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|  | Smart Fridge  *‘Science fiction’ in the ‘Smart kitchen’ - Seesam* |
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# Introduction

We are both third-year students from ‘Artesis Plantijn Antwerp’ in Belgium. When we saw the opportunity to go on Erasmus to Oulu in Finland and do our Bachelor-project there we did everything to make it possible.   
Here we are, and we are very thrilled about the project we finally got!

# The project

The project we are doing is a daughter-project of a bigger project of two years to put some intelligence into the ordinary kitchen (Seesam). We have the privilege to be the first two students to contribute to this project.

As stated in the title, we will delve us into the smart refrigerator!  
Wouldn’t be awesome if your refrigerator knew more about you, your habits and products?  
Well, that’s exactly what we will make for you!  
  
The main idea is to make a refrigerator that will know who’s using it, what he may and what he may not eat and even what’s in the refrigerator. The refrigerator will know this based on the current properties of the user (User-input, Readers, BMI-calculator …)

*This project was given with the purpose to have a mostly practical end result.*

# Acknowledgements

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# Github

To maintain the structure, workflow and to easily monitor the project we have made a repository on Github for this project. As requested by our project managers the Git is public for further enhancements in the future by other international students.   
You can find the repository on:   
<https://github.com/OAMK-Smart-Kitchen/Smart-Fridge-OAMK>

1. Personal information - project participants



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Tom MampaEY

|  |  |  |
| --- | --- | --- |
| EDUCATION |  | 2015 (Jan-Jun) Erasmus - ICT - OAMK University of applied sciences  2012 – 2015 PBA- Electronics – ICT - AP College of Antwerp  2010 – 2012 Electronics - PTS Boom  2008 – 2010 Electro Mechanics - PTS Boom 2005 – 2007 Basic Technical School. - PTS Boom |
| Completed courses |  | 2015 English language test to participate Erasmus: C1  2012 JINTRO-course: Group and independent-education  2012 Drivers license: B  2010 Drivers license: A3  2010 VCA-proof: Safety checklist course for contractors |
| INTRESts & sidelines |  | Head of the SanLuce Summer-Festival (coordinator: 2012 - 2014)  Comenius projects (Spain, Italy, Germany,…)  Scout leader (My totem: ‘Persistent Markhor’)  Sports: kayak polo, bouldering, rock and wall-climbing, Ultimate Frisbee  Volunteer (11.11.11, … ) ICT-experience: C#, C, Flash, Java, HTML, CSS, Visual Studio, Network M. Electronics: PCB-Design (Eagle, Easy-PC), Wireless, Arduino, EasyPICv7, … |
| JOB-Experience |  | **Belgocontrol navigation (BRUSSELS Airport)**  Jul 2012  I did my internship for secondary school here. We were responsible for the systems and communication for all airplanes in Belgium. It was a very nice and instructive experience to be able to do my internship in such a secure and professional company.  **ZAMPASS (Digital crowd management)**  2011 – 2014 (job-student)  A professional service for scanning and managing entrance tickets of big events and festivals with barcodes and RFID. (Refs: Tomorrowland, Rock Werchter,  TW Classic, …) |

# The idea’s and brainstorm

Because we only got a title, and a few start-ideas, of the project we were totally free implement the technologies and features in the fridge that we wanted. This gave us a lot of freedom, but also took a lot of time for research , brainstorming, achievable/serviceable technologies and thinking about what would be handy and what the user would like to have extra in his/her fridge at home.

* User recognition:   
  + **Fingerprint reader in handheld:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Very unique (for each person) | You have to touch something |
| Reliability | Difficult with wet fingers |
|  | Waiting-time |

* + **Active RFID key-hanger or card:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Detection on distance | Physical object |
| Multiple use and handy | Can mix up multiple users |
| Cheap |  |

* + **Kinect face-recognition:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Challenging | Delay(?) |
| Automatic recognition | Height of camera |
| International team-work | Complex |

* + **Face-recognition Raspberry-Pi:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Automatic recognition | Delay(?) |
| Cheap | Height of camera |
|  | Reliability |

* + **Voice-recognition:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Accessibility | Complex |
| Cheap | Reliability |
| Fun |  |

* + **Motion-detection:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Energy-saving (only on when motion) | No direct user-recognition |
| Cheap | Reliability |
| Easy |  |

* Product recognition and recommendation:  
  + **Barcode-reader:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Existing databases | Finding a fast way to scan it |
|  | By hand |
|  | Takes time |

* + **NFC-tag:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Wireless | Attach on the products/tray |
| Stickers are cheap | Reader on every place |
| Place-independent |  |

* + **Mechanical detection/hatches:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Overview and organization | Moving parts |
| Reliability | Expensive |
| Not possible to take other product |  |

* + **LED’s/ LED-strip:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Clearly what product it is | User can take other products. |
| Colors for good and bad |  |
| Fancy |  |

* Health-detection:
  + **Integrated scale:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| User-assuredness | Big surface-area |
| Possibility to calculate BMI | View |
| No extra action required (for user) |  |

* + **Personal point-system (based on earlier snacks):**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Motivating for users | Requires many properties of user |
| Competitive |  |
| Possibility to turn off feature |  |

* + **BMI-calculator:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Easy calculation | Requires (many) properties of user |
| User can compare to average | Frustrating |
| Possibility to turn off feature |  |

* Communication/Platform:
  + **Raspberry Pi:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Performance | Limited hardware ports |
| All-in one computer |  |
| Internet-connection |  |

* + **Arduino:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Perfect test-device | No internet-connection |
| Many possibilities | Limited hardware-set |
| Cheap |  |

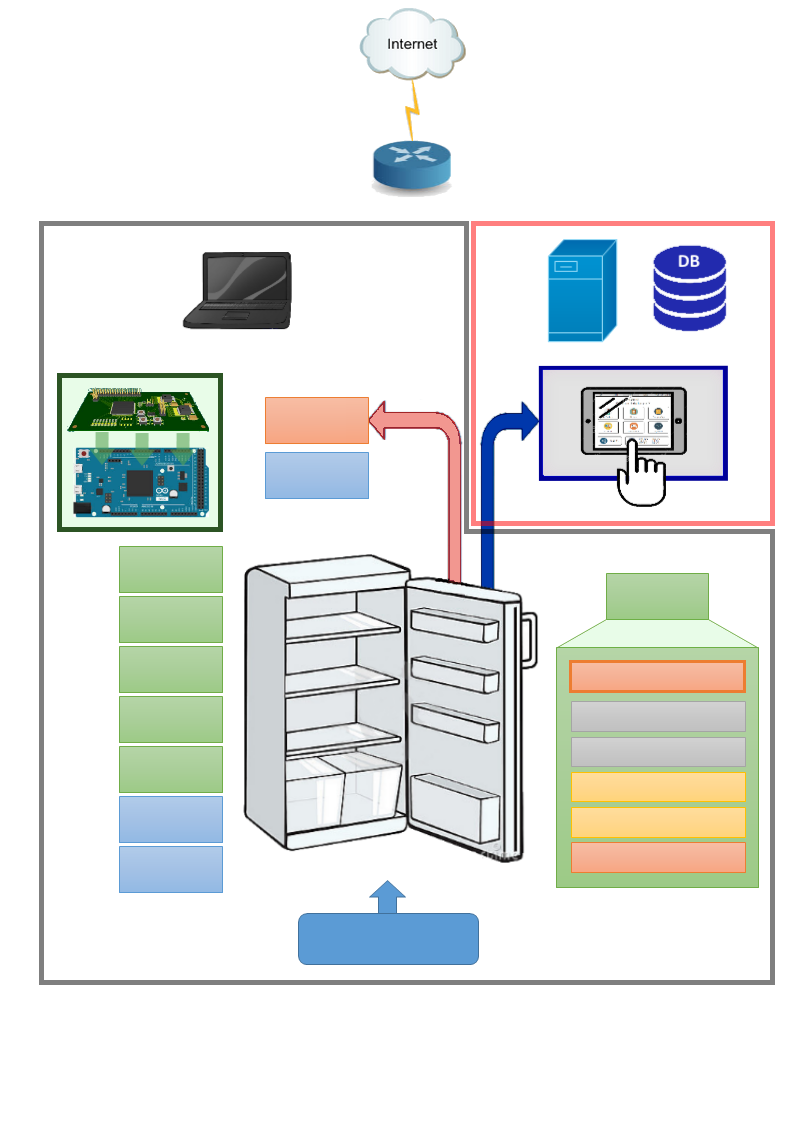
* + **Wi-Fi and Ethernet (LAN):**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Connected devices | Security |
| Software updates |  |
| Monitoring |  |

* + **Bluetooth:**

|  |  |
| --- | --- |
| **PRO** | **CONTRA** |
| Peer-to-peer | Not always reliable |
| Not connected to the internet | Possible delays |
|  | Can only connect 2 devices at once |

1. Conclusion in high-level schematic

After lots of research and discussing about what are the best technologies, and what is realistic in this amount of time we came up with this as the best starting idea:

**...**   
Up to 127 different devices on the same I2C-bus.

(Serial) Level - convertion

RGB - LEDSTRIPS

Addressing + LED driver

NFC reader

Addressing + NFC driver

I2C - Protocol

**Products with NFC-tags**

**Product   
Module 5**

**Product   
Module 4**

**Product   
Module 2**

Server Database

**UI/Server side**

**Embedded side**

**Product   
Module**

Temp. IN 2

Temp. IN 1

**Product   
Module 1**

**Product   
Module 3**

Temp. Out

Motion sensor

Tablet

Custom PCB + DUE

Computer

Router

1. Estimated Gantt-chart:



1. Embedded systems

As the embedded developer I had to figure out which components, set-up, technologies and systems were most appropriate for this application and for extensions in the future.

* 1. NFC-tags

After lots of research of the different possibilities I found some articles on the internet that we are considering to replace barcodes on products by NFC-tags to make it much more user-friendly and the more research I did the better this technology got.

* + 1. What is NFC and how does it work

NFC stands for **N**ear **F**ield **C**ommunication and allows phones, tablets, and laptops to share data with other NFC-equipped devices. The technology evolved from radio-frequency identification (RFID) tech. RFID

* + 1. Reader and Research

* 1. I2C Serial Bus-System
     1. I2C-protocol

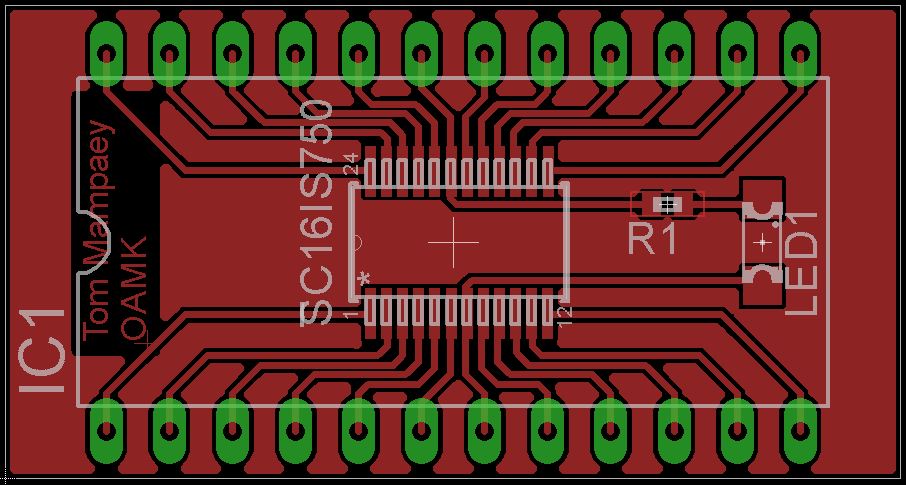
Adresses  
I2C( zie datasheet SC16IS750: p 37 to 40 SCL SDA,... en PCF)

I2C, bit van adress doen omdat Wire-lib werkt met 7 bits (schrijf en leesbit wegdoen) zodat het onder 124(?) blijft

<http://playground.arduino.cc/Main/WireLibraryDetailedReference>

Alle mogelijke devices aan verbinden.

I2C- BUS (serial connection, two little wires, control them all!) up to 127 devices (more then products fit in your fridge)  
Beautiful thing about is that you can now add any device you want (temp, calorimeters, product alarms, YOU NAME IT!)

* + 1. Options
  1. LED indication
     1. Why
     2. RGB
  2. External sensors
     1. Ultrasonic User-detection
     2. Temperature sensors
  3. Surface Mounted Device

1. The Slave Modules

First started; hardest, …

* 1. Code
  2. ALGORITHM

Filtering (pic), multiple algorimes, and again and again,…

Time swallowing thing NFC algo

As you can see on the git hub ...  
When I finnaly tought I got it, I had to start all over again (Other problems, …)

I have written a few… Reader, Server-module, …

1. The Master Module

Controls all devices/readers

* 1. Code
  2. Translation + header  
     The brain of the fridge
  3. Serial level conversion

Problems With voltage level MAX232

MAX232, RS232,

Problem switch (UART levels to high -> new algoritme)

MEGA, DUE  
  
**Sends configerd data to OUTPUT-Bus**

1. Motion detection
2. The Wifi Module
   1. Code
   2. Arduino
   3. Connection Ping
   4. PUT  
      CC3000 M2X  
      Why external? -> Wifi shield not support DUE and must use SPI

Arduino voor Wifi apart wegens:

Master module helemaal aanpassen

Serials al in gebruik

3.3V <-> 5V signalen

Tijdgebrek om in master te integreren

Was als uitbreiding (origineel aan pc met usb)

Veel hogere baudrate

https://learn.sparkfun.com/tutorials/cc3000-hookup-guide/all

1. Custom Printed Circuit Board
   1. Print design

Pull-up resistors on SDA and SCL, filters, GND-plane

For ex. I used fet-transistors for my LED-driver (control the colors) which are very sensitive to static electricity!

When I added the NFC-readerpart the antenne made lots of interfierece by radiation of the antenna.

To eliminate that I made a realibable groundplane and added some filters.

THis were faults I didn't think about in the first place.

That's why it's good to make some testboards first!

* 1. SMD COMPONENTS!!

If you think you saw the smallest component, you didn't

Research and study evry datasheet about the operating temperature.

* 1. Start
  2. Chemicals

1. Personal project information
   1. What I learnt
   2. Distribution of subjects

Taartendiagram (Debug, code, design, algorithm, ...)

1. Optimalisations and further extensions

1 IC,

Smaler

Scale,

Intigrate muliple NFC-redaers in shelfs of fridge.

Schema’s   
PCB process  
Troubles and solutions   
I2C   
What I learned  
WIFI  
SMD  
Sensors  
Internet of things  
Smart objects  
pie-diagram  
Algorithm!! (time swallowing)   
self-evaluation

Problems:  
//Time: Kinect, xTion, Scale, Motionsensor,… 3D-printing, Fault-analyzing/Debug, more problems than expected.   
Level convertsion. UART, MAX232  
Bus system, (took a while when finnaly up and running (stable)   
Interferences on powersuply, by antenna …

1. Of-toppic:
2. Concise self-evaluation

Internet of things  
Smart objects

The extraordinary thing about this project is that we got a blank paper,

This is very nice, but also takes a lot of extra time ofc.

From now on evrything is possible depending on the demand of the client.

What started at a kitchen in this school, is now reality!

# The Annex:

Content:

NFC:

* <https://developer.android.com/guide/topics/connectivity/nfc/index.html>
* <http://en.wikipedia.org/wiki/Near_field_communication>
* <http://www.digitaltrends.com/mobile/nfc-explained>
* <http://mashable.com/category/nfc>
* <http://www.identivenfc.com/en/what-is-nfc>
* <http://www.pcadvisor.co.uk/how-to/mobile-phone/what-is-nfc-how-nfc-works-what-it-does-3472879>

Datasheets:



Images:

* Front-page image:   
  <http://www.revistaexclusiva.com/?p=25851>