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Remote Access to Continuing Engineering Education - RACeE

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Abstract

The aim of this paper is discuss the issues involved with the development and implementation of an on-line postgraduate course for remote access students. This is especially relevant for students who wish to pursue postgraduate qualifications, or to update their skill base, while continuing with their career. While remote access education would not be considered by the author as the delivery method of choice for the majority of an engineering student's educational needs, there will always be niche educational demands that can be addressed by such an approach.

Although the electronic presentation of course notes via the Internet is becoming more common place, the ideas outlined in this paper go beyond this basic concept. The emphasis of any remote access based educational strategy has to be on the interaction between the tutor and the students, and not on note presentation. It is the author's view that the approach taken is novel, and one which has already attracted interest from other universities wishing to implement remote access teaching.

Introduction

Studying a course via the Internet means that a student can communicate with their tutor and fellow classmates via e-mail, electronic conferencing and a host of World Wide Web (Web) tools, submit their assignments via e-mail, and participate in electronic tutorials from home. This educational method requires a high degree of maturity on the student's behalf, therefore it is more suitable for postgraduate and senior undergraduate courses. This is emphasised by the fact that, on average, a third of those who enrol in distance education never complete the course [1].

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A key element of the strategy for the use of the Web for remote access teaching is the high degree of interaction between the course tutor and the students. The technical difficulties in implementing any strategy must also be addressed. Other important design factors outlined in this paper include the educational effects of remote access teaching, maintenance of material, running examinations and coursework assignments, the use of automated review questions, practical implementation issues, legal and intellectual property control concerns. The cost structure of the proposed solution, both to the end user and the course provider, is also discussed.

The work outlined is based on the successful running of a remote access course, namely *Computer and Machine Vision (EE544)*, during the academic year 1996/1997. This course ran as part of a pilot phase of the *Remote Access to Continuing Engineering Education (RACeE)* initiative at Dublin City University (DCU). A key motivation behind the RACeE programme, was the need for key research laboratories within the School of Electronic Engineering to transfer the specialised skills associated with these laboratories to industry and to educate students in these respective research areas. This phase of the RACeE initiative has had a small number of students undertaking the *Computer and Machine Vision* course on a 100% remote access basis. The majority of these students are drawn from a number of multinationals based throughout Ireland. There are two options for people wishing to take this course. Under the *Full Course* option the student will fully participate in the course (including coursework and examinations) and would partially fulfil the requirements for the *M.Eng./Grad. Dipl. in Electronic Systems* degree offered by DCU. The second option excludes coursework and examinations, and is suitable for those who wish to update or expand their skill base, without adding to their qualifications.

This paper reports on the conclusions of this pilot phase, and discusses some of the issues that have arisen during its running. The approach outlined builds on many of the ideas outlined in MIT's recent report on *Education via Advanced Technologies* [2].

Overview: Interaction and Presentation

Any strategy for remote access education via the Internet must ensure that the student can communicate effectively with their tutor and fellow classmates. The key to this form of education is *interaction* and not the presentation of the course notes, after all a good textbook may be far better than static course notes on the Web. Different courses will require/use different levels of interactivity depending on their needs, or a tutors willingness to use Web tools. Web interactivity can be designed in several ways [3], including:

- **HyperLinks** (local and global). All links should be meaningful and add value to the course.
- **Questions**. Questions can increase commitment, motivation and interactivity in instructional materials.

- **Feedback/Communication**. Students should have the ability to communicate with the course tutor and each other. The ability to communicate with fellow students, including full-time students taking the same course may help to alleviate isolation, a key characteristic of distance education. It may be wise to limit the amount of interaction with remote access students, otherwise the course tutors may find themselves constantly on call. It may also be possible to assign teaching assistants to handle student enquires, although this may not always be possible, since students with the appropriate skills may not be available.

There has been much debate about the merits of using on-line course material, this argument is summarised in Table 1. But it is worth noting that in MIT's report *on Education via Advanced Technologies* [2], they state that they expect half of MIT courses to make significant use of Web-based resources within the next couple of years. They also expect that a number of courses might be radically changed in the process.

For	Against
• A rich medium. Text/hypertext (*html*, *ps*, *pdf*) Pictures, Video, Sounds Interactivity, 3D - (VRML), JAVA • Publication. Wide distribution. Virtual universities. Immediacy - "Just-in-Time publication". Easy to change. Channel for distribution of other resources. Collaborative publication. Presentation "package". • Resource source.	• Why is it not more common? • Fragility! • Bandwidth/Speed. • Link-Rich/Content-Poor. Do hyperlinks actually encourage "deep learning"? • Rapidly changing. • Suited to some subjects more than others. • Lack of decent tools? - This is changing. • Expertise: Staff / Students. • Copyright issues. • Design issues - paper-based material can be pretty ugly too! • Access and maintenance.

Table 1. Summary of the benefits and disadvantages of using on-line course material [4].

A range of communication methods [5] can be employed by the course tutor, these include:

Electronic Mail (Email): This is a quick and simple communication medium. It allows users to send documents created by other applications.

Mailing lists/Newsgroups: The course tutor can use a mailing list to send important messages to all participants. Students can use this forum to discuss ideas among themselves.

Synchronous Internet Communication: Real time communication on the Internet. On-line "conversations" (text or voice: i.e. as each person types or talks) are possible. Other possibilities include teleconferencing, video conferencing and electronic whiteboards on which anyone can draw, type or paste documents and pictures.

Creating your own Web documents: This can be done in raw HTML, or using one of the many freeware or commercial HTML editors/converters that are currently available.

1. Educational Concerns

The key educational concern of any course, whether it is taught in the traditional manner or on a remote access basis, must be the quality of the course material. A significant disadvantage of Web based education is that students will be confronted with more information than they can realistically handle. There is a need for guidance as to what is important and what is not, what is correct and what is not, and what is the optimum order in which to learn the various concepts [2].

Students should be encouraged to [6]:

- Know all course requirements, due dates, etc.
- Make a specific study schedule and adhere to it.
- Read, study and review a little bit each day.
- Share ideas.
- Participate actively!
- Ask questions and engage in debates. Work with fellow students.

Tutors should be encouraged to [1]:

- Avoid overloading the student.
- Encourage group work and discussion.
- Keep students informed.
- Make course requirements and grading policies extremely clear.
- Use short, open-ended responses to promote discussion.

Course tutors must be aware of the need for assignment structures that suit remote users and how to avoid the student feeling isolated. Computer Aided Assessment [7] is also

possible, one approach is to make use of automated multiple-choice tests [8] that allow a student to test their knowledge at the end of each session to gauge their progress. On-line course review forms can also be used to collect responses on student's experiences of the remote access course.

2. Examinations

With current technology, on-line examinations are difficult to control and monitor. It would be preferable for students to sit the examinations in the traditional way, at the host university, whenever possible. If the student is resident outside the host country, then it may be possible to use an associate institution in that country to monitor the examination. By having the students sit the examination in the traditional way, we can counteract potential arguments against this approach to teaching by the accreditation institutions. The Open University [9] runs a policy whereby all students, (whether studying conventionally, or via the Internet), must attend the final examination in person at one of the approved examination centres in the UK, Ireland, or Continental Western Europe. Alternatively they can pay the special overseas examination fee to arrange an examination at a local university or British consulate.

3. Legal Issues

Unless access is restricted, an implied license to make copies of the article or picture is granted, therefore it is important to control access to preserve your intellectual property. It is also important to limit your liability, by means of a disclaimer. Nevertheless, it is "*sensible to take extreme care as to the type of information which you put on the net and to ensure that such information is up to date*" [10]. Access control via password protection will be required for a range of reasons. As well as using such protection to preserve your intellectual property, it will enable the host University to control access and thus collect revenue for the course.

4. General Issues

Academic freedom requires that a course tutor keeps control over their course material (i.e. intellectual property). Whatever approach is taken by the course tutor, the Web presence of the course must be maintained. This can mean a significant investment in time and resources for courses, which are dynamic. Some universities have taken the view that it may be wiser to reduce investment in 'bricks and mortar' and concentrate new capital investments in educational technologies and services [2].

5. Possible Models for On-line Education

While there is a number of possible implementation models for remote access on-line education, the two extremes that could be adopted have been summarised. To decide the suitability of any on-line education technique it must be examined in terms of economy/cost both to the student and the course provider, intellectual property control, maintenance and ease of development, see [8, 11] for further details. Key aspects of the design process include a course content expert, course provider (this may be a publishing house), Web page design and maintenance, PERL script programming, and possibly an

instructional designer. Building a team to deal with each of these diverse areas can be an expensive process [12].

5.1 Maximum use of Internet Technology

This is a high technology, maximum feature approach to using the Internet as a teaching medium. This implementation emphasises student interaction and note presentation. Notes would be presented in full HTML format, including graphics, audio, animation and video clips. Automated self-assessment and detailed review questions would be included to help student interaction and understanding. It would be envisaged that on-line discussion groups, making use of electronic white boards and Internet chat lines could also be implemented. The use of the new generation multi-platform languages, such as JAVA, in conjunction with other Web development tools would enable a greater degree of interaction over the Web.

This approach has a number of serious considerations. As well as taking a significant amount of time to design and implement, it is a high maintenance model. On-line courses can generally be considered a niche area of the education. Therefore such a course should not overburden the teaching load of the course tutor. This model imposes significant effort in keeping material up to date for possible minor changes in course content. While, it is acknowledged that many of the current HTML generation utilities make this task easier, a situation may arise where a change in course notes presented to the full time students taking the course, may not be available to the on-line students at the same time. In general, this model has a high cost for student. The downloading of graphically intensive HTML with video, and audio over a low bandwidth Internet connection is expensive. A slow link can make the educational experience frustrating for the student. Finally, by presenting all your material in HTML you lose control of your intellectual property, despite copyright warnings and the use of password protection.

5.2 Minimalist Approach

As the name suggests, this approach takes a minimal approach to using the Web technologies available to it. Information is conveyed to the student via direct email communication. Postscript files containing course material are also presented to the student via email. This results in minimal interaction with the student, and the Web is not used to its full effect.

Key benefits to this approach include its ease of development, minimal maintenance and the fact that note presentation is not tied to specific software. This approach offers the course designer greater protection of material and hence enables them to retain control over intellectual property. From the students' perspective it is a low cost option, since they only need to connect to the Web to request notes/software and for interaction with the course provider. On the negative side the lack of direct interaction makes this approach appear boring for the student to participate in, which in turn makes them less likely to complete the course and hence succeed in the courses educational aims. The approach adopted by the author is a hybrid of the two extremes outlined above, and this will be discussed in detail in the next section.

Implementation: Access, Action and Interaction

The key elements of the on-line education strategy adopted by the author are *access*, *action* and *interaction*. *Access* refers to the ease of access of the student to the course material. The technology adopted by the course provider should not be so advanced that the general computer user cannot use it. The access should be intuitive and be capable of running on an average computer connected to the Internet. To ensure that this was the case, the on-line course was tested using a range of Web browsers on a basic configuration PC (i486), connected to the Internet via a commercial Internet service provider, using a 14.4K baud modem.

Action refers to the student's ability to implement the ideas outlined in the course remotely. This specifically refers to student assignments. Many of the traditional assignments may have to be redesigned to account for the fact that students will be running simulations or design tools over the Internet, or alternatively software should be made available to the students to download and run locally.

The final element, *interaction*, is vital for any on-line educational strategy to work. A dynamic must exist between the student and the course tutor. Lack of such a dynamic will cause the student to feel isolated and frustrated and possibly abandon the course. There is a wide range of techniques to help foster students interaction. Techniques such as mailing lists, direct communication, posing questions/issues which will force students to contact fellow class members or the course tutor and encouraging remote access students to communicate amongst themselves. The on-line course design detailed below aims to cover these key issues. Of course, many lessons have been learnt since the course first ran and these will be discussed later.

Key to this model is the concept that the remote access course runs in parallel with a full-time version of this course run in the conventional manner. Full-time students attend lectures as normal, but they are also given access to all the on-line material used by the remote access students. All course material and general class notifications, such as assignment deadlines, are presented to the full-time and remote access students via the Web. Full-time students are also encouraged to use the mailing list as an additional means of asking questions or resolving issues relating to the course. This has the advantage of allowing remote access students to converse with those students taking the course in the traditional way. Having a mixed peer group of remote access students and traditional full time students helps remote access students feel less isolated and encourages greater interaction. This combined with the weekly class updates helps the remote access student keep in touch with issues raised during the course of the traditional lecture. Previously archived weekly updates and frequently asked questions/responses are also available to all students.

1. Detailed Course Design

When the student enters their username and password they are presented with the course main index, Figure 1. Links to software utilities, such as postscript viewers, are also

included. This ensures that the student can quickly access the utilities suitable for their local machine. The coursework materials link contains all the necessary material for the assignments.

A directory of course participants, both full-time and remote access is provided. This list is only available to students registered on their course. The aim of the list is to encourage interaction between all students, as well as student/staff interaction. It is also important to give detailed deadlines of all course deliverables, such as assignments. A link from the main index helps students to keep up to date with such deadlines. Students are also linked to a widely available external newsgroup and FAQ sites. They are also encouraged to examine the *Machine Vision Resources* homepage, Figure 2. Feedback from the students on the course content and presentation is encouraged using an on-line course review form.

The VISION mailing list is crucial for student/student and staff/student interaction, Figure 3. Remote access students benefit from the interaction between full-time students taking the course. Any issues that arise during the standard lectures are relayed to the remote access students via weekly updates mailed to the mailing list. This helps the remote access students to pace themselves and also encourages a class dynamic. The mailing list is also a useful mechanism for dissemination of additional notes and clarifying issues that arise during lectures to both the full-time and the remote access students. The majority of the material to be referenced by the student can be found under the *Lecture Material/Notes* link. This will take the student to the course material index page, which points the students to the study packages associated with the on-line course.

The course uses Web pages as a means of guiding the student to material. Course notes are only provided in postscript/portable document format. Students can then read these notes using freely available viewers such as *Ghostscript* or *Acrobat Reader*. This is done to ensure minimal maintenance of course material, and to prevent out-of-date material appearing to remote access students. If the original notes are changed by the course tutor, then they are only required to generate a new postscript file from their word processor and to ensure that the Web version of the notes are updated. This method of course presentation has a number of advantages:

- Note presentation is not tied to a specific software package.
- The course tutor has greater protection of material and it is therefore easier for them to retain control over their intellectual property.
- Ease of development.
- Allows students to easily generate a paper copy of the notes. As Thomas [12] points out learning from information displayed on a computer screen is not always acceptable.
- Low cost for the student: They only need to go on-line to request notes/software and for interaction with the course provider.
- Low cost for the course provider: Course maintenance kept to a minimum.
- Additional use of data compression for course material to reduce connection time.

- Point students to related material elsewhere on the WWW. This can be maintained independent of the course notes. Such links are listed in the *Aims and Issues* section of each study package.

The Web pages concentrate on course support material, such as the aims and issues relating to each lecture, reading lists, review questions, pointers to other sites, audio-visual clips, and feedback rather than note presentation. It should be noted that the audio-visual clips are optional, therefore students with slow connections to the Internet can safely ignore them.

Clearly stated aims and issues are very important for remote access teaching. Automated self-assessment questions, and detailed review questions are also provided to encourage the remote student to participate in a problem based learning strategy. Having a wide range of detailed review questions which are representative of the standard expected by the course tutor is very important for remote access students. The aim of on-line assessment is to help the students pace themselves through the course material. The students receive an automated reply once the assessment has been submitted and a copy of the students attempt is also automatically emailed to the course tutor. While multiple choice questions are limited in nature, they act as a warning sign for the students. The automated self-assessment questions and the on-line course review forms are implemented using PERL scripts, see [8] for implementation details.

Application and Registration Procedure

It would be wise to have a range of fees depending on the level of interaction by the user. Under the RACeE initiative there are two options for people wishing to take the *Computer and Machine Vision* course, with a special discount to all registrants not financially supported by their company (i.e. self-funded).

1. Full Course

In this mode the student will fully participate in the course. As well as full access to all course materials, the student will be supplied with a fixed number of hours of on-line tutorial support. Assessments will be submitted electronically. Examinations will be taken in DCU in conjunction with full-time students taking this course. Special arrangements may be made for sitting examinations outside DCU, but this will involve an additional charge. Students will gain full credits for single module (subject) courses (including a transcript of their results and a letter of completion). Single module courses partially fulfil the requirements for the *M.Eng./Grad. Dipl.* course within DCU, or similar courses within Europe. Cost structure: Self-funded: IR£400, Company funded: IR£550.

Since this course runs in parallel with the full time course in *Computer and Machine Vision* students have to register within the same time frame as full time students. Applicants are accepted on the basis of their academic qualifications and their previous experience. Prior to registration, students must provide the programme co-ordinator with a signed declaration stating that they are taking this course for private study, that they

will not reuse any of the material (i.e. course notes, software.. etc.) for any purpose other than private study. Once registered, students will be provided with a username and password to enable them to access all course materials.

2. Course material only

In this mode the student will gain access to all notes, software and course material, but will be expected to work independently without any on-line tutorial support. No examinations or assessments will be submitted. This mode would be suitable for students/employees who wish to update or expand their skill base, without adding to their qualifications. Cost structure: Self-funded: IR£300, Company funded: IR£400.

The registration procedure is similar to the full course outlined above, with the exception that this option will be provided throughout the academic year.

Conclusions

The general response to the pilot phase of this course has been overwhelmingly positive, although to date our experiences are based on a small number of highly motivated students. The long-term viability of remote access education has yet to be established. At the very least it will act as a niche educational delivery format for people in the work place unable to attend university on a full time basis. It is clear that this form of education requires a strong maturity on the student's behalf. By adopting a low maintenance model, which emphasises the interaction aspects of remote access education, we can ensure that our traditional educational role is not skewed by the addition of this form of education. Within the School of Electronic Engineering at DCU, we plan to expand the availability of the *Computer and Machine Vision* course in the coming academic year and to add three additional remote access courses. Our intention is to have a wide range of postgraduate courses available via the Internet, although is should be acknowledged that an on-line educational strategy may not be suitable for all subjects. This will enable key research laboratories within the School of Electronic Engineering to transfer the specialised skills associated with these laboratories to industry. The content and structure of these single module courses are designed to meet the higher skills and educational requirements of graduate engineers.

While the model outlined in this paper was designed specifically for a course in *Computer and Machine Vision*, the general concepts can be applied to a wide range of courses. The introduction of a new on-line courses will bring with it new challenges, and the model proposed in this paper may not always be sufficient. It is important that whatever model is chosen must be based on sound pedagogic foundations and not just on the availability of materials [12]. One key problem that remains is the running of assignments. The software package used for assignments was developed in-house, therefore we have no difficulty redistributing it freely to students registered on the programs. But this will not always be the case. We are currently investigating ways of running a wider range of assignments remotely using a multi-platform language such as JAVA, i.e. without the need for students to download custom software. This would

provide remote access educators at DCU with a more general model for on-line assignments.

Lately, a discussion about the positive and negative aspects of the Internet and its role in areas other than education has become very popular. Nevertheless, it has always been the authors aim to approach the problem of remote access teaching from the educational standpoint, and not from the need to produce attractive and overly complicated Web documents. Another strong motivational force in the design was the need to address genuine educational needs not covered sufficiently by the traditional educational model. Remote access education will continue to be an important niche educational market in the foreseeable future, since it presents educators with a new and potentially powerful medium for teaching. It allows us to respond to the changing needs of the engineering workforce, who need to update their qualifications and/or skill base without leaving the workforce.

While the remote access course outlined in this paper could run independently of the traditional educational model, a key aspect of the design is the need to run it in parallel with a traditional version of this course. The paper has shown that this brings a number of significant advantages to the remote access student.

Acknowledgements

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Figures

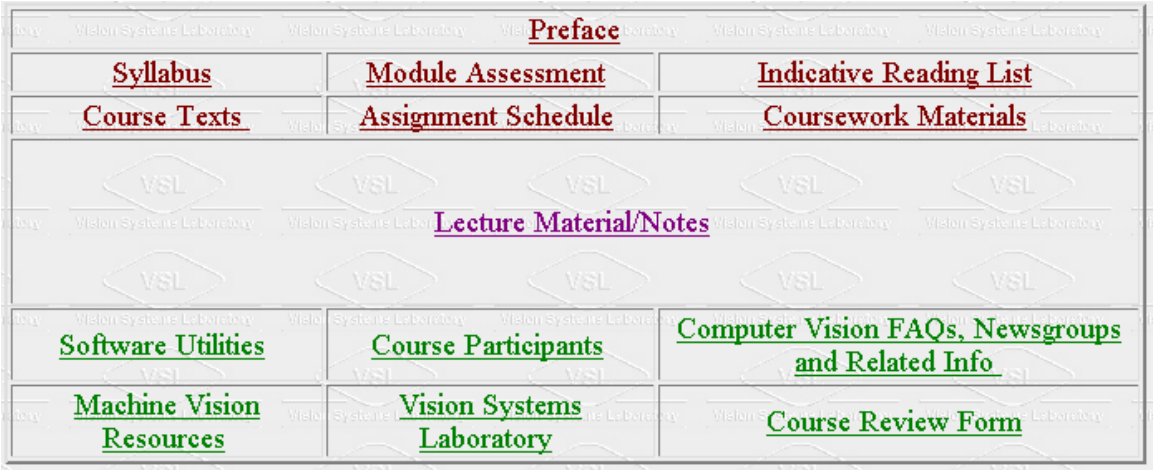


Figure 1. *Computer and Machine Vision* course main index page.

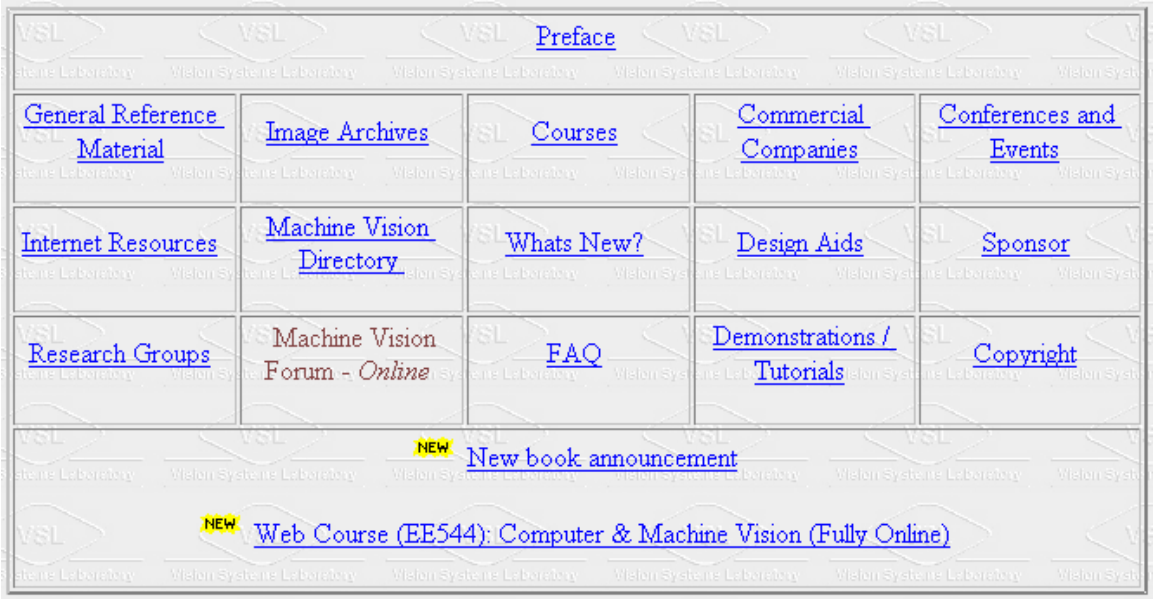
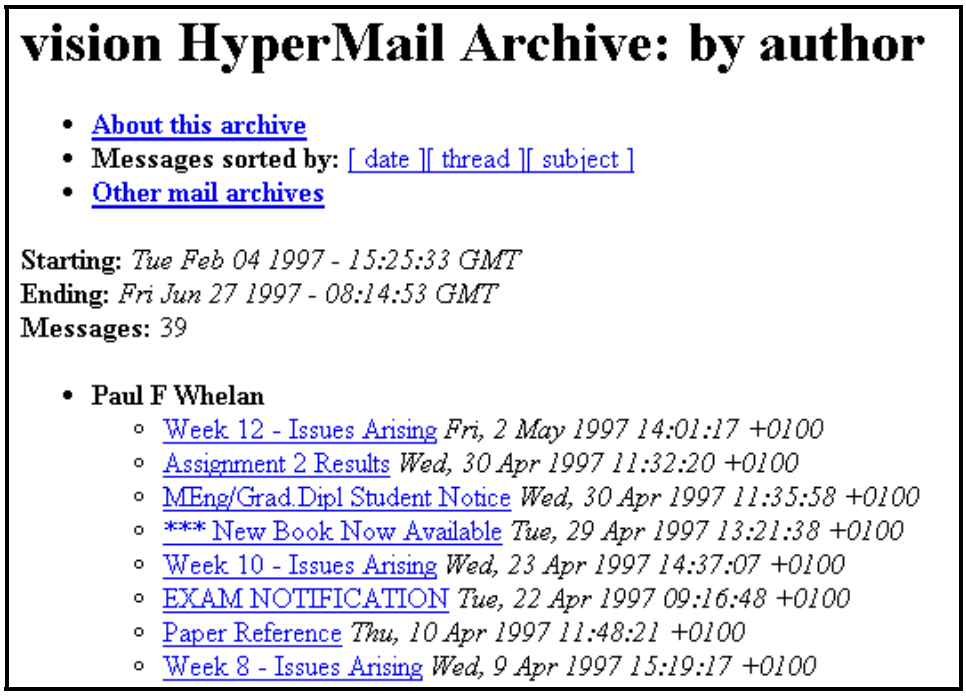


Figure 2. *Machine Vision Resources* homepage. This is an open access Web site for practitioners in machine vision engineering.



vision HyperMail Archive: by author

- **About this archive**
- **Messages sorted by:** [date][thread][subject]
- **Other mail archives**

Starting: *Tue Feb 04 1997 - 15:25:33 GMT*
Ending: *Fri Jun 27 1997 - 08:14:53 GMT*
Messages: 39

- **Paul F Whelan**
  - Week 12 - Issues Arising *Fri, 2 May 1997 14:01:17 +0100*
  - Assignment 2 Results *Wed, 30 Apr 1997 11:32:20 +0100*
  - MEng/Grad.Dipl Student Notice *Wed, 30 Apr 1997 11:35:58 +0100*
  - **** New Book Now Available *Tue, 29 Apr 1997 13:21:38 +0100*
  - Week 10 - Issues Arising *Wed, 23 Apr 1997 14:37:07 +0100*
  - EXAM NOTIFICATION *Tue, 22 Apr 1997 09:16:48 +0100*
  - Paper Reference *Thu, 10 Apr 1997 11:48:21 +0100*
  - Week 8 - Issues Arising *Wed, 9 Apr 1997 15:19:17 +0100*

Figure 3. Sample output from the VISION mailing list.