Lappeenranta University of Technology
School of Business and Management
Degree Program in Computer Science

Jayden Khakurel, Toni Martikainen, Joonas Salminen, Edson Nascimento Silva Neto

EASE – ENERGY AUTOMATED SAUNA EXPERIENCE

Home Automation Code Camp 2016

Examiners: Professor Jari Porras

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Background

This report presents our project for the course Code Camp on Platform Based Application Development in Lappeenranta University of Technology in spring 2016. This time the topic of the course was home automation. Home automation is about the technology to make your home more automatic in sense of heating, lights etc. in general everything requiring energy. Making things automatic provides easy way to start saving energy and money. However, human in the end is responsible and need to learn while automation might help him. The learning happens through measurements, visualizations and persuasions.

1.2 Goals and delimitations

The task was to create a scenario to change human behaviour by measuring, visualization and persuasion techniques. The scenario could basically be anything, e.g. focusing on home, office or public environment. Then the goal was to use home automation equipment as a tools to demonstrate the scenario, measure the energy consumption and try to persuade human to change his behaviour.

1.3 Structure of the report

This report is structured in the following way. In chapter 2 we present our idea for scenario and motivation why we chose this scenario. Chapter 3 presents the solution, implemented features and the equipment setup. In chapter 4 we present our energy and cost calculations as well as the effects on human behavior as the results of using our solution. Finally, we summarize the project in chapter 5.

2 THE IDEA AND MOTIVATION

Our scenario is about a person trying to save money and energy in a single-person apartment when using a sauna. With electricity prices going up yearly and global economy in rough shape, it seems logical to start saving from one the biggest electricity consumers at home: the sauna stove. Usually, stove requires about 6-10 kWh/session with over half of the energy consumption coming from preheating and the rest from keeping the sauna warm during the session.

Energy companies usually give some general instructions how to use the sauna energy-efficiently:

- Go to sauna immediately when it's ready
- Energy-efficient temperature for sauna is 70-80 ◦C
- Avoid breaks between people going to sauna
- Avoid keeping the door open
- Keep the power on only during sauna session

Our idea is to automate some of these to make person's life easier when trying to save some energy and money. More specifically, we are going to address the first two points listed above in our solution. In addition, we are going to resolve how much one can save by installing motion detection based lighting in sauna.

In general, the problem is not that big however: current sauna thermostats control the energy consumption quite well already. Furthermore, common sense and seeing a little trouble can get you far when it comes to energy saving. Despite that, we feel like there's always room for improvement in technology. Also, people tend to be lazy when it comes to energy saving so that's where our solution comes in handy.

3 SOLUTION AND SETUP

Our solution consists of three different parts. First part is an alarm system that notifies the user when the sauna has reached certain temperature. That saves user from the trouble of having to check the temperature every once in a while. It also saves around 10 minutes of time from the heating period.

The second part is the motion sensor based lighting in the sauna room. We find it very convenient to base the lighting system on the user's motions since people usually spend reasonably short periods in the sauna room and usually forget to switch off the lights when leaving the room to cool down. A lot of people also keep the sauna lights on during the heating period so they can see the thermometer in the sauna when they check the temperature. Our system solves this problem and we estimated that the lights are on around ⅓ of the normal time.

The third part in our system is the stove heating control system that enables switching on/off the stove when needed and keeps the temperature at the level the user wants. The control system can be programmed to follow a schedule so the user is able to for example set the sauna to heat up every Tuesday from 19:30 to 21:00.

We are going to set up a TUXRADIO, equipped with Fhem home automation software, as the server which controls the whole system. For the lighting part of the system we will of course need a lamp, a switch and a wireless motion detector. For the heating and alarm system we will need a thermometer to measure the temperature of the sauna and some sort of alarm system that is connected to a switch and gets triggered on certain temperature. The alarm system can be a light bulb that switches on when the temperature is reached. The stove is also going to be connected to a switch for the automatic temperature control system. The functionalities of the system are explained in figures 1 and 2.

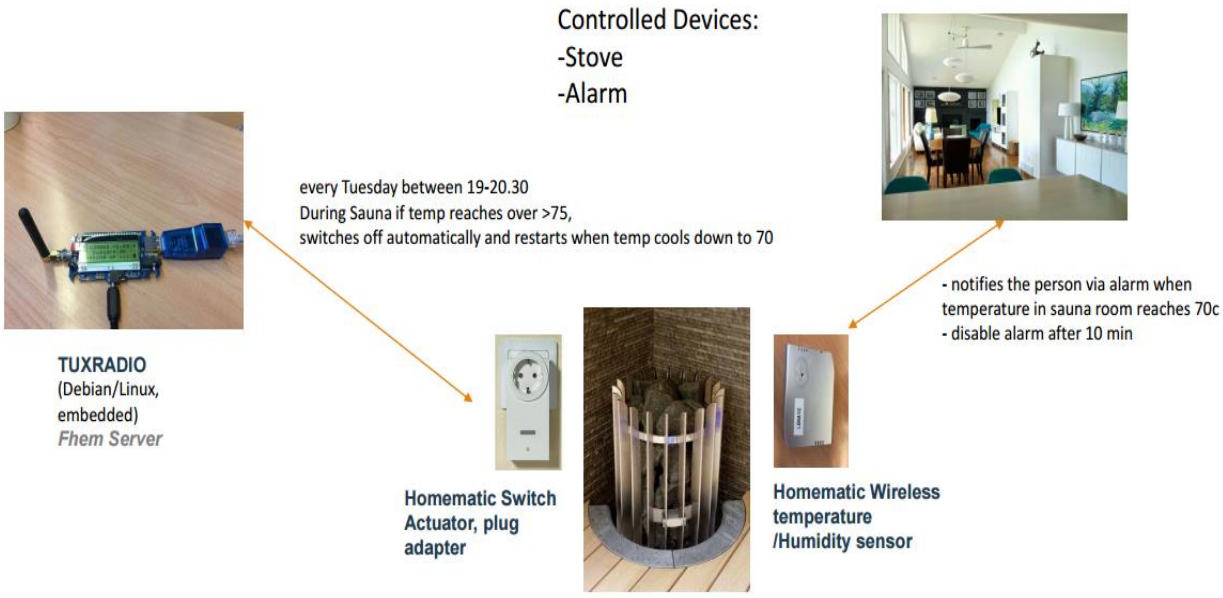

Fig 1. The control and alarm system

Fig 2. Switching on the lights based on motion detection

4 RESULTS

Since we could not test our solution in real life conditions because of lack of time and possibility to use a real sauna room and stove, we based our energy saving calculations on estimations. We measured the estimated energy consumption of our solution and compared it to ordinary sauna. With this data we were able to calculate the annual cost and energy savings. Chapter 4.1 presents the calculations.

4.1 Energy and cost calculations

Calculations are based on the scenario where person uses the sauna 7 times a week for 1.5 h (1 h for warming the sauna to 80 °C and 0.5 h for the sauna session itself) every week during the year.

We assume that the energy costs 0.12 €/kWh which is the average price of household electricity in Finland [3]. We also assume that the power of the stove is 6 kW and we know that the lamp's power is 0.053 kW.

Stove

Normal situation: Let's assume that without alarm the person would go to sauna 10 minutes later than with alarm and thus waste energy.

6 kW * (1.5 h + 10/60 h waiting time) * 0.12 €/kWh * 52 weeks * 7 = 436.8 € in a year

Our situation:

6 kW * 1.5 h * 0.12 €/kWh * 52 weeks * 7 = 393.12 € in a year

So the saving is about 44 €/year.

Lighting

Normal situation: We assume that the light is on during the heating phase and sauna session itself.

0.053 kW * (1.5 h + 10/60 h waiting time) * 0.12 €/kWh * 52 weeks * 7 = 3.86 € in a year

Our situation: We assume that the motion detecting light is on for 22 minutes (two 4 minute cooldown breaks) during the whole session

0.053 kW * 22/60 h * 0.12 €/kWh * 52 weeks * 7 = 0.84 € in a year

So the saving is about 3 €/year with one lamp.

Total

Thus with our system **the total savings are about 47 € (~392 kWh) in a year.**

Cost for the equipment:

HomeMatic 131776 Wireless motion detector Indoors: 65 €

HomeMatic 130248 Wireless switch 1-channel Adapter 3680 W: 3 x 54 €

HomeMatic 132095 Wireless temperature and humidity sensor HM-WDS40-TH-I-2 Indoors: 54 €

TUXRADIO : 40 €

Total: 321 €

One time investment. Return of Investment (ROI) : 321/47= 7 years.

4.2 Effects of the solution to human behavior

Our solution has some minor effects on human behavior. User can easily schedule the sauna to heat up and switch off whenever he wants using the scheduling system of our solution. Thus he does not manually have to switch on the sauna when he wants to go there, although this is also possible with our system. When heating up the sauna the user does not have to check the temperature of it every once in a while because he can rely on the alarm system. Also switching the lights on and off manually becomes unnecessary since our system takes care of it. In fact our system causes little less effort for the user to go to the sauna while also saving energy. It is definitely a good solution for lazy people.

The impact of our solution is quite small in the end. Energy prices in Finland are relatively low so the cost savings would not be that high. The alarm system could have a big impact for the people that switch on the sauna and then forget to check the temperature for a long while. The system could save significant amount of energy and money for these kind of people.

5 SUMMARY

During this codecamp our group has designed and developed an automation system to tackle a number of social and economic problems regarding the use of saunas in Finland such as, for example: hyperthermia due to over staying in sauna (for reasons of unconsciousness caused by the effect of alcoholics, medicines and etc.) that causes 30 to 40 deaths every year in this country. And unnecessary consumption of energy in times when the sauna stove is turned on even though it is not being used.

Our team has developed a 3-component system with the main goal of providing awareness in cases of over staying. Persuasion and awareness in cases of absence, and also energy saving in the last case previously mentioned. In order to be able to provide those services, we make use of the FHEM automation server, that through a radio platform TuxRadio (Debian/Linux) equips users with interfaces (smartphone apps, telnet or TCP/IP) for controlling many house appliances. In our project, we've interfaced these communication elements with three main components (house appliances) making use of the HomeMatic device protocol on our system: motion sensors that enable the system to evaluate the sauna place for presence. Stove heating control to be controlled by our system to keep the temperature at acceptable (energy-efficient) levels. And alarm system (initially, we use light switches) to provide awareness for the user.

The EASE system switches the sauna on automatically at specific times and days previously inputted by the user on the interface, and notify him/her via alarm when temperatures are acceptable (usually when it reaches 70º C). It also controls the lights inside, keeping them on if continuous movement is detected inside an active sauna, turning them off if movement is not detected during a certain period of time.

Therefore, if we make considerations about energy saving and investment, and look at the calculations previously made, the EASE system can provide a yearly saving of 47 euros, thus, the system's return of investment is predicted to happen in seven years, given the cost of 321 euros of the system.