

Summary of results and potential improvements:

How to address these potential improvements: **INFOB3IT 2022/23**

Assignment 1

Group 23:

Student name:

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Type: Group work

Deadline:

Submit: Blackboard

Evaluation: Graded

Description

You need to write an 8-to-10-page paper which describes the functional and technical features and details of your smart interactive automatic toilet freshener, including the process of building it and a reflection on its success (or lack thereof). This description allows you to elaborate on the topics covered in your video. Use it to add detail to these topics and/or cover subtopics which could not be covered in the video, time-wise. But please make sure that the description can be read stand-alone: if one only has the description, it should be clear what you've built, how you've built it, why you've built it that way and whether you think building it was a good idea.

Be sure to include a state diagram of your system (no specific format required). Please do add pictures to illustrate certain points. For teams of three this is also the place to shine and reflect on your experience with two installations of your system. Report on your user needs gathering exercise (write who your participants were, how you recruited them and how you gathered data). Include your context of use and requirements specifications. Similarly, report on your heuristic evaluation.

NOTE: This is a template that can be used to deliver your work. However, you can use other formats, if you prefer as long as you remember to write your group number and student names and adhere to the description.

Context of Use Description

User Needs Gathering

Explain how you conducted your Context of Use research by eliciting from your first Assignment (0). Describe how you carried out the study and what research questions were asked in the interview/questionnaire. This section describes your research goal and the study setup.

User needs gathering: For this assignment, we conducted a survey to ask our target audience about their opinion regarding automatic air fresheners. In assignment 0 we constructed the following questions:

1. Which air freshener type provides a better user experience in terms of ease of use, effectiveness, and overall satisfaction?
2. What are the features or functionalities of smart air fresheners that are most valued by users, and how do they impact the user experience?
3. How do the environmental factors such as the size and lighting of the bathroom impact the user experience of air fresheners, and are there any specific design considerations that need to be taken into account to optimize the user experience in different environments?

We decided that we primarily wanted to ask the first and second question as the third question was too specific for the sole purpose of gathering information on the users.

Generally, the people who we enquired about question one are quite divided (see appendix B4), yet we still are destined to pursue this prototype. Furthermore, users would mostly want to see a simple and easy to use design. Therefore in the following sections we will describe further how we get to work with the user needs

Target group

Explain which groups of users you identify for the prototype. These groups can be the main target groups as well as secondary ones who will interact with the device. Describe what is the context their share and what are their primary activities (e.g., students sharing toilets from the University building).

Main target group: Our main target group is primarily people living in a house with a bathroom that is described in the physical-section below heading 'Environment of the System'. Preferably, the types of people we test on are diverse given that we would like to have as unbiased results as possible. This would mean: families from three to five people, but also student houses with the same capacities. We will only conduct surveys on the adults of the test subject, but this does not exclude other inhabitants from exposure to our prototype

Secondary users: As for the secondary users of the prototype, we are primarily looking at visitors for the main target group. The subjects that fall in the group of secondary users will not be asked about their experience with our prototype.

User characteristics

Specify your users' characteristics such as age, height, and gender. You can specify their behavior/habit if relevant to the study.

User characteristics:

Physical characteristics: as for the physical characteristics, age is not as much of a problem here. Let's assume for the sake of it however that the user is of age that they are able to use the restroom by themselves, without any third-party help. Put in a definition, our users are of age that they are potty trained. We are aware of the fact that this does not answer the question, however we want to point out that there is no precise age for which an individual suddenly is potty trained. However, we would prefer if all users are adults which of course would mean that they would be 18+. This would then infer that they are eligible to fill in our questionnaire(s).

When it comes to the height of our users, we require our users to be of a minimum height of 1.30 meters tall.

Despite differences between how men and women could perform a number 1, we do not concern ourselves with these differences.

Behavioural characteristics: We assume that our users do not use the toilet for comfort time. That means, they do not use the restroom to scroll their phone tirelessly, or that they bring a book while serving their private time.

Goals and Tasks

Explain what are the goals of your prototype development and study. Clearly list what are the features expected from the device and in which scenario context they are needed.

The core purpose of the air freshener is to purify the air in the restroom by releasing a spray of fresh scents in the air whenever someone made their visit.

For our prototype we had a couple of features in mind. First of all, one of the user-requirements was that the user had to be able to keep track of the amount of sprays left before the canister had to be changed. Therefore, we put a counter of the estimated amount of sprays on the little LCD-screen so that the user can decide when is the best time to change canisters. An additional feature that is related to this feature is that after a change of canisters, the counter should be reset to 2400, therefore it's also expected that the prototype has a feature that resets this counter.

The base prototype has a standard delay between power-on and spraying of 15 seconds. However we want to be able to have the user decide what the delay should be. If a user is very slow with finishing up and vacating the premises then it could be possible that the user needs more time between the moment of power-on and spraying. Thus, an expected feature from this device is a configurable delay between spraying. This delay won't get below 15 seconds, however.

In order to easily configure the abovementioned settings, the prototype is expected to have an LCD-screen and two push-buttons for navigation.

The above features are all expected to be manageable through the use of buttons and the LCD-screen.

Furthermore, in case of a malfunction we want to be able to reset the prototype. In that case, the user should be able to press the designated controller-buttons and, after a delay, it will spray once. After this spray the prototype returns to its 'not in use' state.

We also asked the target audience their opinion on what they would look for in their prototype. 5 out of 5 people who filled in the questionnaire said they are fond of the idea of hiding the electronics in some form [appendix A2]. Therefore, it is expected to have some form of casing for our prototype.

Lastly, our last goal is to make the device more user-friendly towards people without knowledge on electronics. The prototype normally requires the user to tape a wire to the flat end of the battery (appendix A1). In order to improve the user-friendliness of our device, we aim to construct a contraption in which the user should only be required to replace the battery instead of having to mess around with wires and tape.

Environment of the System

Write about the 1) technical, 2) physical, and 3) social constraints of developing the toilet freshener considering the context of use, users, and target groups. You can write a paragraph for each of these three aspects of your product development. You can support your description with figures and schematics of the environment of the system.

Technical: For our technical constraints, we assume a maximum time of 15 seconds that is required to open and close the door. We do this in order to be able to distinguish between the use cases of a number one and two, and cleaning.

Use: the device needs constant power supply in order to be functional. One difficulty in this matter is that the setup requires constant electrical throughput.

Physical: Our first physical constraint is about the size of the room. We will conduct the experiment in small bathrooms, measuring between two and six square meters. Furthermore, for our design we also have the constraint that the bathroom is only lit by non-natural lighting that only comes from the room itself.

Another physical constraint is that the door remains open whenever the toilet is cleaned. Given that the space for a toilet is relatively small, we figured that it would be rather difficult to clean the toilet whilst the door is closed.

The third physical constraint is about the placement of the device. The device will be placed above ground-level.

Social: Our first social constraint is that we assume that all users of the toilet almost always close the door and turn off the lights after their use. This has as primary reason that it is easier to reason about the program logic and distinguish between the different use cases (not in use, number 1, number 2 and cleaning). Besides, it's not comforting to have the smell of the restroom somewhere else in the house. We assume that this happens in about 97-99% of the cases.

Not per se a constraint, but something we still want to address nonetheless: we do not limit the number of users in these bathrooms, as this might influence the comparison with the regular, normal, everyday experience.

Requirement Analysis

List 1) client requirements (functional needs of the users e.g., not spraying when cleaners are working), 2) usability requirements and objectives (e.g., system designed to be intuitive, reliable. Possible ways to gather more usability needs from users), 3) requirements derived from user needs and context of use (summary of the system features evaluated by the study participants).

1: client requirements

For our users, it would be trivial that they would not appreciate it if they were to be sprayed on while they are doing their private business. Therefore, the device will not spray whenever there is someone in the room. Also, there should be a delay between the end of a use (i.e. a user leaving the room), and the spraying.

Another functional need the users have, is that the toilet is not sprayed when the cleaners are working (or afterwards, when they are finished cleaning).

Furthermore, the device should keep track of the state it is in, and it should be possible to configure the top-level settings.

Lastly, our clients want to be able to easily change canisters and batteries when necessary. (see appendix B3)

2: usability requirements and objectives:

We want our system to be designed in such manner that it takes no or not much effort in order to get used to working with the prototype. Furthermore, we want our interface to be easily controllable and visible.

3: user needs and context of use:

In order to actually find out what our users would like to see most in the product, we conducted a survey to gather the needs of our users.

First of all, a materialistic matter: 80% of our users want the prototype to be out of plastic. (see appendix B2)

Also, our users do not want to be required to work tirelessly with the setup. They mostly either want to change some settings or in some cases only even change the battery and/or canister (see appendix B3). Therefore, we aim to provide both. We aim to construct a contraption that ensures that the user only needs to replace the battery when it's empty instead of also having to add tape and wires (see appendix A1). Also, we aim to make it possible to configure the delay between sprays.

Functional and Technical Features

Describe how the system addresses the above-mentioned requirements and what other features it provides. You can make use of tables to describe the system states and how they are mapped by the prototype sensors/actuators (e.g., LED color/pattern).

In order to avoid getting sprayed on (either while cleaning or while doing your toilet-time), we constructed that the device's wait-time starts when the light turns off. This way we ensure that the user left the room when there's being sprayed. The device also keeps track of the state using LEDs. In order to differentiate between the different states, we use an RGB-LED for demonstrating the different states. The following colours represent the following states: Not in use: off (for energy saving-reasons), state unknown: Red, state cleaning: purple, state number 1: green, state number 2: blue, state trigger 1 spray: white, state trigger 2 sprays: yellow and state in-menu: orange.

We made the interface easily controllable through the use of 2 buttons: In order to navigate between some of the states that are only accessible through the menu, we have setup some configurable states that the user can navigate through using the two designated buttons (the middle button is the iterator that iterates through the different menu selections, and the right button is the button that is used as a selector).

We met the first user-requirement: we used a PVC-like material as housing. Given its grey-ish color and its simplistic design it's not much of a distraction to the eye.

We incorporated a contraption in which the user should only be required to swap the battery when it would be empty instead of having to tape a wire to it. Also, the user can configure the spray delay through the menu.

Building process

Explain what choice you made to determine the use of the components available to you and the logic that you followed (e.g., Early on, we made the choice to use the light sensor as an indicator for when the user would enter or leave the toilet since it is an instant visual clue.) You can explain how you designed the menu system aided by screenshots and photos.

When we started the process of working on the system, we scanned through the requirements and the sensors that we were required to use. We thought about the different possible uses for the magnetic contact sensor. We eventually made the choice to use the magnetic contact sensor to indicate that someone flushes.

As for our distance sensor, we thought about using that for recognizing if the door is opened or closed. The distance to the door is a set distance, therefore if that distance changes with a certain proportion, there is action with doors.

Our motion sensor is used as an interrupt. Simply put: when motion is detected and the spray timer is counting down, the spray timers is halted and stopped.

Furthermore, we use the light sensor as another indicator of occupation as this is an instant clue that someone interacts with the room.

As for building the board, that consists of two parts. The first part is deciding the placement of parts and how to wire these. This was not as much of an issue given that this can be found either on the Interaction technology website or elsewhere

online. The second part however was more difficult. We did not want to expose all wires or let alone expose the breadboard. So we decided to put a large portion of the sensors on a plastic plate (see appendix-section C). We decided to place the LCD over some of the electronics and sensors, such as the temperature sensor and the mosfet. This makes the interface more minimalistic and ensures a less distracting interface. We specifically chose that position of the light sensor as well so that it has little interference from bleeding light from the LCD or the rgb-LED.

Button bus:

We make use of multiple buttons on one pin (appendices C and D1) in order to be able to differentiate between different buttons due to the fact that through each button goes a different voltage.

The menu:

For building the menu we decided to use a couple of bytes to keep track of the states of the menu. We saved the states in bytes because that is the most memory efficient way of doing this. We have a byte to keep track of the type of menu selection and one for the different types of actions in that menu. (these are called `submenu` and `menuselection` respectively).

The system:

For building the system we started with constructing a state diagram (see appendix E1). After we had the menu working we already had the function that is responsible for spraying (because we needed to test the override button). So the only thing left to do was to construct the actual logic of the prototype.

Heuristic Evaluation

Explain how you carried out the heuristic evaluation and the results you collected from it. You can use a table to list the heuristics and the results of the severity ranking for each according to the experts. Following, summarize the results and discuss potential improvements and ways to address issues.

How did we do our heuristic evaluation: We showed our prototype to three other students who also followed the course. These are our heuristic experts. After exposure to our device, we made them fill in the 'Expert heuristic Survey', of which we will also put the questions below.

In this survey: the values go from 0 to 4, where 0 has the highest level of satisfaction, and 4 connotes to a 'usability catastrophe'

Subject of question	Answer expert 1	Answer expert 2	Answer expert 3
Visibility of system status	1, you need to know it	2, you really need to know the values, it's not visible without knowledge	2, Leds are not clear
Match between system and the real world	0	0	0
User control and freedom	1, perhaps add more possible delay and/or tweakable settings	2, no extra features and spray counter only resettable	2, aside from the required features there are no additional quality of life control features
Consistency and standards	2, lcd sometimes bugs due to structural integrity	2, lcd glitches sometimes	1, it's like a Russian roulette with the lcd, sometimes it glitches but the functionality still works, it's only visual
Error prevention	2, no error prevention on the spot but it makes little errors either way.	1, hardware sometimes crashes and off-on fixes it	1, logic works, but the lcd gives visual glitches for which an on-and-off only seems to be the fix
Recognition rather than recall	1, maybe shortly show the now implemented action like a different delay or reset of the counter.	2, leds need to be known, like said earlier. Menu is really good.	1, menu is really intuitive and simple to use, and leds are a downside but is not that complex.
Flexibility and efficiency of use	0	1, Sensors resettable	1, the position of the

		which is good, but not 100% flexible	prototype requires some kind of elevation for optimal usage.
Aesthetic and minimalistic design	1, satisfied, maybe a nice cover that contains all wires	1, ductape and cutouts could've been better, but overall decent.	1, wires could've been hidden and a more clean finished casing, but for a prototype it's okay.

Reflection on success

This section is dedicated to your reflection on the prototype development process and study design.

Regarding the device: (what do our heuristic experts say?)

Summary of results and potential improvements:

Generally, we found out that the heuristic experts are quite agreeable on the prototype. To summarize: the led should be more intuitive, i.e. right now you really have to know what each state is in order to work with it. Also there is probably some hardware error so perhaps for the next prototype it would be better to construct a new prototype in order to try to avoid such hardware issue.

From a time-based point of view: we could have started earlier and perhaps also test on a LED instead on the air freshener by making it blink when it should spray. This would have changed our agenda probably for the better as we primarily focussed on the design of the air freshener and it's housing instead of the supporting software. For future projects we should focus on first developing the software and simulating it and then finalizing the product instead of first making the final product and then work on the software.

As for the survey: we did start on time. However, we hardly got any results (even from the people around us). This delayed our process while we were hunting for more survey-results. Sadly, we have to do with 5 results so that makes the survey less reliable. In the future, in order to combat this we will combine starting earlier with spreading the survey more through our networks. I think we were too critical on who our target audience was and also limited ourselves with the spreading of the survey (and thus indirectly limited the provisional amount of results).

In case we would continue to develop this prototype, we would like to add a sensor that recognises when a canister is swapped. Now the user has to reset the remaining amount of sprays through the menu, but through a sensor it could be possible to automate that process. Although that could be complex to implement, for example when someone takes out the canister to read what's written on it and puts it back afterwards, so a button simply for this purpose would also suffice.

Appendix: Diagrams and additional material such as dataset and questionnaires.

Appendix A1: visual representation of what we wanted to avoid by using our way of having the battery connected.



Appendix A2: our way to change the battery without having to rewire the system.

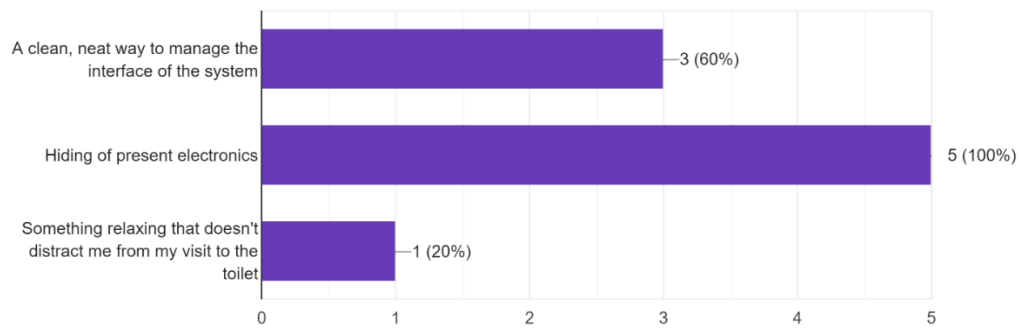
The negative pole of the battery should be taped and wired (A1). We cut off the coil and reproduced the same contraption, but as the battery as an individual entity.



Appendix B1: questionnaire answers on additional housing

If it would have additional housing, what would you look for in the additional housing?

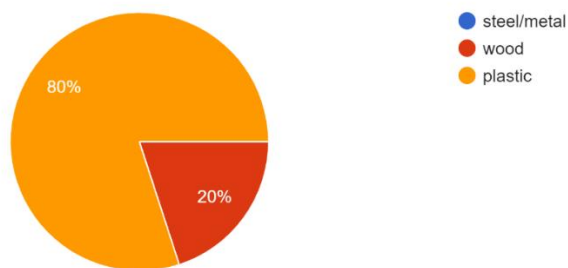
5 antwoorden



Appendix B2: material preferences of our users for additional housing

What kind of material would you want the additional housing to be made out of?

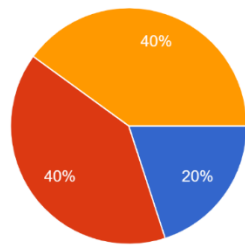
5 antwoorden



Appendix B3: The amount of maintenance users would be willing to perform for the prototype

How much extra effort would you be willing to put in the maintenance of the system?

5 antwoorden

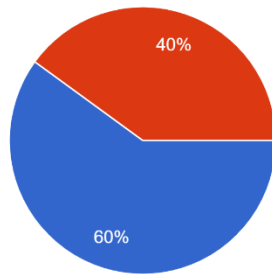


- I would want to be able to add new sensors and configure the workings of the program.
- change some top-level settings like the delay between sprays
- Only change a battery and canister when they're (nearly) empty

Appendix B4: would the users want an automatic air freshener?

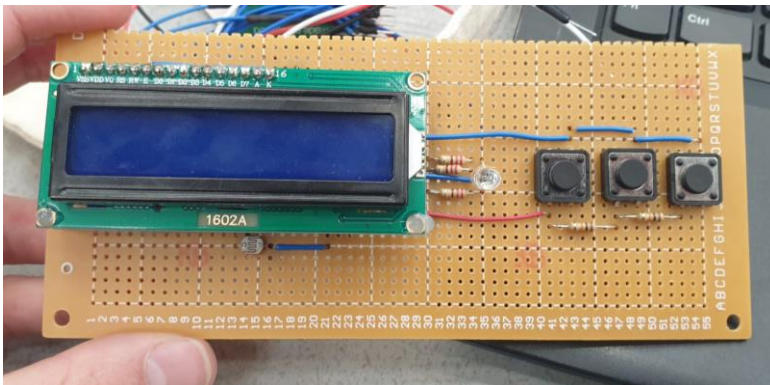
If you were to buy a smart airfreshener for your toilet, would you want a neat (additional) housing for the freshener to be placed in? With additional housig... of the whole system, not just the freshener itself.

5 antwoorden

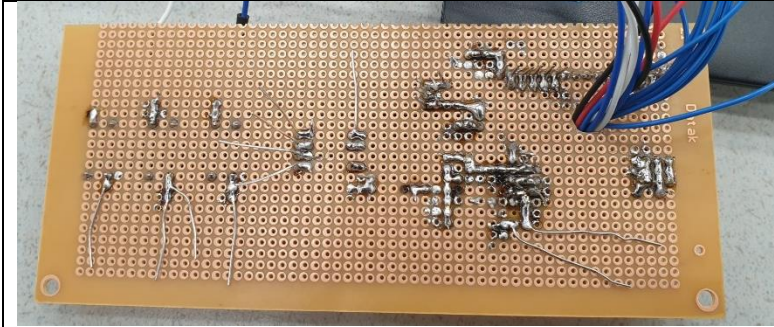


- Yes I would
- No I would not

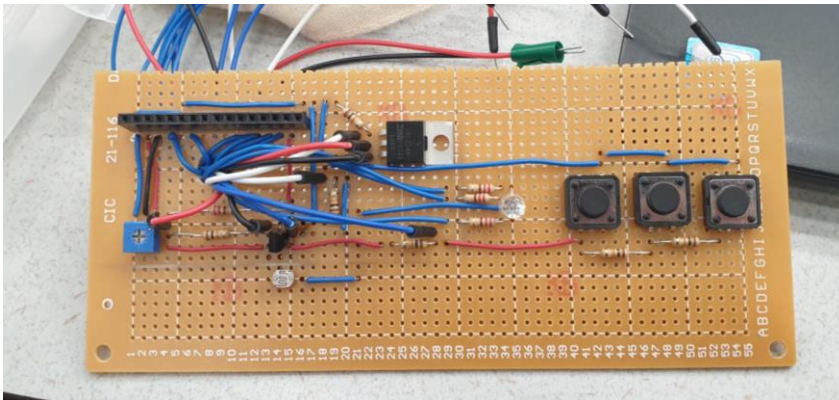
Appendix C1: Board front view with LCD in place



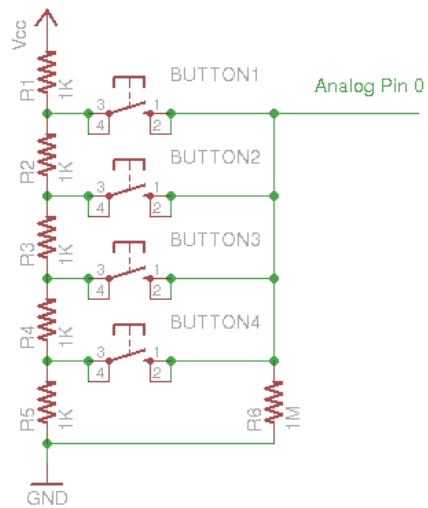
Appendix C2: Board back view



Appendix C3: Board front view without LCD in place



Appendix D1: multiple buttons on one pin ([Source](#))



E1: state diagram

