run with the system in a small pilot programme from late May/June 2003, followed by a larger pilot programme through the autumn, with the telescope being relaunched around the ASE meeting next January. The Australian telescope will be put on a time schedule later this year, but will not start until the Tenerife one is almost complete and operating efficiently.

International projects

Elsewhere, robotic astronomy continues to develop on a smaller scale (at least in terms of aperture!), with several exciting projects on the drawing board. The Monet (**Mo**nitoring **Ne**twork of **T**elescopes) project is funded by the Alfried Krupp foundation in Germany and seeks to place two 1.2 m telescopes at professional observatory sites in Texas (McDonald) and South Africa (Sutherland), to be accessed by high school and university students. More information can be found on their website (see end of article) along with a list of current and planned robotic astronomy projects.

In Australia, the Eye on the Sky Observatory near Bathurst, New South Wales plans to install 36 remotely accessible 14-inch (0.36 m) reflectors in three roll-off sheds on a large site which will incorporate the Eye telescope, a 36-inch (0.91 m) wide-field instrument dedicated to NEO research. In Japan, the Bisei Spaceguard Center is nearing the start of operations, and participants in the NSO programme will be able to take part in NEO searches using data from the Bisei facility.

The Telescopes in Education (TiE) programme in the USA continues to operate despite ongoing funding problems, and now has small robotic instruments being established in Chile and Australia, in addition to the Mount Wilson facilities. More news on their website.

The 'Hands on Universe' (HoU) project run by Professor Carl Pennypacker at the Lawrence Livermore Laboratory, Berkeley, is gathering together a large number of groups interested in using astronomical data in schools education. Participation in Europe is particularly high, with France one of the leading Global HoU nations. In the UK, the FT project has links with Global HoU and hopes to collaborate on astronomical research projects in future.

The future

The prospects for schools involvement in real astronomy look very exciting, particularly now that all three of the larger instruments (LT, FT North and FT South) will carry spectrographs. Access to smaller instruments, such as those offered by Bradford, will mean that obtaining data is much easier, and schools can 'practise' on these telescopes before moving up to the research-grade instrumentation on offer through NSO/LT and Faulkes. Collaboration with international projects such as TiE, the Eye Observatory and the Hands on Universe project means that schools can also participate in global educational programmes. The future of real astronomy in the classroom has never been better.

WWW links

Bisei Spaceguard Center:
www.spaceguard.or.jp/bsgc/pamphlet/index.htm

Bradford Telescope:
www.telescope.org

Faulkes Telescope:
www.faulkes-telescope.com

Hands on Universe:
http://hou.lbl.gov/global/

Monet Project:
http://alpha.uni-sw.gwdg.de/~hessman/MONET/

National Schools Observatory/Liverpool Telescope and others:
www.schoolsobservatory.org.uk

Spaceguard UK:
www.spaceguarduk.com

Telescopes in Education:
http://tie.jpl.nasa.gov/tie/index.html

Received 20 March 2003
PII: S0031-9120(03)61155-X