FINAL PROJECT

Autonomous Software Agent – UniTn 2021/2022

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INTRODUCTION

Thanks to the rapid development of information technology has developed a new programming where the construction of the software is centered on the concept of software agents called Agent Oriented programming. In this project there is a system model for managing tasks in smart homes using multi-agent solutions. In particular, in the house there are the agents that interact with each other and with the devices.

Intelligent agent is anything which perceives its environment, takes actions autonomously in order to achieve goals and may improve its performance with learning or using knowledge. Thank to the sensor like thermostat, lidar, light sensor and so on they are able to acquire data from the environment and they are able to interact and share the information with the other devices on the network.

This document is divided into different sections:

- Overview of the house on different levels, with a house's blueprint.
- Description of the different devices that are connected to the house.
- Metrics used to evaluate the impact of the agent on the house.
- Main Subject that interacts in the house: the agent and the resident

HOUSE DESCRIPTION AND BLUEPRINT

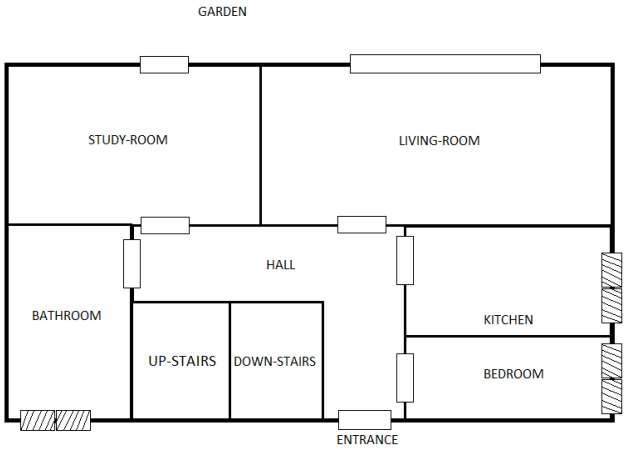
The house has one floor:

- On the ground floor is the main entrance to the house, 4 rooms, connected by a corridor. the kitchen is in the north-west; the living room is in the south-west; the study room is in the south-east and finally the bathroom is in the north-east and the bedroom.

  From the stairs it is possible to access the second floor and the lower floor, where the ceiling and the garage is located, but which has not been considered in this project.

  From the living room and the study room it is possible to go into the garden.

GROUND FLOOR



ROOMS

KITCHEN:

The kitchen is located at the ground floor. The kitchen has a wall in common with the living room and using the hall it is possible to change the rooms. For simplicity, we don't consider any smart devices like fridge, dishwasher, microwave and so on.

The kitchen has a light located in the middle of the room and two windows that allow light into the room during the day and two shutters that are used both to keep the kitchen cool during the afternoons of the summer's days and during the winter nights to help the house stay warm.

It is used by people for cooking and eating.

LIVING-ROOM:

The living room is at the ground floor, and it is the place where people relax while watching television. Light is placed in the corner between the two sofas. In addition, there is access to the garden through a sliding door and to all the other rooms on the floor using the corridor.

The shutters make it possible to keep the living-room cool during the morning of the summer's days and during the winter nights to help the house stay warm.

STUDY-ROOM

This room is located at the ground floor, and it is reachable by the hall. Over the desk placed in the room there is a desktop computer with the monitor and a desk light that is on only if the person wants to turn on. The lighting is provided by natural light thanks to a door opening onto the garden and thanks to a light positioned in the centre of the room.

The shutter makes it possible to keep the living-room cool during the morning of the summer's days and during the winter nights to help the house stay warm.

This room is used for study.

BATHROOM

This room is at the ground floor, has two opaque windows to allow natural light to enter and a light in the middle of the room to illuminate it at night.

HALL

All rooms on the first floor can be accessed from the hall. Access is through the entrance door or the stairs from the lower and upper floors.

There are two lights for illumination, and they are placed a few metres apart.

BEDROOM

Near the entrance there is the bedroom of the residents. It communicates wit hall.

DEVICES

LIGHT

Lights are the most present device in the home. They are LED, saving both money and consumption. The lights allow rooms to be illuminated at night and when needed, i.e. when a person passes by.

The lights consume 5W when turned on.

Status:

light_on() -> return on if the light is turned on, off otherwise

Actions:

turnOn() -> turns light on

turnoff() -> turns light off

Preconditions:

The lights turn on only if:

brithness_high -> false if brightness is low

someone_in_room -> true if someone is in the room

someone_is_sleeping -> false: nobody is sleeping

SHUTTER

Shutters consume 300W when closed or opened.

The living room and study room shutters are closed in summer from 8 a.m. to 12 noon. While the kitchen shutters are closed in summer from 12 noon to 4 p.m. While every day of the year, the shutters in all rooms are closed from 10pm to 6am.

Status:

is_open() -> returns true if it is open, false otherwise

Actions:

openShutter() -> if the shutters are close, it opens the shutters

closeShutter() -> if the shutters are open, it closes the shutters

getRoom() -> returns room

SOLAR PANEL

Solar Panels produce 2kW per day from 8:00 to 18:00.

It is a passive device.

Status:

status()-> returns active if it works otherwise inactive

Actions:

activate() -> simulate the production of the solar panel and update the energy production.

inactivate()-> simulate the no-production of energy

VACUUM CLEANER:

It moves between rooms and cleans them if dirty.

Actions:

Suck() -> it sucks the rooms.

Move() -> it moves between rooms.

PRINCIPAL DOOR:

Automatic closing of the entrance door at 23:00.

Status:

is_open() returns open if it the door is open otherwise close

Actions:

open() -> if the door is close, it opens the door

close()-> if the door is open, it closes the door .

METRICS

Cost of Electricity

The cost of electricity varies depending on the time of use. Three bands can be distinguished:

- F1: these are the peak hours from 8:00 to 18:00; Monday to Friday, excluding national holidays.
- F2: runs from 7:00 a.m. to 8:00 a.m. and from 7:00 p.m. to 11:00 p.m. Monday to Friday and from 7:00 a.m. to 11:00 p.m. on Saturdays, excluding national holidays;
- F3: runs from midnight to 7 a.m. and 11 p.m. to midnight Monday to Saturday, Sundays and public holidays all hours of the day;
- F2+F3: 7 p.m. to 8 a.m. daily, Saturdays, Sundays and public holidays. This band includes the hours included in F2 and F3.

Segment	Price €/kWh
F1	0,228
F2 – F3	0,205

Produced electricity is sold at 0.05 €/Wh. The overproduced electricity is stored into batteries, when these last are full it is sold.

Cleaning Time

Ground floor

Room	Time (min)
Hall	10
Study	5
Living Room	15
Kitchen	13
Bedroom	10
Bathroom	5

PEOPLE AND AGENT

People

The house is inhabited by two people: Ivana and Marco.

Marco gets up at 6:00 every morning; he goes to the bathroom and has breakfast in the kitchen. At 6:30 he leaves the house and goes to work.

While Ivana gets up at 6:30; then goes to the bathroom and finally goes to breakfast in the kitchen. At 7:30 she leaves the house and goes to work.

They both return at 12:30 to have lunch. At 13:30 they go back to work and return home at 19:00. They have dinner in the kitchen and finally go to the living room for a moment of relaxation, watching television; finally, they go to sleep at 23:00

Agents:

House Agent:

The House agent receives and computes all the information received by the different sensors present in the house (lights, shutters, motion sensors, brightness sensors,..)

It helps people to save money as there can be energy savings by avoiding waste and to perform easier jobs:

- turning lights on and off;
- opening and closing shutters;
- Cleaning: every day at 8:00 and at 13:30
- Communicating with the other agents in the house

There is an agent for each device:

- **light_agent**: agent controlling the switching on and off of lights.

- **shutter_agent**: agent that controls the opening and closing of shutters

- **vacuum_agent**: agent that controls the cleaning of rooms

The vacuum cleaner agent interacts with the vacuum cleaner device, which is able to move around the house autonomously when a specific cleaning task is assigned. It detects the dirty in each room and the position of the vacuum in the house. The vacuum cannot clean the room if there is someone. The agent beliefset receives 'dirty room_name' and this means that the house must be cleaned.

IMPLEMENTATION

In this section I try to describe how I implement the code with the description of the source code.

SENSORS AND AGENT PERCEPTION

The sensors, other agents or the users provide information to the agents. The turn on and the turn off of the illumination and the open/close of the shutter are related to the time.

The agents relies on element that are called beliefs. Those beliefs are the representation of specific status of the environment that are known by the agents and that are stored in their memory.

AGENT ACTING IN A SHARED ENVIRONMENT

The belief of an agent can change because of an actions that was performed by the agent or by other actors that interact with the environment. For examples, the agent according to the movement of the people turn on/off the lights starting from 19.00 to 7.00 the agent turn on the light if the residents aren't sleeping, and turning off all the lights that are useless in order to avoid energy wastage. To control the fact that the people are sleeping it is enough to change the belief: '`someone_is_sleeping`' equal to true.

AGENT INTERACTION AND COORDINATION

The interaction between the agent can be for example the coordination between an house agent and the light agent, or shutter agent, or vacuum cleaner agent.

SCENARIOS

The day starts at 6:00 am with Marco that wakes up, he goes to the bathroom and then he goes out at 6.30 The light agent follows the movement of him and turn on/off the lights. Ivana wakes up at 6:30, she goes to the bathroom and then in the kitchen. Finally, she goes to work at 7:30. From 7:30 to 12:30 they are at work.

At 8:00 the solar panel are activated and at 18:00 they are disactivated. At 8:00 and 13:30 the vacuum cleaner controls if there are rooms dirty and it starts to clean. The shutters are opened and closed regarding the season that is take as a random value at the beginning of the implementation. The residents at 13:30 go to work and they come back at 19:00. The lights if it is necessary, are turned on or off. The people at 20:00 go to the living room and finally at 23:00 they go to the bedroom.

Running the scenarios - Logs
[Compact and/or extended version of logs from running the scenarios]

Additional scenario
…

SOURCE CODE ORGANIZATION

The **src** folder contains all the source code that compose the project. The subfolders of src are:

- bdi
- pddl
- planning
- utils
- houseworld

houseworld

This folder contains all the code developed to realize the project, in particular:

- BrightnessSensor.js: it contains the intention of a brightness room: the room is bright from 7 to 19.
- Device.js: it contains generic device.
- Light.js: it contains the class of a light and the intention and the goal of turn on/off the light when specific situations occurs
- Person.js: contains the definition of the person class.
- ResourceMon.js: it contains the information about the consumption of the house with intention and goal. In particular, it monitors the energy consumption of the entire house using the electricity utility.
- Room.js: it contains the definition of the room class and the intention and goal to connect the room.
- scenario.js: it contains the generation of the house with rooms, lights, devices, people, shutters and the scenario. The timer started and ended here.

- Shutter.js: contains the class of shutter and the intention and goal of open/close the shutter regarding the season.
- SolarPanel.js: it contains the definition of the solar panel class and the intention and goal of energy production.
- VacuumCleaner.js: it contains the definition of the vacuum cleaner class and also the Intention and goal like SuckGoal or MoveGoal.

GITHUB REPOSITY LINK

https://github.com/eliana97/ASA_DomoticHouse.git

(There is no a log file because I have some problem with vacuum cleaner).