



An Integrated Course to Introduce Intelligent Environments and Intelligent Systems

A building or a city can be defined as ‘smart’ when modern (ICT) communication infrastructure fuels sustainable economic development and a high quality of life, with a wise management of natural resources.

Intelligent environments (IE) are enablers for smart cities. IEs are spaces where information and communication technologies create interactive spaces that bring computation into people’s everyday physical world. One of the driving forces behind the emerging interest in highly interactive environments is to make computers not only genuinely user-friendly but also essentially invisible to the user. IEs describe physical environments in which information and communication technologies plus sensor and effector systems disappear as they become embedded into physical objects, infrastructures, and the surroundings in which we live, travel, and work. The goal here is to allow computers to support activities in new ways, allowing people to interact with computers via gesture, voice, movement, and context.

One of the biggest problems facing the realisation of Intelligent Environments to realise smart cities is the ability to scale up intelligent environments to cover a whole city or beyond. This was the focus of the ScaleUp project between King Abdulaziz University, Saudi Arabia and the University of Essex, UK. The project has made research breakthroughs that allow intelligent environments to be scaled-up to interconnect people and buildings across geographically dispersed physical and virtual environments.

This training aims to transfer the project outcomes to KAU to enable KAU to be a World leading centre of excellence in the field of Large Scale Intelligent Environments.

This course will aim to provide an introduction to the field of Intelligent Environments and Intelligent spaces needed as to provide the capacity required for KAU students be the future leaders of the Centre of Excellence on Large Scale Intelligent Environments.

The course will provide an introduction to the area of intelligent environments and intelligent systems via a series of lectures and labs which will provide a hands-on experience on introduction to the area of intelligent environments. The course will involve the following three components

1. Introduction to Formal Methods for Intelligent Environments
2. Introduction to Intelligent Environments
3. Introduction to Robotics and Intelligent Systems



An Overview on the lectures on Introduction to Formal Methods and their relation to Intelligent Environments

One of the most problematic aspects of managing complex technologies is accurate description and communication – are we sure we are talking about the same thing? Are we sure we have not misunderstood one another’s intentions? Another problem is the management of scale – when systems become very large it is very hard to comprehend them. Are there ways to manage scale? Can we “hide” complexity within a hierarchy of models of increasing levels of abstraction?

In these lectures and class activities we will explore a framework in which we can begin to answer these questions. In particular, we will introduce and explore a language in which we can describe spatial relationships between parts of large systems, connectivity between components of systems, and dynamical relationships within and between systems – that is, how systems can change and develop.

The emphasis will be describing and designing intelligent environments – capturing organisation and activity within individual environments and between, possibly geographically separated multi-environments.

The course will comprise lectures, video podcasts, and class exercise sessions.

Learning Outcomes - After finishing the module, the student will be able to:

1. Use the bi-graph notation to describe and design simple intelligent environments and their components.
2. Express system dynamics in terms of reaction rules.
3. Relate designs at different levels of abstraction, using refinement.

An Overview on the lectures and labs on Introduction to Intelligent Environments



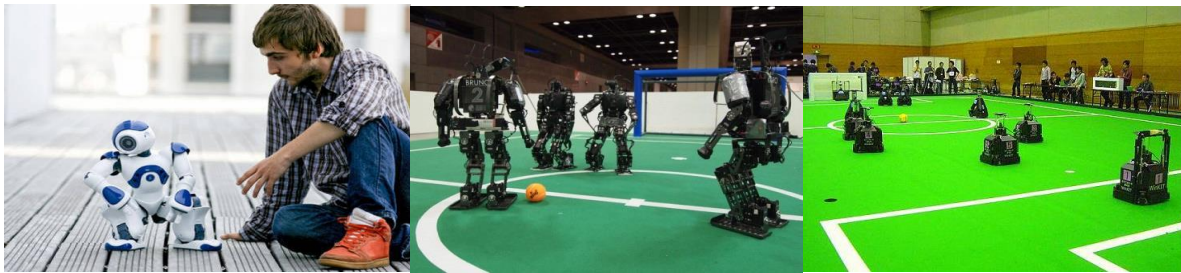
In this section of the course you will learn what intelligent environments are and how to design and build them. As part of acquiring this knowledge you will be introduced to the underlying technologies such as sensors, actuators, embedded-computing, field busses and control systems. The course will describe the core challenges relating to designing intelligent environment technology that arises from the use of computationally small processors operating in real-time, using noisy big-data sets gleaned from sparse inaccurate sensors, applied to problem spaces displaying large elements of non-determinism arising from having people in the control loop. Various solutions will be discussed but the course will focus on the use of artificial intelligence techniques. In particular, the course will explore how behaviour based artificial intelligence applications, such as found in mobile robots can be applied to create self-programming embedded-agents for intelligent environments. Students will be shown how to apply these techniques to create differing types of human-computer

interaction that range from fully autonomous (implicit human interaction) to partial or no autonomy (explicit interaction). Finally, using a sophisticated desk-top sized intelligent room the students will be guided through the steps of designing and building a fully functioning behaviour-based embedded-agent to control their own intelligent environment. Finally this course forms a bridge between the earlier formal methods course (agents and other components simply being nodes on a bi-graph) and the Robotics and Intelligent System course (rule based agents being used in both environments).

Learning Outcomes - After finishing the module, the student will be able to:

4. Explain the issues governing the specifications of embedded-agents, products and intelligent environments.
5. Explain the issues involved in the practical development of embedded agents and intelligent environments.
6. Design embedded-agent environments.
7. Build a simple Intelligent Environment

An Overview on the lectures and labs on Robotics and Intelligent Systems



This part of the course will give an introduction to intelligent systems and robotics and their role within intelligent environments. This part of the course gives introduction of robotics and how they can be viewed as an excellent platform to realise intelligent systems. This part of the course will give real world examples of robots applied in various real world applications. The lectures consider the essential sensing and manipulating the real world, and their properties and characteristics. This part of the course then considers how to allow robots to act in an intelligent way thus trying to mimic some of the human intelligence in order to allow the robot performing difficult and complicated tasks.

The programming of intelligent systems and real-world robots are explored in the context of fuzzy logic control. The module finishes by discussing the recent advances in robotics, especially multi-robotic systems and robot learning.

The students are going to receive the practical labs on the real robots on the newly constructed lab for Robotics and Intelligent systems in KAU.

After finishing the module, the student will be able to: Learning Outcomes

1. Demonstrate an understanding of a range of intelligent systems and robots
2. Explain the characteristics of a range of sensors and actuators
3. Explain the basic principles of robot kinematics
4. Make use of the principles of fuzzy logic in controlling real-world devices
5. Perform simple programming of a robot