



AControl

It's just AController.

Human-Computer Interaction
@aueb 2022



Human-Computer Interaction

Project Report - 2022

Improving a User Interface

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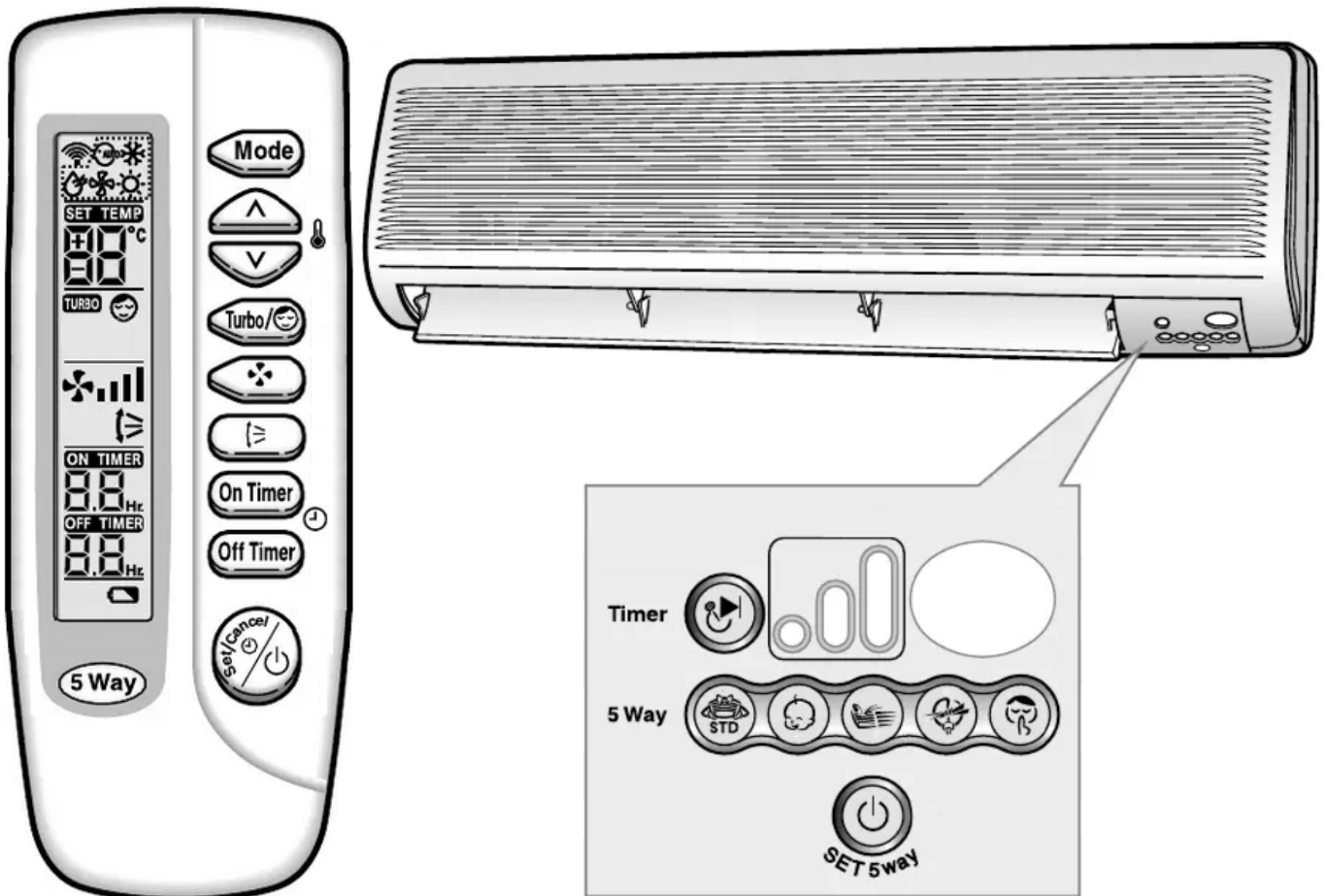
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Demo Video [here](#)

Cycle I: Initial Assessment

Device


Samsung SH12ZA1B, a Split-type Room Air Conditioner (Cool and Heat)



Issues

Remote: Display

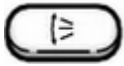


It is unclear what each **mode** icon represents, thus giving us an inadequate understanding of each mode, which in turn forms the need for someone to read through the manual. Indicatively, the sun icon  could be interpreted as both “a mode to be used when it’s sunny” as well as “a mode to be used for heat”, two utterly contradicting use cases.



The **battery** discharge indicator is on the bottom while the industry standard location is on the top right. This is a small gripe but it makes the use of the device a little less intuitive.

Remote: Buttons



The **swing** button icon is hard to interpret while the button itself is not labelled, unlike others on the remote (e.g. “On Timer” button)



Similarly, the **fan speed** control button icon is also unclear. Additionally, the press of the button cycles through the 3 fan speed options rather frustratingly. Should the user miss their desired option, they will have to loop through the rest of the options all over again.



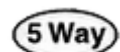
The **temperature** adjustment buttons, while intuitively placed, use a small symbol that can be hard to make out. As for the buttons, their shape is distinctive but their size is small .



The **Turbo/Sleep** toggle button is inconsistent in its symbology as it uses both text and an icon. This could lead a new user to associate the “sleep” symbol with the turbo mode, even though they are mutually exclusive.




The Set/Cancel/Power button contains 2 very important functions. They should be separated instead with the power button being the largest and most prominent button present.



The “**5way**” button allows the user to choose between 5 different modes. Rather unintuitively, it is placed on the opposite end of the main mode selection button. There is also no indication of the mode you have selected on the remote, instead you need to look at the indoor unit’s light indicators complicating operation. The whole purpose of a remote control is operating **remotely**, having to look at the indoor unit’s display beats the purpose, since it forces the user to be in close proximity to the unit.



Those different modes are indicated with some egregiously incomprehensible symbols. Take for example the baby head symbol  , it indicates the “nature” mode. For anyone to understand what the symbol and mode do, they would have to read and memorise the manual as their symbols and functions are barely if at all correlated.

Target groups

The improved user interface must accommodate all users, regardless of age, physical or mental impairment and familiarity with technology. Due to the current remote's cluttered nature, people with reduced vision may find the usage of the remote control difficult and frustrating, this is further exacerbated by the need to look at the indoor unit's poorly implemented indicators in order to determine the currently selected "5way" mode.

People with partial or complete loss of vision will be unable to use the remote control even for the simplest function, as it lacks textured surfaces which distinguish its functions. Additionally, most AC remotes are difficult to use in the dark, and when you're half-asleep.

As for people that suffer from dementia using simplistic and intuitive symbology helps them instinctively understand the function of each button allowing them to lead a more independent life.

Implementation Goals

Visually

Each function should be **separate**, there needs to be **clear** indication for each button and the design of the text and icons must be **consistent**.

Functionally

More specifically we will have the following modes. We cut a lot of the less useful or downright gimmicky modes that were added purely for marketing reasons rather than actual functionality without affecting overall functionality. This will allow the remote to be accessible to a wider array of users. More specifically our interface will implement the following:

Main Modes	General Functions	Turbine Modes
Cool	ON/OFF	Turbo
Heat	Temperature Control	Economy
Air	Swing Control	
Dry	Fan Speed Control	
	Timer	





Evaluation Method I

Interview: Personas

Since we aim to please as **broad an audience** as possible we made sure our personas fully represented the people we have interviewed. By including their **frustrations** with inadequate interfaces and fully comprehending **what each of them seeks** in a remote control solution, we have equipped ourselves with a plan for our own interface.

Naturally, what each user seeks from such a solution might differ, **users familiarised with technology** wouldn't use an **interface that is lacklustre feature-wise**. However, **less tech-savvy users** might feel **overwhelmed** by an abundance of options presented to them, which could keep them from using the device at all.

It is our responsibility to develop an interface that covers all of those requests in the best way possible, **achieving the best of both worlds**.

Elderly User		
		
Yannis - 82 (Retiree)		
Seeks <ul style="list-style-type: none">- High legibility- Memorable procedures		
Frustrations <ul style="list-style-type: none">- Small symbols- Too many options		
Tech Savvy User	Tech Illiterate User	Visually Impaired User
		
Jennifer - 28 (IT Consultant)	Nguyen - 46 (Housewife)	Artyom - 58 (Musician)
Seeks <ul style="list-style-type: none">- Advanced functionality- Smart features	Seeks <ul style="list-style-type: none">- Basic design- Quick operation	Seeks <ul style="list-style-type: none">- Audio/Haptic feedback- Voice commands
Frustrations <ul style="list-style-type: none">- Lack of features- Lack of connectivity	Frustrations <ul style="list-style-type: none">- Cluttered interface- Unintuitive symbology	Frustrations <ul style="list-style-type: none">- Non-Inclusive design- Lack of feedback/tactility

Our solution must **implement every feature the device offers** without cutting corners, while also making the use of those features **intuitive and clear in their design**. Inclusivity also demands a **variety of feedback and easily legible –and comprehensible– text and symbols**.

Interview: Q&A

I: Do you use air conditioning daily at your home? If so, for what purposes?

1. “Not daily no, unless it’s summer. During the winter months we use central heating.”
2. “Yes I use it all year round. I live alone so it’s cheaper than heating the whole house with oil.”
3. “We have 3 of them for us and the kids. We use it sometimes in the winter and daily in the summer for cooling.”
4. “My wife is the one that uses it as I can’t use it effectively. Otherwise we use it daily.”

II: What features do you seek in an air conditioner?

1. “WiFi connectivity is important for cooling the house before I get back from work.”
2. “I just need it to be able to heat and cool the house. I forget what the buttons do all the time and I need to call my daughter. I understand fan speed, but “dry” and “auto” or “eco”? I don’t get it!”
3. “I need it to cool and heat the home and have a swing mode so it doesn’t disturb the kids when they sleep. The cheaper it is to run the better.”
4. “The usual stuff like heating, cooling and low consumption. But mainly I’d like to be able to use it myself.”

III: Do you find using the remote control of your AC difficult?

1. “Not particularly, I just find using the app easier so I usually don’t use it.”
2. “Yes, there are many buttons and the letters are very small so I need to get my glasses.”
3. “It’s not that it’s hard to use but when you have 3 air conditioners the remotes get lost because the kids hide them or I just misplace them.”
4. “Yes it is difficult because I can only make out the power button because of its shape and size.”

IV: What are some changes you would want to make to your AC remote?

1. “I would want it to be less old school. A touchscreen and functionality that matches that of the app would be ideal.”
2. “I would make it simpler, with larger buttons and larger lettering.”
3. “I’d like a remote that controls every device.”
4. “I would make it compatible with a visually impaired person.”

V: What are your thoughts on this remote control?

1. "It's pretty typical. At first glance it can certainly appear quite confusing."
2. "It's just like mine. Looks very frustrating to use."
3. "I don't understand what all the buttons do. I can understand some but I have no idea what 5way does for example."
4. "The buttons feel the same and are spaced too closely. I can make out a circular button on the bottom which is good."



VI: What are some changes you would want to make to the above AC remote?

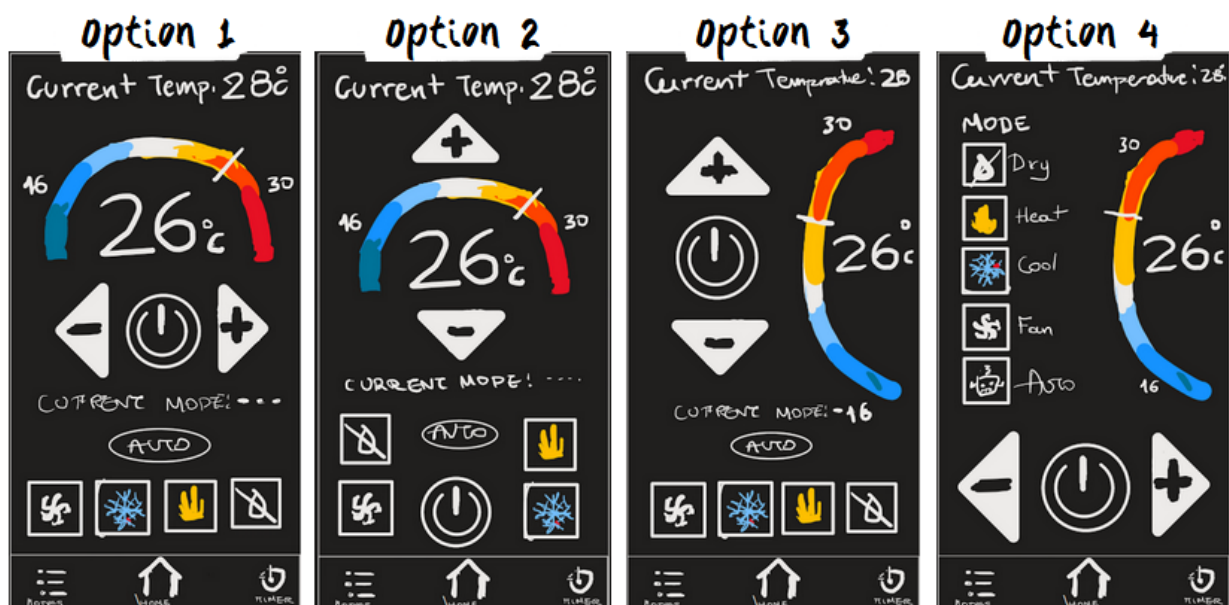
1. "Less buttons and a larger display. Overall more user friendly."
2. "Larger symbols and lettering on the display. Less buttons with larger symbols."
3. "I would make the buttons easier to understand. Just less cluttered and simplified."
4. "Larger and fewer buttons with some bumps so I can feel them and memorise its operation."

Mockups

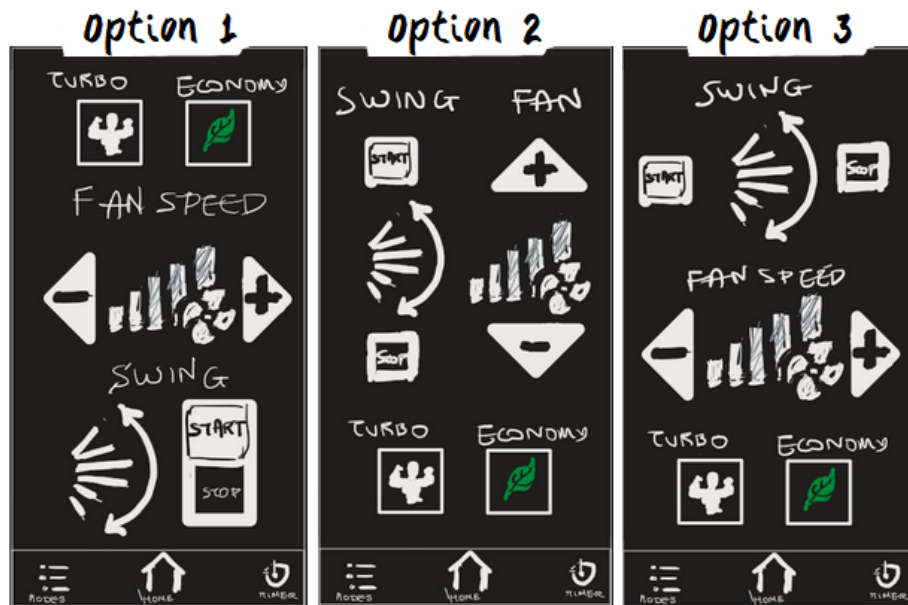
We started by sketching out different versions for each screen of our remote control app. Those 3 screens and their different versions are the following:



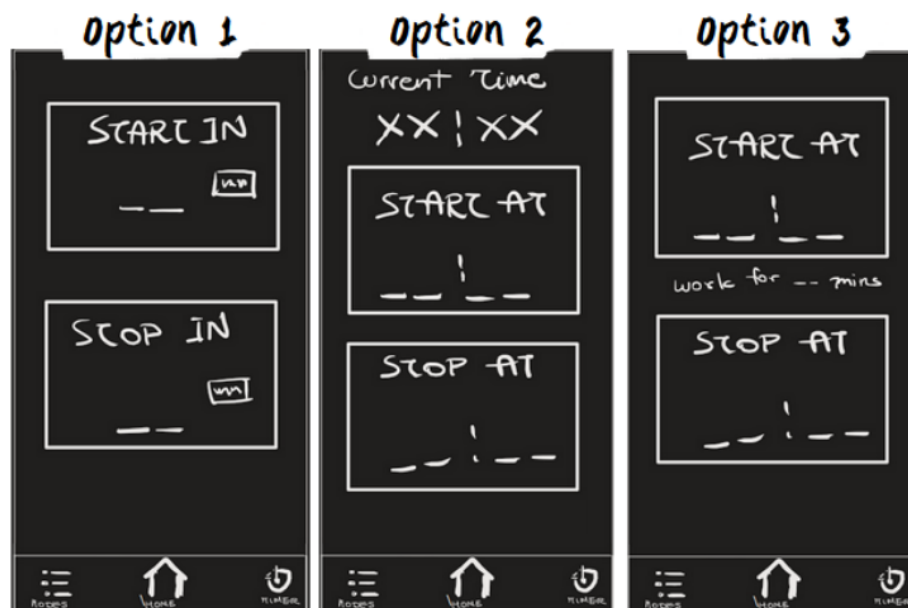
Main Screen



Advanced Controls Screen



Timer Screen



We found that a simple sketch for each option would give us the ability to more easily come up with different layouts and run through different potential designs.

Evaluation Method II

Survey

In order to obtain further info on the needs of users of air conditioners and get an idea of which of our mockups is preferred by the public, we conducted a survey. The survey consisted of 13 questions split into 3 sections and could be completed within a few minutes. In total we had 130 participants and the results can be viewed in detail [here](#).

Through this survey we have made some interesting observations. First of all the survey was completed by people of ages 18 to over 55, with the majority of them in the 18-24 group, since it was mostly shared amongst our colleagues. Somewhat unsurprisingly everyone had used an AC device in the past and the overwhelming majority of people control it using a remote control.

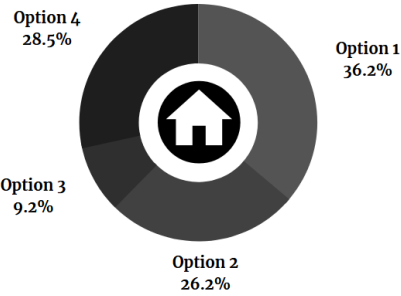
Furthermore, most people claim to feel familiar with their device's features but in instances where the surveyees were asked about some more specific features they were not able to answer. Also of note is that 62.3% of our surveyees said that some of their device's icons and symbols were hard to interpret.

These findings further our belief that most users are unaware of their lack of knowledge when it comes to their device's feature set. We should also clarify that this is through no fault of their own and is instead the unfortunate consequence of poor user interface design. Additionally an impressive 90.8% said that they would find an app that controls an AC useful to them.

We also asked users whether they'd prefer the app to be "Simple and concise", "Complex with a variety of features" or "A mix of both". A majority of 48.5% responded that they'd prefer the app to be simple and concise. This is something we've stayed consistent with when designing our application. As for the permanent dark theme, a significant majority of the surveyees said they'd prefer it over a light one.

We also presented the surveyees with the different versions of the mockups and had them choose their favourite option. The results are as follows:

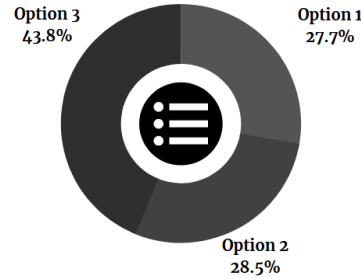
Main Screen Results



option 1



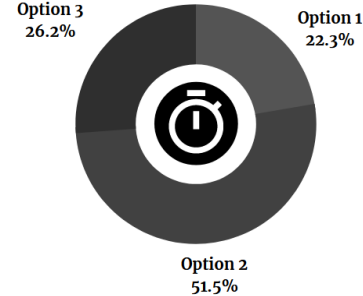
Advanced Screen Results



option 3



Timer Screen Results



option 2



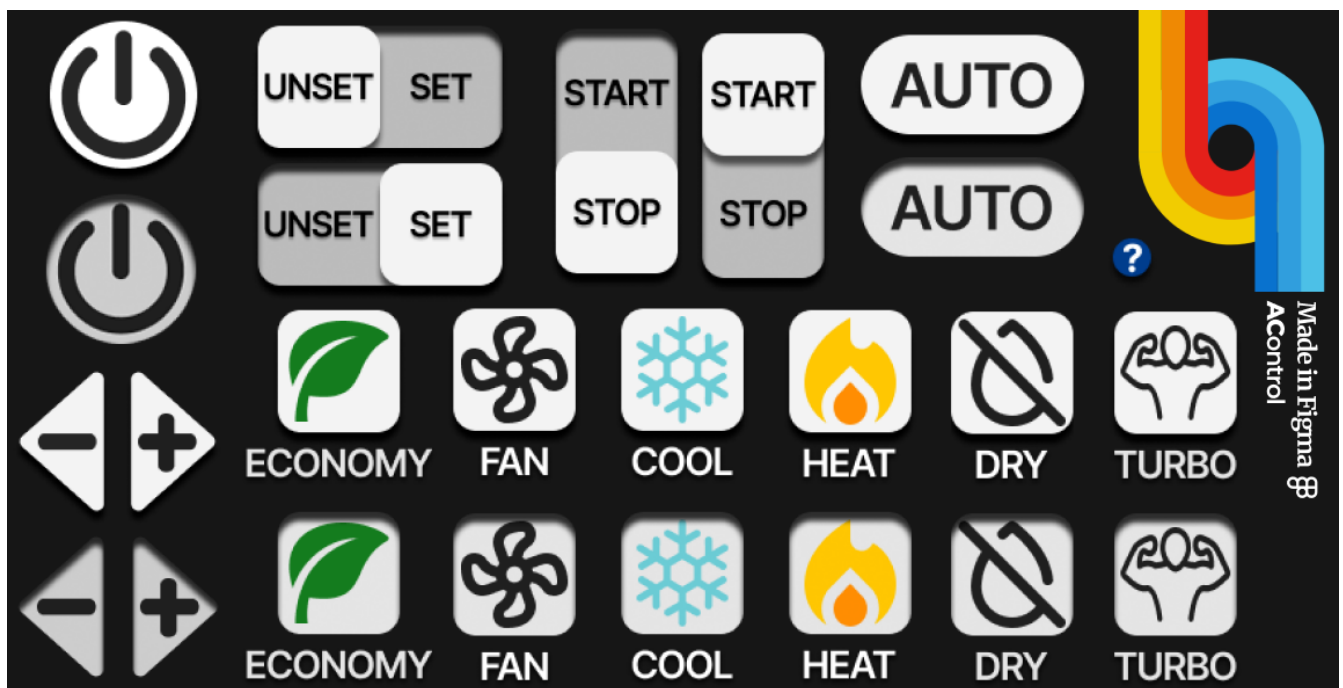
Cycle II: Starting Development

In Cycle II we started working on the app's implementation using Android Studio. To aid us in this move from a digitally drawn mockup to an Android application, we made use of Figma, an online tool that can quickly and efficiently create detailed mockups and vector elements fit for an app.

After finalising the design in Figma, we exported each element individually and started implementing them in Android Studio one by one. This resulted in a functional final design that is nearly identical to the initial mockups, allowing us to stay faithful to the design that was chosen through the survey.

This is a showcase of a variety of symbols we designed using Figma. These include both their pressed and unpressed variants. Having a pressed variant adds more visual feedback for users.

Assets used in our application, pressed and unpressed buttons, icons and logo.



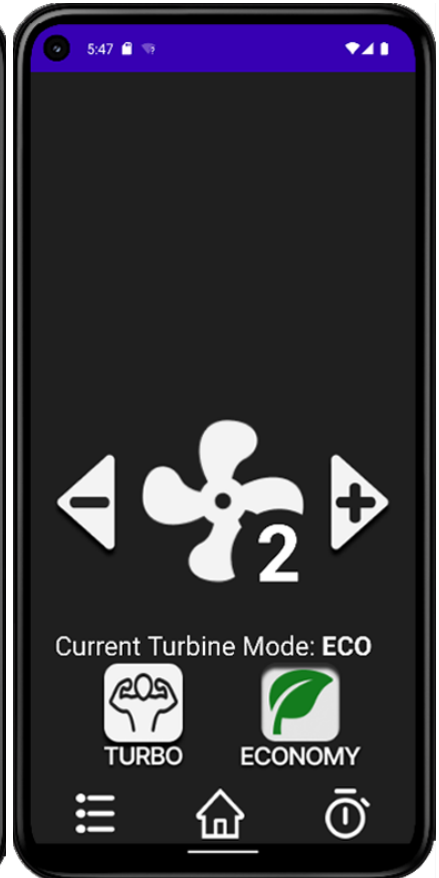
Figma
Main Screen



Android Studio
Main Screen



Android Studio
Advanced Screen



These screenshots showcase the transition from Figma to android studio and the app's state during Cycle II. In its current state, the application is almost ready in terms of design with the exception being the timer screen.

Further additions would be storing the session's profile so that any changes made by the user remain on each screen. Still remaining faithful to our original mission, we also plan on adding voice commands as well as haptic and audio feedback.

Evaluation Method I

User Testing: Interactions

Five users were presented with the app and then asked to perform a few basic interactions. The users were varied in age and technological literacy. All users had previously used an air conditioner and some of them had previously participated in the interviews for “Evaluation Method I” of Cycle I.

At first the users were presented with a phone and had no familiarity with the app. By asking them to perform basic tasks in this state we aim to gauge their reactions in order to ensure that use of our app is intuitive, and frustration free.

1. “Launch the app. Activate the air conditioner and set it to 25°C.”

All users were able to perform this task intuitively within a few seconds of launching the app. Some users commented that the interface’s similarity to that of a physical remote helps greatly in that regard.

2. “Switch to the dehumidifier mode.”

In the app the dehumidifier mode is abbreviated as “DRY” and this means that users won’t just be able to click on the button with the relevant word. Most users clicked on the button labelled “DRY” immediately. Two users were initially confused and attempted to look for a mode labelled “dehumidifier” in the mode menu but quickly realised that it was the “DRY” button, in part thanks to its icon.

After these two interactions we let the users explore the app for 5 minutes at their own pace in order to familiarise themselves with other features in a more natural way. Although from what we observed, 5 minutes was way too long a time-frame since most people became familiarised within 1-2 minutes. After this we continued with the interactions.

3. “Set the fan speed to 1 and set the turbine mode to Economy.”

All users had clicked through to the other menus in the time they’d been given to familiarise themselves with the app. As a result the users switched to the “advanced” menu and selected the relevant modes fairly quickly.

4. “Set the mode to Cool and the temperature to two below the current room temperature and set the turbine mode to Turbo.”

This final interaction combines all of the functions as well as a useful part of the UI that some may not have paid attention to. Most users performed the task intuitively within seconds. A user was confused by the current temperature reading but noticed it soon after switching to the other menu.

Evaluation Method II

User Feedback: Q&A

Following these interactions, we interviewed the users to gauge their impressions of the app in its current state.

I: What is your general impression of the interface on the “main” and “advanced” menus?

1. “I really liked it. It’s way simpler than a remote.”
2. “I don’t know much about this kind of stuff but I thought it was great.”
3. “I liked the fact that it’s very straight to the point. No useless accounts or pop-ups.”
4. “It was very good! Similar enough to a remote that even I understood it quickly.”
5. “I liked it a lot. The icons were very pretty.”

II: Is there anything you found difficult to understand?

1. “No, as I said it is simpler than a remote.”
2. “It was a little overwhelming at first but I got the hang of it.”
3. “Nah, it was very easy to understand.”
4. “It was fine once I clicked around a bit. Very easy to understand.”
5. “Nothing really. I got a little confused about the DRY mode but that is all.”

III: Is there anything you would like us to add to the interface?

1. “It’s great as it is. But if you insist I would like it to be a little more colourful.”
2. “I don’t know about this kind of thing and it is fine as is.”
3. “Sound effects and vibration would be a nice addition in my opinion”
4. “More feedback would be nice as my eyesight isn’t what it used to be.”
5. “Fine as it is. Nothing more needed.”

Impressions were overall positive but a few of the responses were key in identifying a few more issues, or reinforcing our suspicions. One such response mentions vibration, something that we had considered ourselves. Now we have all the more reason to add it in the following iteration.

Evaluation Method III

Usability inspection: Expert review

For this stage of the evaluation we recruited three of our colleagues.



p3180172 Charalampos Spanos

p3180177 Iasonas Stefanitsis Papageorgiou

p3180186 Eleni Trampari Larda

The testers were presented with the application and left to explore it on their own for a few minutes. The user interface was thoroughly inspected and tested, making sure to test for potential conflicts that may occur. Afterwards we listened to their comments and asked them further questions.

Through this exchange we reached the following conclusions:

- The gradient accented frames, used in the figma Main screen mockup, were deemed unnecessary and their removal will help simplify the design.
- Adding text to some of the icons will help alleviate potential confusion.
- Changing the leftmost icon in the bottom bar to something more fitting will also be beneficial.
- The addition of information boxes to some of the buttons could help users become familiar with some of the more complex options.
- Adding the celsius symbol to the current temperature indicator will help with consistency.

This was an enlightening experience and their feedback will be implemented in full during Cycle III. We are also considering asking them to make a return in order to review our work after we've taken their advice into account. This way we may potentially identify a few more oversights or at the very least further verify our work.

Cycle III: Final Implementation & Evaluation

For Cycle III we finished all of the basic functionality which was deemed necessary to include in Cycle I. These being the swing function, the timers and voice recognition.

Additionally we used the feedback we had received during the second cycle's evaluation in order to add a variety of useful features that improve the overall user experience and the app's inclusivity, such as info boxes, haptic and voice audio feedback.

Below are screenshots of the application, showcasing the final look and feel of the new user interface. Notice the microphone icon on the top left, this is a button which allows the user to input voice commands. Also take note of the question mark icons which give info on each function menu when pressed. We have also accented the navigation bar icons to further aid with usability.



Evaluation Method I

Heuristic Evaluation: Expert Review II

For the second evaluation method of Cycle III we once again contacted the colleagues with whom we had conducted the usability inspection for the third evaluation method of Cycle II. This time, having taken their advice into account, we set out to do a heuristic evaluation of the user interface using the following 20 usability guidelines. In 2000, Susan Weinschenk and Dean Barker created a categorization of heuristics and guidelines used by several major providers into the following twenty types. First we asked the testers to read the source material to gain a clear understanding of the requirements of each heuristic. Then they would have to discuss and reach a consensus on each heuristic. Afterwards the testers would have to write a sentence describing their thoughts on the heuristics.

Weinschenk, S and Barker, D. (2000) Designing Effective Speech Interfaces. Wiley.

- 1. User Control**

Once booted the application presents the user with the main screen and awaits input, clearly informing the user they are in control at all times.

- 2. Human Limitations**

The interface is minimal and elements are evenly distributed. There are no potentially overstimulating colours and sounds.

- 3. Modal Integrity**

The interface fits all potential modalities.

- 4. Accommodation**

Accommodations have been made for a variety of user groups that may find using apps difficult.

- 5. Linguistic Clarity**

Despite a couple of abbreviations, linguistic clarity remains high.

- 6. Aesthetic Integrity**

The design is appropriate for the usage case and highly consistent throughout the application.

- 7. Simplicity**

All elements are presented in a consistent and simple manner.

- 8. Predictability**

The interface behaves as one might expect thanks to its simple functions and few

menus, especially when compared to its physical counterpart.

9. Interpretation

The application accounts for a variety of edge cases.

10. Accuracy

The interface is simple and well tested to make sure that no errors will be found.

11. Technical Accuracy

The interface has been thoughtfully designed to ensure that it works on all modern android smartphones.

12. Flexibility

The interface is not exactly flexible as it does not allow for customization, but that is a deliberate design choice in order to minimise confusion and clutter.

13. Fulfilment

Great care has been put into ensuring that using the interface is functional and satisfying, providing proper visual, audio and haptic feedback.

14. Cultural Propriety

The interface is based on a remote that is common on a global scale and uses standard symbology.

15. Suitable Tempo

The user is free to operate the interface at their own pace free from interruptions.

16. Consistency

There is a high level of consistency in the stylistic choices and layout of the interface.

17. User Support

Potentially unclear options are explained through the usage of info buttons. Voice audio feedback explains errors in voice command mode.

18. Precision

Users are allowed to control their device with precision and there is no ambiguity in the modes.

19. Forgiveness

Every action is recoverable within a single click.

20. Responsiveness

All actions include, at the very least, various forms of visual feedback.

Evaluation Method II

Interview: Q&A 2

For the second part of the evaluation we asked a few more questions to the same people that we based our personas on. This time we focused on their opinion on the new functions rather than gathering info on their needs.

I: Do you find the info button descriptions to be comprehensible?

1. "I had to get my glasses but they are just great."
2. "Yes the descriptions are nice and I also like the button placement."
3. "Very well designed and very useful. I'm glad they are there."

II: Do you find the toast function to be distracting?

1. "I think they are fine."
2. "Not at all. I think it's a nice feature."
3. "Not distracting at all. I appreciate that it notifies me."

III: Do you find the text-to-speech function to be useful?

1. "Reading small text is hard for me so the fact that it speaks is excellent."
2. "It may get old but I understand its purpose and overall I like it."
3. "How exciting it speaks too!"
4. "Yes it is just what I need."

IV: Do you find the voice recognition function to be useful?

1. "It's very useful indeed. I'm surprised it understands my English accent."
2. "I think it's good from an inclusivity standpoint."
3. "Yes it's good. I may not use it myself but it's very good for those who do need it!"
4. "It works like a charm. I would finally use the AC all by myself if it was a real remote."

Evaluation Method III

User Testing: Interactions II

Four users were presented with the app and then asked to perform interactions involving the newly implemented features. All the users had also participated in the previous User Testing segment.

As the users were already familiarised with the app, thanks to our previous testing, we could start much faster. We simply asked them to do the following.

1. **“Launch the app. Set a timer for the air conditioner to activate at 17:00.”**

No users had trouble with navigating to the timer screen thanks to the intuitive symbol. Then all users set the time correctly although a single user didn't realise that they'd have to click the SET button. This error was realised and corrected rather quickly.

2. **“Unset the previous timer. Activate the AC manually. Set a timer for the AC to deactivate in 30 from the current time.”**

This interaction involves a few more steps than most but isn't actually that much more complex. Its main purpose was to determine whether users would use the current time indicator correctly. All users set the timer at exactly the right time without much trouble.

3. **“Check an info box of your choice.”**

All users quickly identified the question mark symbols as info boxes. One of the users even clicked one of the icons before explicitly being told to do so. Response to the infoboxes was overall very positive.

4. **“Activate swing function.”**

Most users recognised the symbol and switch and activated the mode within a few seconds. One user was initially confused and thought it might be one of the modes on the main menu but realised his mistake after reading the label. Afterwards they too activated the correct mode.

After these three interactions we had the users interact with the app using voice commands only. We explained to them what voice commands are and how to access them. After this short introduction users were asked to restart the app and proceed accordingly.

5. “Activate voice command mode and say “help”.”

Every user clicked on the microphone icon and spoke out although it didn't go perfectly from the get go as Google's voice recognition struggled with the word help if the accent wasn't perfect. After some tweaking we found that the word “assistance” would be recognised much more easily.

All users listened to the instructions and understood them fairly well. Two users chose to listen to them twice to get a better grip on them.

6. “Using voice commands activate the air conditioner.”

All users activated the air conditioner successfully. Of note was the inclusion of the toast which assured users that the activation was successful.

7. “Using voice commands set the mode to cool.”

This worked as expected and all users were recognised after at most three tries.

8. “Using voice commands set the temperature to 20°C.”

This also went rather smoothly. In this case the app listens for a number followed by the word “celsius”. The inclusion of the word celsius is important; it was added after testing to ensure that the word before Celsius would be recognised as a number by the neural network. We've also made sure users get notified if they attempt to exceed the minimum or maximum temperature.

Evaluation Method IV

Timed Comparison: Original versus New User Interface

Having settled on functionality and design we decided to compare the app's interface to that of the original remote by timing simple tasks. To ensure a fair comparison we timed the diverse group of people on which we had based our personas. Following the feedback we received during the presentation of Cycle III, we chose to rerun the tests using multiple people for each group. Their times were then averaged out.

The actions are performed in sequence assuming the air conditioner is initially off and the devices are set on a table. In the case of the new interface, the app must be launched before usage. Settings were reset between each test.

Tech Savvy User - 22.88% faster		
Actions	Old Interface	New Interface
Activating the AC unit	2.14 sec	2.25 sec
Setting the mode to COOL	2.12 sec	0.66 sec
Setting the temperature 20°C	2.42 sec	1.31 sec
Setting the turbine mode to turbo	1.45 sec	2.05 sec
Total time for all actions	8.13 sec	6.27 sec
Tech Illiterate User - 13.68% faster		
Actions	Old Interface	New Interface
Activating the AC unit	2.39 sec	2.70 sec
Setting the mode to COOL	3.59 sec	2.10 sec
Setting the temperature 20°C	5.58 sec	3.94 sec
Setting the turbine mode to turbo	3.21 sec	4.01 sec
Total time for all actions	14.77 sec	12.75 sec
Eldelry User - 6.8% faster		
Actions	Old Interface	New Interface
Activating the AC unit	3.29 sec	3.48 sec
Setting the mode to COOL	3.02 sec	2.58 sec
Setting the temperature 20°C	6.23 sec	4.01 sec
Setting the turbine mode to turbo	3.93 sec	5.28 sec
Total time for all actions	16.47 sec	15.35 sec

Using the application results in operation of the air conditioner that is considerably faster than using the original remote control. This result can be attributed to the clunky and unresponsive interface of the original remote. Especially the fact that you cannot select a specific mode and you have to cycle through every mode instead and in case you miss it you have to cycle through the options again. Interface faults also include the small text and convoluted symbols as well as the tightly packed button layout.

These are all issues that we had identified from the start and our improved user interface aimed to solve. These results go to prove our success. It should be mentioned that younger people benefit even more from these improvements, especially if they are experienced with the usage of an android device.

Conclusion

When we set out to improve the interface of this air conditioner we thought this would be a rather straightforward task. After all, the original remote and indoor unit have a variety of glaring issues.

We compared the interface to that of other air conditioners and a variety of existing applications, making sure to take into account the evolution of such interfaces.

We selected elements that we viewed as useful and comprehensible for all users and slowly but surely created the initial mockups. At that point we thought we had cracked the code and created a perfectly fine interface but we quickly understood the importance of evaluating one's work and working against our own biases.

The spiral model played a crucial role in ensuring the project's success - working on the interface incrementally allowed us to identify problems and fix them in a productive and methodical manner. Receiving feedback and testing during every stage of development helped us identify issues that wouldn't have crossed our minds otherwise.

So through thorough evaluation, testing and a lot of positive feedback our interface has reached a state in which we can conclusively call it a success.