Smart Open Space

(v.1.0)
18/1/2017
Departamento de Informática
Nova Lincs
Faculdade de Ciências e Tecnologia
Universidade Nova de Lisboa

Date	Commit	Change
18/1/2017	Vasco Amaral	Created Document, introduced structure

1. Structure of this document

2. Introduction

A Smart Building in commonly known as a building that is supported by technology that can include multiple systems and automation to control its operation. To support the people who inhabit/occupy building spaces (home, office, or other), complex systems are built to provide ambient intelligence by incorporating data acquisition, computation, intelligence and behaviour to everyday objects and spaces in an interconnected and unobtrusive way.

Usually, the goals and benefits expected to smart offices include safety, reliability, cost-effectiveness, occupant comfort, productivity effectiveness and energy efficiency among others.

The Departamento de Informática at FCT/UNL wants to build a smart Open Space so that Researchers and Students can have a good, comfortable and productive working environment while at the same time lowering the energy waste. Its services should be managed in an unobtrusive and transparent way, contributing to the well-being of their occupants without intruding on daily activities. Therefore, minimising energy waste and operating costs cannot be achieved at the expense of occupants' comfort, productivity or health.
Building environmental conditions should be regulated within an optimisation space that is compliant with the comfort of its occupants i.e. the BAS must avoid taking actions that will, with high probability, lead to counteractions by those occupants and therefore leading to annoyance.

In the next section, we will describe further the intended requirements for the Smart Lab.

3. Description of the Smart Lab System

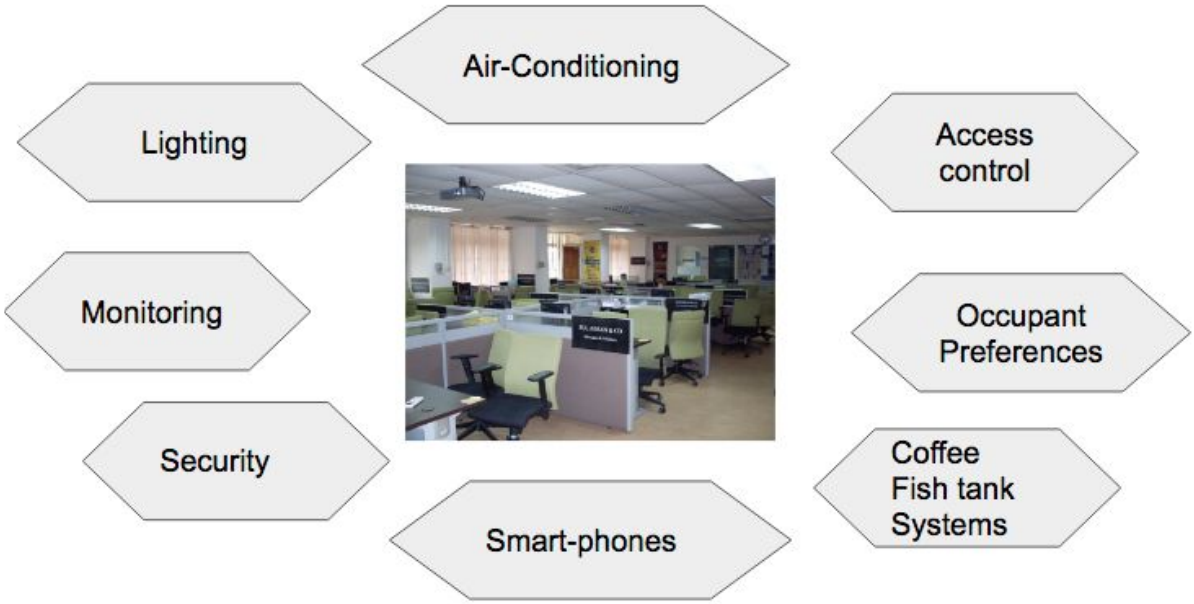

Fig. 1. Some perspectives of the intended system

3.1 Physical Setup

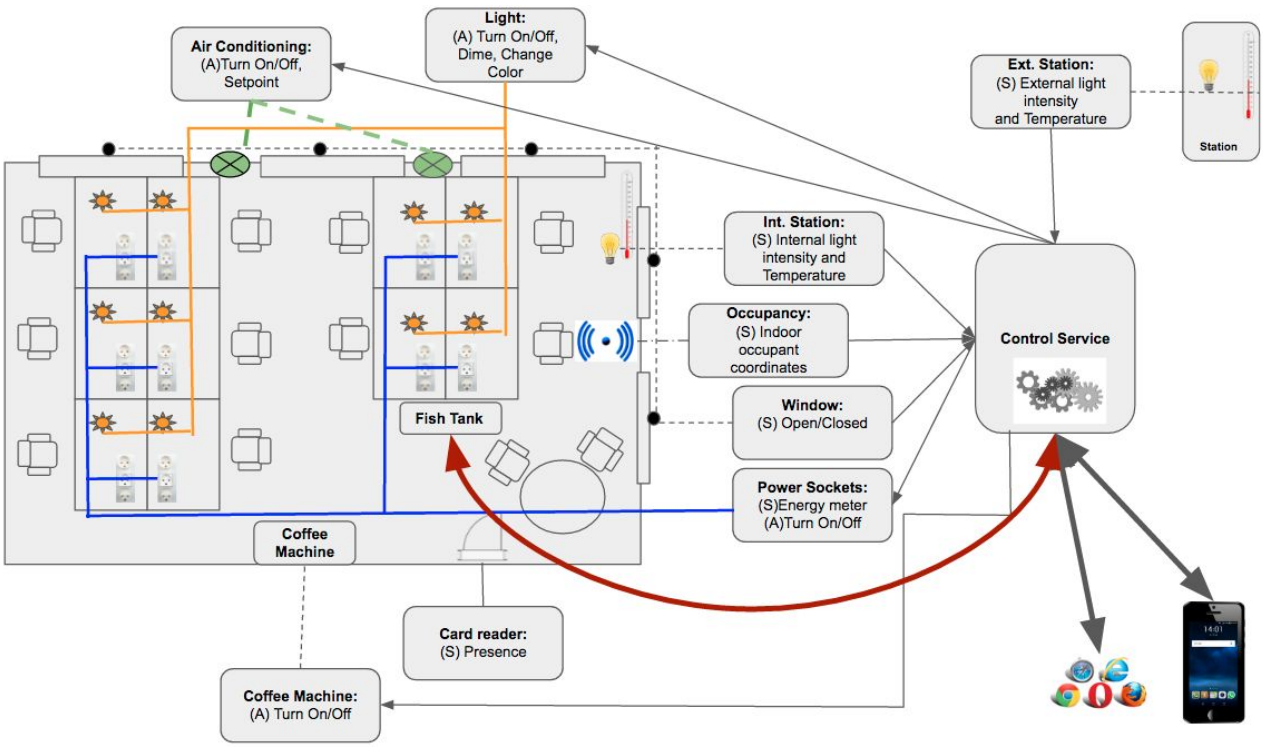

Fig. 2. Hardware setup in the room.

Actuators

- Colored LED lights
- IP power sockets controllers (on/off)
- Air-conditioned, IR to control (turn on/off and temperature set point)

Sensors

- Energy consumption meters
- Presence/Occupancy controller (with a card reader at the entrance and an indoor location technology that gives the occupant's coordinates)
- Light sensors (measuring the intensity of the light both inside the room and outside the building
- Temperature sensors (measuring the intensity of the light both inside the room and outside the building
- Window open/closed sensors

Server

- responsible for the control service
- connects to the internet for web services and apps
- connects internally with a local User Interface

Internet communications

- all sensors/actuators have a given IP address and are networked in a subnet.
- the server should communicate with the outside world to offer services to the mobile app and web service (for monitoring purposes)

3.2 Involved people

The usual occupants of this lab are:

BSc Students. (use meeting table, access during working days)
MSc Students. (use conference table or desktop if available, access during working days)
PhD Students. (fixed desktop, access anytime)
Post-docs (fixed desktop, access anytime)
Supervisors (use meeting table, access anytime)
Cleaning Staff (access every day from 19h-21h)
Security guards (access at any time, no kind of activity expected besides the lighting)

Occasionally there can be visitors, that should always be followed by a responsible person registered in the room, and the security guards, that will just access the room for few minutes. In the case of the second ones, their access cards will be identified, the door will be opened, and all the lights should be turned on - as soon as the guard leaves the room showing the card again the lights will be switched off).

3.3 Services

3.3.1. Preferences

Fig 1. user satisfaction options so that the system gets feedback from the occupant

The user can set some preferences in his workspace. The settings can be preferred light intensity/colour, environment temperature, whether he/she is a coffee drinker, ...
The satisfaction of the user is also recorded at the moment of the registration by the system administrator. Also, the gamification service, accessed via a mobile app, should capture and update this information by prompting the user occasionally. The first preferences can be set by the administrator when creating the account or editing the information related to the user.

3.3.2. Monitoring/Controlling

A mobile app service and web service for monitoring the sensors' status.

It is also possible to control actuators but only with a menu based local User interface application to be run on the server inside of the room. In this application, when running, it will allow manual control of all the actuators in the room overriding the automatic operation. As this should be done with care, the user will have to identify himself. There will be a voice recognition interface to allow the occupants to give voice control instructions (e.g. "I'm Jose, turn on light desktop 1", or "I'm Antonio, turn off Air Condition 1"), and therefore do the same as the menu based.

3.3.3. Webservice

There should be a web service, running on the server, accessible to the intranet and the internet, to allow the registered occupants to introduce their agenda regarding the room occupancy (meetings, expected time slots to work).

For the purpose of learning new strategies for operation in the future, data related to energy consumption and people's presence and services (to identify user patterns) in the lab should be logged (history should be kept).

3.3.4. Gamification System (integration with other similar labs)

To engage the occupants in contributing for low energy consumption, reducing absence and promote teamwork, a gamification system (for instance base on Badges and scoreboards, with a monthly report of the scoreboard via group mailing lists or mobile app), should be set.

- It should ask the occupants to open a window when the outside temperature is fine enough to raise or lower the internal temperature level.
- It should ask/remind the occupants to feed the fish or do maintenance work in the aquarium.
- It should prompt the occupants via mobile phones questionnaires about the satisfaction regarding the room's temperature and lighting levels like Fig.1 (to update the preferences profile).
- Should rank the people who less contribute to the ecological footprint (consumes less, and highlights those that have reduced at a higher pace the consumption along the month).
- Competition with other similar labs can also be listed (just concerning the consumption rates according to the number of users).
- Allow the system to register other similar labs and ask/get reports from those.

3.3.5. Subsystem fish tank

The Fish tank is a contribute to a relaxing atmosphere in the room. However, special care must be done to keep the fish alive. It is necessary to feed the fish (either automatically, every day at a given time, or manually). When in manual mode, there should be a scheduled event with a responsible assigned for that task. If not scheduled, the system should be informed of the fact that this operation was already done, to avoid double feeding the fish (otherwise, they get sick). The gamification strategy will promote the occupant's engagement in the system making use of lights and the mobile app.

There should also be possible to schedule the Light in the aquarium (minimum 6 hours light per day), which is fundamental to the plants to produce oxygen.

It should also be possible to schedule cleaning/maintenance (filters, water change). This is the only situation when the system allows to turn off the power supply to the fish tank and should have a limited time of intervention that should not exceed 3 hours.

Besides a programmed intervention, the user can request for a manual intervention using the local control application in the room.

There is also an alert system based on the LED colours and intensity to provoke awareness to the occupants about possible problems (values are configurable by the administrator in the control application): lack of energy, ph too high, water level down, need to cool down,

The light in the fish tank (LED) should become coloured (colour configured by the administrator) when the system is in self-operating mode.

The fish tank has the following sensors/actuators:

- Ph level sensor
- Temperature sensor
- Water level sensor (to know when it has lack of water possibly evaporated)
- LED (lights with control over intensity, on-off and colour)
- Water pump valves (to extract water and pull in fresh water)
- Ventilator (to cool down water)

3.3.6. Subsystem Coffee Machine

Waste of energy is very common in public spaces, for instance, the coffee machine is very often forgotten to be switched off (permanently heating). However the device should be turned off when not used, the machine should be turned on for at least 15 minutes so that the internal temperature is optimal to get a good coffee (fundamental for the happiness of the occupants). The systems should be aware of the schedule and preferences of the occupants and determine the need or not to turn the coffee machine on or off.

3.3.7. Lighting System

Lighting control is deeply related to the occupancy sensing. When the registered occupants enter the room, they must show their access card and put around the neck a locator card (for indoor location). The preferred places (if not the fixed desks, then the available desks where the occupant can seat) should light on according to the individual preferences. The indoor location sensors should detect that the occupant is moving inside, therefore should gradually reduce (for instance 10% of the lighting) the light at the place where he is no longer there. When the system realises that the occupant left the room, it will wait for 10 minutes, and the lights are first dimmed to very low intensity just to show some presence if there are more occupants (and if the room and the internal/external natural light intensity is too dark). The intensity should be according to preferences and the influence of the natural light (to avoid spending too much energy).

When meetings are going on (including Skype meetings), all the lights in the room (except fish tank) should be pale green to announce newcomers that, if possible, they should be quiet when entering.

Any alert coming from the aquarium should be focused only on the LED of the aquarium itself.

3.3.8. Air conditioned System

Switch on and off in a clever fashion according to the agenda (1 hour before should be turned on, and should be turned off 15 minutes later if no more activity is predicted). The windows should be closed if the air condition is to be switched on. The occupant will be able to use the provided web-service to suggest at a given moment, in a manual fashion, his strong preferences about the temperature (to raise or to lower it like the options in Fig1.). The system will take into account this information and is going to ask the other occupants about their preferences. The result of the mean of the choices will prevail.

3.3.9. Access Control

The system should be aware of the schedules of each occupant, as well as of the meetings in agenda. Door controls (with presence control devices at the entrance) should contribute to identifying the occupants at every moment as well as giving the system significant figures (predictions and real) relating to the occupancy along the time. Therefore, all information regarding accesses (who, when, in or out, how long) should be logged to issue a report to the system administrator every month.

3.3.10. Security

As soon as the system detects an unauthorised presence of people in the room the security guards system should be notified, and the lights should be blinking yellow (as the rotation lights of an ambulance) so that the security guards can spot the room immediately when walking in the building. When the security guards enter the room, if they show the access card the lights will be turned to white. If the guard shows the card three times, the lights will turn off (false occurrence), otherwise showing just once the event will be registered and the lights will be turned off.

3.3.11. Administration

The Administrator manages users and users' access rights, as well as the profile settings. For instance, a user can have a limited time slots rights to access the room (every Monday from 14h to 17h). This can be done as a regime of shifts along the day if there is a peak of occupancy and the room administrator wants to optimise the use of the space.

The Administrator also manages sensors and actuators in the system. Some hardware devices can break down. Therefore the system should identify the devices that need substitution and inform the maintenance team to do that. As soon as new hardware comes, there should be kept in a list as updated.

The interaction with the administrator should be done via a back office User Interface.This access is done in the local network on the server that is physically located in the room.