



Robotics for Distance learning: A Case Study from a UK Masters Programme

Jenny Carter

De Montfort University

The Gateway

Leicester LE1 9BH

jennyc@dmu.ac.uk

<http://www.cse.dmu.ac.uk/msccir/>

Simon Coupland

De Montfort University

The Gateway

Leicester LE1 9BH

simonc@dmu.ac.uk

Abstract

The MSc Intelligent Systems (IS) and the MSc Intelligent Systems and Robotics (ISR) programmes at De Montfort University are Masters level courses that are delivered both on-site and by distance learning. The courses have been running successfully on-site for eight years and are now in the fifth year with a distance learning mode. Delivering material at a distance, especially where there is technical and practical content, presents a challenge and in this paper we focus on some of the techniques adopted to overcome the particular challenges encountered in the delivery of Robotics modules.

Keywords

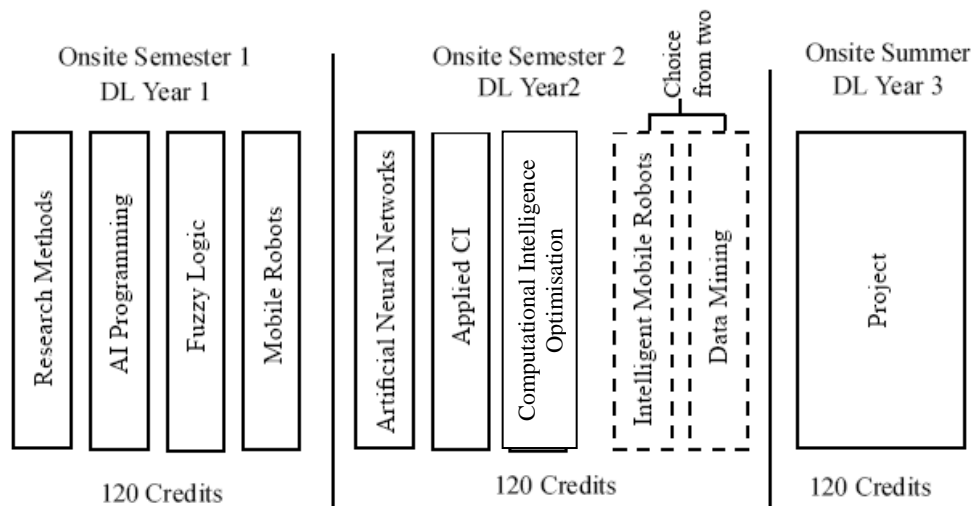
post-graduate, distance learning, robotics.

1. Introduction

The MSc Intelligent Systems (IS) and the MSc Intelligent Systems and Robotics (ISR) programmes at De Montfort University are Masters level courses that are delivered both on-site and by distance learning (DL). The courses are delivered mainly by the members of the Centre for Computational Intelligence (CCI) at De Montfort University. Their development enabled us to capitalise on the research taking place within the CCI and therefore on the strengths of the staff delivering the modules.

Each MSc consists of 8 taught modules and an independent project which is equivalent to 4 modules. Each module is worth 15 credits (7.5 ECTS). The MSc ISR includes two mobile robots modules whilst MSc IS replaces one of these with a Data Mining module as an alternative application area for those less interested in pursuing mobile robotics work. A Research Methods module is delivered in semester 1 to ensure that students are equipped with the necessary skills to carry out literature searches, write project proposals and so on; and a module titled 'Applied Computational Intelligence (CI)' enables students to pursue an appropriate area of their own interest in greater depth. An overview of the course content is shown in figure 1. In this paper we discuss the issues associated with delivering such a course at a distance and focus in particular on the approach taken to delivering the robotics modules.

The remainder of the paper is structured as follows: Section 2 discusses approaches to learning on the MSc programmes and how this fits with recognised approaches from the associated literature; Section 3 considers the; Section 4 provides a discussion of; and Section 5 draws conclusions from this work.



2. Approaches to learning

In order to deliver the course effectively it has been useful to consider approaches to learning and teaching in higher education more generally. Most of the modules include both theoretical and practical work and the assessments are usually open enough to allow the students to investigate appropriate topics in their own way thus there is an attempt to facilitate experiential learning as defined by [1]. We believe it to be very important for our students to draw on non-course experiences as many of them have work experience: for example, DL students are often in full time employment, there is a wide variety of first degree subjects amongst them and some already have PhDs.

We aim to adopt an approach to our delivery of the courses that embraces modern technology in such a way that the students have appropriate learning experiences whether they are studying on-site or at a distance.

3. The Robotics Modules

There are two robotics modules on the MSc Isr – Mobile Robots and Intelligent Mobile Robots. To be successful the robotics modules must combine hands-on practical work with advanced theoretical concepts.

3.1 Teaching and Learning Strategies

The teaching and assessment strategies have to work face to face and at a distance. For many students this module is their first exposure to programming robots and the first time they have come across the inherent challenges such as hardware limitations, behavioural debugging and dealing with uncertainty. To best support our diverse student population we have developed a clear delivery strategy which we believe serves as a model when delivering a first semester postgraduate robotics module. Our strategy is depicted in Figure 3.

Arguably the most important and probably the most difficult part of the Mobile Robots module to teach at a distance are the first two weeks. It is vital that students come out of these first two weeks with the core knowledge and skills to make progress on the module. The students come on the module from a diverse set of backgrounds, some may have good knowledge of the topics covered in these first two weeks, others may have limited or no experience. Additional challenges come not having face to face contact with the students and so normal cues such body language and informal questioning cannot be used. To help overcome these issues we provide the students with a diverse range of materials covering topics from a very basic level these include:

- Building the robot model

- Changing the batteries in the robot.
- Updating the robot's firmware.
- Basic operation of the robot.
- Installing the BricxCC IDE. Using the BricxCC IDE: writing your first program, compiling, uploading and executing. Installing GCC with OpenGL and OpenCV.
- Setting up compiler short cuts and makefiles

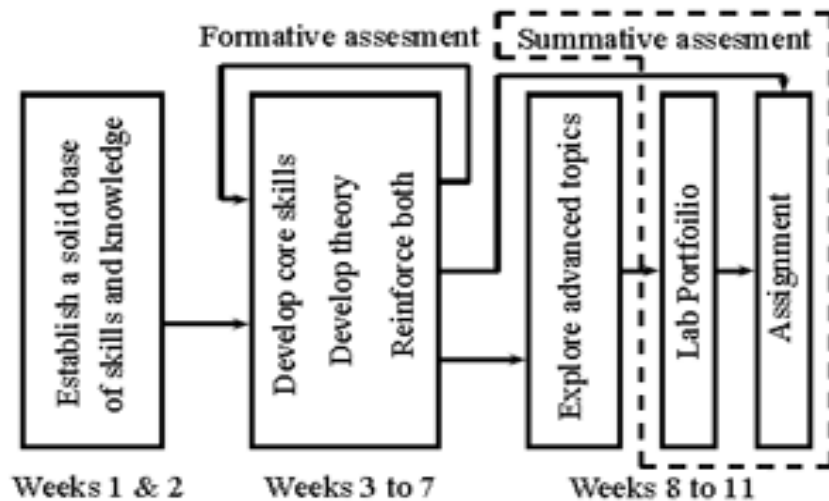


Fig.3 Teaching and assessment strategy for mobile robots

These topics are often present through video presentation which are high effective as they student can go through these multiple times with the additional benefit of giving a human face and voice to lecturer.

Core competencies are built up through a series of videoed lectures supported by structured lab work and an online discussion board mainly used by the student to interact with each other but to allow the tutor to contribute ideas, techniques and further reading suggestions.

When exploring the advanced topics the students are given guidance giving them a basic understanding of these topics and how to implement them and are given the space to explore how far they can take the idea they have been exposed to. This has been hugely successful ensure all students get the core idea whilst the most able can really stretch themselves

The teaching and learning strategy on the second and optional module, intelligent mobile robots follows similar pattern:

- Weeks 1&2 core skills learning and reinforcement such as additional mathematics and robotic architectures recapitulation
- Weeks 3-6 learn and develop underpinning techniques such as the application of geometry to robotics, dead reckoning and statistical data fitting techniques.
- Weeks 7-10 understand and implement the advance techniques.

There is no assessed lab portfolio for the IMR module as the topics are not discrete enough to fit into a single lab. The work is built up over a series of guided labs culminating in coursework submissions.

3.2 Simulation versus Hardware

When robotics is taught there are decision to be taken about when to use real robotics hardware and when to use simulations of that hardware. Simulators have many advantages: low cost, students can take them home, the robots actions can be paused at any time, no damage can be done to them and there are no issues with hardware failure. Using real robots also has advantages: the student get to see their work moving a physical object, the sensors are subject to real-world uncertainties and understanding the intricacies of robot hardware setup and operation.

Clearly offering a robotics course at distance adds another dimension to this, how to the distance students get access to the real robots? Until recently each distance student on the course was sent a Lego Mindstorms NXT robot so they would have access to robot hardware. However as well as being expensive the NXT robots and more importantly the next generation the EV3 have limitations which make them unsuitable for the content of the intelligent mobile robots module.

The IMR module has always used the pioneer range of robots from AdeptRobotics. These robots are based around a server-client architecture where the server is an onboard PC and the client is bespoke micro controller. This configuration although for simple and straightforward simulation of the robotic hardware (the microcontroller) and leaving the control software running on any PC running Windows or Linux. The simulator and control software library ARIA are freely available to download and are well supported. The other advantage of the client-server architecture is that it allows remote access to the robot hardware. Typical operation of the robot is involves the onboard PC communicating with the microcontroller via a hardwired serial connection. However when running with the simulator the communication is done via TCP/IP. It is simple to have programming running on the real robot which take in microcontroller commands over TCP/IP and sends them to the microcontroller via the hardware serial connection. The ARIA library comes with an example program (lpthru) demonstrating how to do this. This results in remote control of the robot via TCP/IP to be possible, so distance students can control the real robots in our University's robot lab from anywhere in the world. Of course it is important that only our student are able to gain access to the robot, to achieve this we require the students to root through a single machine at the University via the University's Secure Shell server. This configuration is depicted in Fig 4.

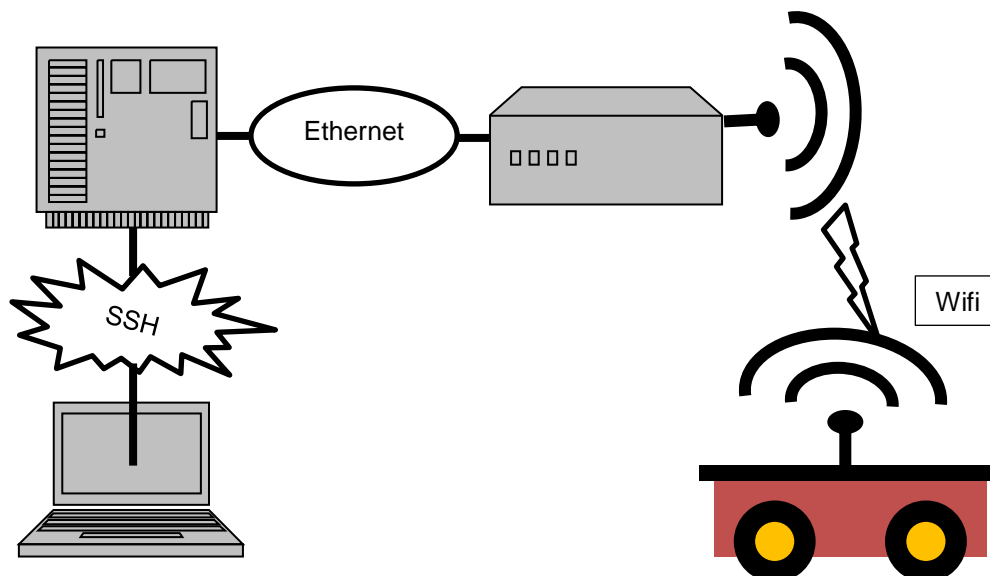


Fig 4. Robot Remote Access Configuration

4. Student Performance

Table 1 gives the student numbers and pass rates on the mobile robots module over that past three years and table 2 distils these numbers in to fail, pass and distinction rates for on-site (OS) and distance learners (DL). It seems that study at a distance presents no barrier to students achieving the highest standards on this module, in fact a slightly higher rate of distance students achieve a distinction on this module.

Year	Enrolled	Passed	Fail/Resit	Withdraw
2013	16	14	1	1
2012	14	11	0	3
2011	20	17	1	2

Table 1. Student Numbers and Pass Rates for the Past 3 Years

Year	Study Mode	Distinction	Merit	Pass	Fail/resit	Withdraw
2013	OS	2	1	3	0	0
	DL	8	0	0	1	1
2012	OS	1	2	0	0	2
	DL	4	2	2	0	1
2011	OS	2	4	0	0	0
	DL	6	1	4	1	2

Table 2. Fail, Pass, Merit and Distinction rates for OS and DL students.

4.1 Student Perceptions

Each time one of our modules runs we collect feedback from the students in the form of an anonymous questionnaire. We use this to judge how the students perceived the modules content, organisation and difficulty which feeds in to a module improvement plan.

5. Conclusion

In this paper we have described the MSc in Intelligent Systems and MSc Intelligent Systems and Robotics. As courses that runs both on-site and by distance learning, they are often used as an example in our own institution.

Delivering courses at a distance is a topical area. With the many available mechanisms for interacting with learners electronically there are a number of choices to be made regarding the approach to take. In this paper we have described some of the approaches taken to the delivery of the learning materials and our approaches to assessment and feedback.

The course is successful and sustainable with a total of 59 students currently enrolled. It continues to evolve as the available technologies improve; we continue to gather feedback regularly, using the responses to inform future developments. We hope to continue in this way ensuring that our students benefit from a carefully crafted course that makes appropriate use of current technology enhanced learning research and associated technologies.

6. References

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Journal

Smith, D. (2004) Issues and trends in higher education biology fieldwork. *Journal of Biological Education* **39** (1), 6–10. DOI: 10.1080/00219266.2004.9655946

Book

Davies, M., Cook, A. and Rushton, B.S. (2007) *How to get your kids through university*. Bedlinog, UK: Accent Press Ltd.

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Online resources

Links to online resources should be cited as a reference; a link should be included in the references, not within the body of the text. Include the author of the citation, if possible. Cann, A.J. (2007) MicrobiologyBytes. Available at www.microbiologybytes.com/index.html (accessed 27 March 2008).

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