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| Project Report Document  Comfort Home |
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# Document history

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# Terms, Abbreviations

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| VOC | Volatile Organic Compound |
| CO2 | Carbon dioxide |

# Summary

In this document we will explain our working process throughout the length of the whole project and explain what we have done, how we have done it and why we have done it. This report will go in-depth on our way of working and explain in detail all the steps we took as a group to deliver a satisfying product that proves useful to the end user and has good and reliable functionality.

We will start with a small introduction explaining what product we were expected to create and deliver to the product owner. The we will continue with a project overview where we explain our way of working throughout the project as well as introduce the company that tasked us with this project and explain the way our system works. After that we will go in-depth on our process of working and what we have done and how we have done it. The report will finish with our overall conclusion as well as some recommendation for the future.

The purpose of this document is to give and in-depth overview of what our group has been developing for the past five months and give some insight on our way of working and our organization for the project. After reading this document you will have a better understanding of how our overall system works and the exact steps we took to make it a reality.

# Introduction

Would you like to have a fully automated ventilation system which takes care of all the negative compounds in the air in your home, to ensure a healthy lifestyle for you? For our second semester project we were tasked with exactly that. We have built a fully automated system that ventilates the air in your home to ensure a healthy lifestyle and does not leave you worried about the whether the air you are breathing in your home is not health enough. With our system you also do not have to worry about the humidity in your living space since with our system you will never have problems with mold or condensation.

Throughout the last five months we have been working on realizing such a system and make the best product the user can ask for and we are happy to say that this has become a reality. Our system is robust and ventilates the air in your living space, so you do not have worry about polluted air in your home. Our product also helps preventing the chance of inhaling any unwanted particles in the air to keep you healthy at all time.

Throughout the course of this project our team members have been working on turning this task into a reality by creating a system that uses different types of sensors that send their collected data wirelessly to a ventilation box that runs those reading through an algorithm and controls a fan based on those readings to ensure a good enough environment in your home. The ventilation box has some other useful features that we are going to explain in this document.

In the following report we are going to explain how our ventilation system works and how it benefits the users of it. In chapter 2 we are going to give you a small overview of the whole project as well as a small introduction of the company that gave us this project. In chapter 3 we are going to explain how exactly our system works and why does it work the way it does. In chapter 4 we are going to give our conclusion and recommendations.

# Project overview

Throughout the course of this project, we have been applying an Agile way of working. We did that by having weekly meetings with the product owner in which we showed our progress so far and based on the feedback we received we planned on what we should do for the weeks to come. By using this way of working we ensured that we are always in contact with the project owner to make the project to their liking and standards. Our team also held weekly meetings in which tasks for the upcoming sprint were divided and organized. To keep track of everyone’s tasks we used a scrum board in which everybody could see their personal tasks and the time slot they had to complete them. By using the scrum system, we kept track of everyone’s work on the project and whether they complied with the given deadlines.

The shield module provided to us by the company of Airios has three different sensors and a ZigBee module (used for wireless communication). At first, we had to research how all those hardware components work. We read through the datasheets (Datasheets) of each individual component for fully understand how it works and how it could be coded and implemented for our project. After all the research had been done, we started implementing those sensors in our application so we could send their readings to our ventilation box.

## 2.1 About the company

This project was given to us by the company of Airios which specializes in state-of-the-art climate control for homes and buildings and has different products that can contribute to keeping your home in a good condition. The company gave us a shield on which multiple sensors were attached as well as a ZigBee device (used for wireless communication with the ventilation box). We had to research all the hardware that was given to us and use it for our implementation of the project.

## 2.2 About the system

Our system uses four different sensors: A temperature sensor, a humidity sensor, a CO2 sensor (Carbon dioxide) and a VOC sensor (Volatile organic compound/Particulate matter). We believe that those four sensors are perfect for assessing the air quality in your home and giving us the readings, we need to make sure that your living space is well ventilated. The readings from these sensors are sent to our ventilation box wirelessly over a ZigBee module and are used to regulate a fan which ensures a healthy environment in your home.

# Procedure and Results

## 3.1 What we have done

We have created a system which uses one or more sensor modules connected to a simulated ventilation box to measure the air conditions of one or more indoor spaces to decide the speed of a simulated fan. We believe what we have created can truly offer a good user experience that leaves the end user satisfied so they do not have to worry about any inconveniences that might lead to an unhealthy life due to the air in their home being not ventilated well enough.

The system was built over the course of 5 months by dividing the system into smaller components which were built either separately or cumulatively by multiple people. Here is a list of the major components which combine to make the fully functional system:

* CO2 sensor class,
* GUI,
* VOC sensor class,
* Zigbee communication handler,
* Zigbee communication viewer form,
* Chart generation and viewer,
* Communication error handling,
* Communication protocol method (Nucleo and C#)
* Fan class (algorithm),
* Fan speed indication,
* Humidity sensor class,
* Led support,
* Multiple room support,
* Reading CO2 Sensor data,
* Reading temperature and humidity sensor data,
* Reading VOC sensor data,
* Registration to ventilation box,
* Sending data to ventilation box,
* Sensor module handler,
* Sensor parent class,
* Temperature sensor class,
* User determined threshold setting,

Every team member contributed with the creation of those components and conformed to the schedule we had set for developing these essential parts of our system.

## 3.2 How we did it

The first step was making a project plan (Project Plan) in which we defined the organisation of our project group and laid out the use cases and actors to help us design a system that would work optimally for the end users. The organisation of the group involved assigning certain responsibilities to group members and defining a protocol of communication within the group, this is done to decrease the chance of misunderstandings within the project group.

Diagram

Description automatically generatedThe next step was making a system design document (System Design Document) where all the functionality of the completed system is described based on the use cases from the project plan. The document lists the use cases, hardware components, communication method, and diagrams as an elaboration on the individual functionality of these components within the system. In Figure 1 our system context diagram can be seen, which explains how our overall system works:

Figure 1 – System Context Diagram

After all of the documentation had been reviewed and submitted our group started working on developing the actual system. Firstly, we had to read all of the datasheets that were provided to us to fully comprehend the capabilities of the hardware we had. After thoroughly investigating the datasheets we set our goal on developing codes for all of the available sensors and testing them. After realizing that all of the sensors worked correctly, we started designing our ventilation box simulated through C#. When the initial design of the GUI was completed with set out on making different sensor classes as well as a fan class in which we set the according data readings and designed an algorithm which took those values in consideration and base on them determined how the room should be ventilated. When that was done, we began collaborating with the other groups to come up with a reliable and robust protocol (Protocol) that handled the ZigBee communication. After the protocol (Protocol) was designed each group had to implement it in their own program. By using the same protocol (Protocol), we ensured that multiple sensor modules could be connected to the same ventilation box. Those sensor modules act like different rooms in your home. The protocol (Protocol) consists of different commands we send which allow us: to register modules in the ventilation box, to send the data over certain interval of time and also send spikes whenever a sharp increase is recorded in one of the data readings.

After the protocol (Protocol) had been implemented, we started tweaking our code and making sure that the functionality of it would be good. The GUI we have is simple for a user to navigate through and understand, we also added graphs for all of the data readings so they could be monitored over time. Another feature we added to our system is to allow the user to set their own thresholds for all of the different parameters so they could modify their ventilation exactly to their liking. Whenever any of the threshold settings are changed, they will be remembered so the next time the user wants to change those thresholds again the value of the previously set threshold will be remembered and displayed.

After adding all those features, we were finally satisfied with the product we had created, and we felt ready to present it in front of the product owner and the company that had tasked us with this project.

## 3.3 Why we did it

We believe the product we created will satisfy the end user and all the different features we implemented would benefit the user and enhance the user’s experience overall. The threshold feature makes it easier for the user to set their desired parameters and feel comfortable in their own home while the ventilation system takes care of everything. The graphs make it easier for the user to track different values in the room over time (temperature, humidity, CO2, VOC). The ZigBee protocol (Protocol) we created is reliable and considers all the important messages we need to send to the ventilation box and has a robust error handling that considers all the problems we might have when a message is corrupted or when an unregistered module tries to send data to the ventilation box so any unnecessary interference in the communication between sensor module and ventilation box is avoided.

# Conclusions and Recommendations

## 4.1 Conclusions

The objective of this project was to provide a proof of concept that proves that a climate control system can be developed using Zigbee as a method of communication. The fact that the system functions as intended proves that it can be done. ZigBee was initially hard to use, but after some experiments we got it working. There was one problem that we (and the other groups) never managed to solve, which is that to connect the module to the ventilation box, the ID of the dongle needs to be hardcoded, which is not an option for a commercial product. Aside from that we are happy with the final product we managed to deliver, and we believe that it will provide the end user with a truly satisfactory experience in which they do not have to worry anymore about the air quality in their home.

## 4.2 Recommendations

A possible topic of further research could be finding a way to deliver the id of the dongle to the module without hard coding the value. We also believe the use of a ZigBee module to establish a wireless connection is not the most reliable way to transfer data to the ventilation box, due to the internet being of such huge importance in today’s society, we believe a better way for the wireless connection would be through some sort of internet connection, whether that would be using an ESP module to send the values of the sensors to a remote server from which the ventilation box would be reading them or any other way. With all of that said, we still believe that the ZigBee proved reliable enough for the goal that this project tried to reach.

# References / Literature list

Datasheets:

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