Introduction to the Research Study and General Theoretical Foundation for the Prototype

This study's purpose is to evaluate the overall usability of our car prototype and its effectiveness in solving our user problem. Our user problem is the burden of having to carry personal belongings whilst walking or jogging. This encompasses all areas of the car's functionality. We must identify our car's affordances and signifiers, so we have an idea of how to improve how intuitive the car is to use for users.

We want to assess the extent to which the car's design evokes positive emotions and contributes to a satisfying user experience. But also, we will make sure the car is functional and usable by testing the functionality of all the components in controlling the robot's movement and facilitating user interaction. Lastly, we will then assess the accuracy of the data obtained from the sensors to ensure they are functioning properly. To verify that the sensors are functioning properly and providing reliable information for obstacle detection and user tracking.

The second objective is to gather feedback on the physical implementation and build quality of the car. This includes the size, materials, and overall design. The aim is to determine whether the physical characteristics of the car contribute to the usability and enjoyment of the product, or if they present hindrances. By addressing these research objectives, we aim to identify areas for improvement in the car's design, ultimately enhancing the user experience of the product.

Research Questions

What are our car's affordances and signifiers? How do these elements contribute to the intuitiveness and user-friendliness of the product?

Do the sensors perform as intended in detecting obstacles, tracking the user, and providing accurate data? Are there any limitations or issues that need to be addressed?

How effectively are we solving the user problem? To what extent does provide convenience for the user?

What emotional feedback and user experiences are elicited by the car prototype? How do users perceive the design, functionality, and overall experience of interacting with the car?

Are there any additional features or improvements that users suggest to enhance the usability, effectiveness, and emotional appeal of the car prototype?

How do the physical attributes (size, weight, materials) of the car prototype impact user comfort, convenience, and overall satisfaction?

Background and Context

The development of this prototype was driven by a user-centered design approach, starting with an empathetic understanding of user needs and challenges. Through individual ideation and group discussions, we identified a common user problem: the burden of carrying items while walking or jogging. Recognizing the potential of Arduino and various sensors, we aimed to create a solution that could alleviate this problem.

Informed by our research on existing Arduino projects and technology limitations, we conceptualized a mobile storage device that could autonomously follow users and provide a secure space for their belongings. The prototype consists of a chassis with two wheels, a motor, and a mounted box for storing personal items. To enable tracking and navigation, we incorporated an ultrasonic sensor to measure the distance between the prototype and the user, as well as an infrared sensor to detect the user's temperature.

This is so the car can distinguish walls/objects from actual people (identified by a higher temperature). The objective of the prototype is to offer a convenient and hands-free storage solution that seamlessly adapts to users' movements. To validate the effectiveness and usability of the prototype, we conducted a user study involving participants from the University of Technology Sydney.

By observing and gathering feedback from participants, we sought to understand how well the prototype addresses the identified user problem and assess its performance in terms of tracking accuracy, interaction, and overall user experience.
By contextualizing the prototype within the broader field of user experience design and leveraging our understanding of user needs and existing technology, we aim to contribute to the advancement of mobile storage solutions and enhance users' daily experiences while walking or jogging.

Theoretical Framework

The theoretical framework for this user study draws upon concepts and principles from the fields of user experience design, human-computer interaction, and product design. Key theoretical references include 'Getting Started with Arduino' by Massimo Banzi, 'The Design of Everyday Things' by Donald Norman, 'Making Things Talk' by Tom Igoe, and 'Emotional Design' by Donald Norman.

Banzi's 'Getting Started with Arduino' provides a foundational understanding of Arduino technology and programming and serves as a technical guide for developing the prototype and leveraging the Arduino platform to implement functionality and control various components.

Norman's 'The Design of Everyday Things' offers insights into the principles of usability, affordances, and signifiers in product design. It emphasizes the importance of creating intuitive and user-centered designs that align with users' mental models and expectations. This resource informs our approach to designing the prototype's interaction elements, and overall user experience.

In 'Making Things Talk' by Igoe, the focus is on creating interactive projects that communicate and respond to human inputs. This resource provides valuable guidance on integrating sensors and actuators, enabling the prototype to perceive and interact with its environment. It helps shape the selection and implementation of the ultrasonic sensor, infrared sensor, and other components that facilitate user tracking and obstacle avoidance.

Norman's 'Emotional Design' explores the emotional aspects of product design and the impact of design on users' affective experiences. This resource helps us understand the role of aesthetics, form, and emotional appeal in creating engaging and enjoyable interactions. It guides us in considering the emotional response of users to the prototype and how it can be enhanced through design choices.

By integrating these insights, the theoretical framework provides a foundation for assessing the prototype's adherence to design principles, understanding user interactions and perceptions, and deriving recommendations for iterative improvements.

Research Method and Protocol

Participant selection criteria and recruitment strategy

Our participants are required to be fluent in English for accuracy in the follow-up interview questions and easy interpretation. They also must be comfortable with moving around and potentially jogging to test the features of the car. Furthermore, they must be comfortable with being partially on camera. We will recruit university students studying at the University of Technology Sydney. Students were chosen because most will be fellow peers as they have more free time and will not need compensation. Due to the participants being students, the age demographic will be 18+. The participants do not require any familiarity with Arduino, or of any specific technology used in the product. Participants will be both male or female, and range in height.

Design and procedure for conducting the observational study

The observational study will use a mixed-methods approach, utilizing both quantitative and qualitative data to evaluate the robot's effectiveness and usability. The location of the study will be the university campus on level 2 of building 2, as there are wide spaces with flat ground which are both ideal for testing the cars performance, as the wheels struggle on rough/sloping surfaces and the car needs plenty of space so we can test its search and follow actions accurately.

Everything will be recorded with a smartphone, with the participants consent to film, and then the video will be stored with the number of the participant e.g., participant 1. Every session takes about 15 minutes, we will have four participants so that makes up 60 minutes. We will ask our participants to guide the robot near obstacles to test if it gets distracted, and if they could place their personal belongings in the storage box to test movement and storage.

1. Testing the ultrasonic sensor and infrared: Participants will be asked to test the ultrasonic sensor and infrared sensor by standing at various distances from the robot and we will check the serial monitor to observe how each sensor responds at various distances and record the values. The values will be recorded at distances of 10 centimeters, 30 centimeters, 60 centimeters, 1 meter and 2 meters (using a tape measure). This will help evaluate the accuracy and sensitivity of the sensor and identify any potential issues.

2. Testing the car behaviour, DC motors and wheels: Participants will be asked to test the movement of the robot by navigating it through the campus grounds and then near some obstacles (tables/chairs and walls). They will be given limited instructions and only told that it is meant to follow them. This will help us evaluate the responsiveness and reliability of the motors/wheels and the coded car behaviour to identify any potential issues.

3. Additionally, qualitative data and quantitative will be obtained by giving the participant an interview questionnaire after testing (see raw data/transcripts). This is to understand if the car was successful in solving the user problem and their opinions on potential improvements.

Materials

-Chassis made from acrylic plastic

-2 DC motors

-Jumper wires

-2 wheels connected to the motor

-1 fixed wheel

-3D printed plastic storage box

-L298N DC Motor driver

-Arduino Mega2560 Rev3

-Phone

-Tape measure

-Laptop for taking notes and providing the interview questionnaire to be filled out by the user

Data Analysis and Description of Perceived User Needs Based on Evidence

Overall, our prototype is functioning and solves the user problem at a basic level but its attempt to solve the user problem is not adequate and it will require some further modifications. We have come to this conclusion through our user testing in which we used successfully gauged the effectiveness of our prototype.

Firstly, we recorded the values of the sensors based on the distance away from the person to ensure the car would perform accurate readings and to determine how the sensor values were affecting our prototype's functionality. For the infrared sensor, the values from tests 1 to 4 were similar to each other. However, at 1 meter, the infrared becomes unable to detect a temperature of above 24 which is what we set our car to go forward in response to. This means that the car will not detect the user if they are 1 meter away from the sensor.

User 2 commented that “Although it was able to track and follow my movements most of the time, there were occasions where it was unable to detect my location and either bumped into me or a neighbouring object.” This, along with the data, is indicating that the infrared is not performing as intended, most likely due to its limited range of detection. This may also explain User 1’s experience of “sometimes it stopped following me out of nowhere”. The user needs the car to follow them without losing their location so this must be improved.

User 2 also experienced the car going past her without stopping. To prevent this, we added to the while statement in the code that states that while it is moving if an object is too far away or not within the temperature range, it will stop and turn to find them. This helped stop the car from wandering off with no target but did not solve the problem of losing the user, which seems to be linked to the infrared range and speed at which it receives data. If it doesn't receive temperature data quickly enough it will miss the user whilst turning.

The ultrasonic sensor, on the other hand, was able to detect objects at long distances very well according to our sensor data. And it receives data a lot faster too as it was tested without the infrared, and it picked up object locations whilst turning without issues. However, it can’t distinguish between a person and an object like the infrared.

When questioned about the gap between the user and the car when following, User 1 stated the gap could be bigger and User 2 also mentioned “I think this modification would allow the car more space to stop before bumping into the user's feet.” So, inside the code, we mitigated this by increasing the distance from the user at which the car stops. This made sure that even whilst going fast, it has enough time to stop before hitting the user's feet. As a result, Users 3 and 4 did not report any issues with the gap.

Another commonality in our user's responses was the lack of speed. With an average rating of 4/10, our data shows this is a significant area for improvement. According to the questionnaire, 3 out of 4 users want a car that can follow them whilst running. User 3 stated “I had to walk at a very unnaturally slow pace and when I tried to speed up a bit, I would get annoyed as the car would then lose track of me and start spinning” so this conveys that the car needs to be enhanced to be able to keep up with the user's pace as it can cause frustration when it loses their location.

Unfortunately, due to the make of the wheels and potentially the power of the motor, our car is not all-terrain, it heavily relies on flat surfaces to function. This was discovered when User 1 navigated the car towards the carpet. Her response in the questionnaire illustrates her understanding of the limitation and concern “Also, theoretically stairs, grass or in the testing case carpet makes the robot have issues or makes it fail to follow further.” It is important to ensure the car can be used in more varied environments to add utility for our users.

The user testing has shown that users responded well to the functionality of the prototype and the overall behaviour of the car was very clear to them. With limited explanation, they were able to figure out how to use the prototype. They could perceive the car turning as an action to locate them for example. User 1 described it as “self-explanatory” with the car following when she was walking and stopping when she was stopping. User 2 described the car following them as a “primary visual cue” in terms of its behaviour. As she took steps away from the car User 2 noticed the car began to reorientate itself by turning and then moved towards her again.

More subtle affordances perceived by users was the light of the motor driver turning on when it moved, this conveyed to the users when it was moving, as observed by User 1: “The only thing that I could see was a light indicating that the robot was on and could start following me.” Another affordance was the whirring sound of the motor as pointed out by User 2 and User 4 which indicated that the car was on.

Users also correctly understood how to use the box and that using a simple lid made it “intuitive to use”. User 3 understood where to place his items as the box served as a visual cue. An unexpected signifier came from the look of the ultrasonic itself in the case of User 3 who stated, “I noticed two eye looking things at the front, and I guessed that was probably what the car uses to search and find me.” The two circles of the ultrasonic sensor acted as a metaphor for the eyes of the car, with the users understanding that the car could not ‘see’ them unless they were in front of the ultrasonic sensor.

Storage seemed to be very important to our users, in terms of what they could store in the car and how securely they could store it. User 1 expressed concerns over the limitations of the use of the robot stating “For just walking around carrying a drinking bottle, wallets, keys… it is quite useful and the space is perfect. It just has a limited range of use at the moment.” It is very important to integrate larger storage facilities so users can carry more than just small essentials.

This further need for greater storage is summed up in User 2's answer "I am frequently in a position where I have too many things to carry, especially when transporting my belongings from my car to my front door." They need a car that can carry their belongings/potentially even shopping in their car regularly, so this has to be considered.

Users also expressed the desire for storage of liquids but thought the car may be limited in this storage as they were concerned it could damage the prototype. User 2 exemplified this in her response "For obvious reasons, I would not store any liquids within the container as they may leak and spill onto the electronics." User 1 also mentioned the car may need to be waterproof to withstand various obstacles and weather conditions. Our users have identified water resistance as an important aspect to consider when using the prototype and it is linked to the users' need for a durable product that will have longevity.

Secure storage also needs to be ensured. User 3's response indicated that he did not feel comfortable placing things inside the prototype box: "Personally, I would not put my phone in there in a practical setting, as I like to always have my phone on me." As a result, we should create a more secure storage compartment that users feel safe using to ensure they will want to regularly use the product.

Emotional feedback was varied but overall was positive as our prototype proved to provide a novelty experience for users that captivated and engaged them. User 1 felt "amazed by the product. // I liked the fact that the robot followed me and that it is noticing I am a human being by the infrared sensor – I was quite amazed by that." Here, the behaviour of the car has impacted the user positively and they enjoyed the basic functionality that it provided by following them. And the fact that it could distinguish them from an object.

User 2 felt a certain connection to the car, indicating a deeper level of engagement. "Invoked feelings of excitement and amusement. There were moments during the test when the car failed to read my location and proceeded to drive past me, this caused some slight frustration." This suggests that the success of the car in terms of emotional engagement was partially affected by its ability to consistently track and respond to the user's movements.

User 3 initially felt very curious about the prototype but was let down when it did not function as expected. The user found it frustrating to have to walk at an unnaturally slow pace and experienced annoyance when the car lost track of them and started spinning. This feedback highlights the importance of the car's responsiveness and ability to keep up with the user's movements for a satisfactory user experience.

User 4 expressed captivation and amusement when the car followed them and attempted to find them, but also felt a little disappointed when it lost track and struggled to locate them again. Again, this emphasises that any lapses in performance can lead to diminished user experience.

The aesthetic also contributed to the emotional engagement. User 2 liked how miniature and "pet-like" the prototype was, through its behaviour and look, the user connected with the

prototype as if it weren't just an object. However, all users commented that the exposed wiring and components detracted from how the product looked and many expressed they would've liked a casing, perhaps modelled after an animal or character. With an average rating of 5.5/10, we understand that this is very important to consider for our users.

For the real-life application of the product, we received an average rating of 5.75/10. This is showing that our car needs to be improved to solve the user problem. There is, however, a lot of potential recognised by the users. User 2 noted its utility for short-term trips to her car, User 1 mentioned it could be commercially successful with some adjustments along with other users who noted it could be used more regularly after fixing certain issues.

Description of Design Alterations and Refinements Planned and Their Basis in User Feedback

Our car has achieved its goal to a basic level, through many code iterations, and tests with ourselves and users we have discovered many improvements that could make our prototype more usable and effective. Based on our user feedback, the main issue is related to tracking the user. Mainly, because of the infrared's limitations the car isn't always able to track the user when it's turning to find them. It also operates in a limited range of 60cm. To mediate this, we can choose another method to track the user, such as a camera linked to AI tracking software.

There exists AI software that is used to identify and make out objects and this would be far more accurate than relying on temperature values to be transmitted quickly enough. This way, it will have an increased range of detection and we can also increase the speed at which the car follows without worrying about it affecting the tracking of the user. The potential to isolate the user and not get distracted by other people using AI is also apparent and will be explored.

Users also wanted a faster car that could keep up with them, we have also noticed that the mobility of the car is greatly hampered by the weight of the storage. If it is too heavy the wheels do not move and the more you add in storage, the slower the car goes. For this, we need more durable wheels and a weight detection sensor. In the code, a function increasing the speed based on the weight will be implemented. Adding more durable wheels is also important to ensure the car can move on varied surfaces (another identified user need).

More powerful motors will compensate for more weight and enable us to implement more storage in a larger model of robot which solves the issue of user feedback requiring more storage. We will also add a secure lid with a lock mechanism, so goods are safe and secure for our users. The car will have a casing to cover up its internal components. It will be made of waterproof material and will resemble a cute animal or a character from popular culture to appeal more to our users.

We also will include a switch that turns the car on and off and is potentially looking at a remote control to automate the on/off function and the locking mechanism. Also, the potential for speed settings has been recognised as it will save battery if the car is only slowly moving forward whilst you are walking, rather than going at fast speeds all the time. This could be automated on the remote as well. The lights from the motor seemed like a good signifier that the robot was on so we will implement a light on the
casing that activates whilst the car is on.

Raw data/transcripts

Quantitative Data

Infrared Values (°C) based on the distance from the sensor to the person

	Test 1	Test 2	Test 3	Test 4
10cm	35.27°C	35.87°C	34.98°C	35.54°C
30cm	34.78°C	34.13	33.43	34.32
60cm	26.25°C	28.84°C	23.30°C	25.86°C
1m	22.78°C	21.24°C	20.13°C	22.32°C
2m	21.13°C	20.92°C	19.45°C	21.45°C

Ultrasonic Values (cm) based on the distance from the sensor to the person

	Test 1	Test 2	Test 3	Test 4
10cm	10.82cm	10.23cm	10.13cm	10.34cm
30cm	30cm	29cm	30cm	30cm
60cm	60cm	60cm	60cm	60cm
1m	101cm	100cm	100cm	99cm
2m	205cm	202cm	200cm	203cm

User ratings of the prototype based on the speed, its real-life application and the overall aesthetic

	Test 1	Test 2	Test 3	Test 4	Mean
Speed	3/10	6/10	4/10	3/10	4/10
Application	6/10	6/10	6/10	5/10	5.75/10
Aesthetic	5/10	7/10	5/10	5/10	5.5/10

Questionnaires

Questionnaire 1 (User 1)

1. Did you understand how to interact with the car?

Yes, it was clear from the beginning. It started following me directly, I didn't need to do anything special to get it to interact with me.

2. Can you provide some specific features of the car (physical or behavioural) that gave you an idea of how it worked?

It followed me when I was walking and stopped when I was stopping. There is not much to figure out, it is self-explanatory.

3. Can you describe any visual or auditory cues that indicated how you can interact with the car?

To be honest, there are no visual or auditory cues necessary, the robot started following me immediately. The only thing that I could see was a light indicating that the robot was on and could start following me.

4. Were you able to adequately store your items in the car? Is there anything you wouldn't put in the car?

Yes, it was possible to store small important everyday things in the robot, such as my phone, keys, wallet, and small water bottle. It would be nice to come out with a bigger version.

5. Do you think the cars ability to follow you could be improved? Were there any specific moments where it failed to do so

I liked the car's ability to follow me, but it could be improved by going faster, for example when I go running then it could follow me as well. Also, theoretically stairs, grass or in the testing case carpet makes the robot having issues or makes it fail to follow further. Also, sometimes it just stopped following me "out of nowhere" -but that only happened sometimes.

6. Do you think the maintained gap between the product and user should be increased/decreased? Why? Why not?

I think it could even be a bit bigger, not a lot, so people can't steal the robot with my stuff in.

7. How did you feel whilst testing the car? What features do you think prompted these feelings and at what part of the experience were they? (annoyed, happy etc..)

I felt amazed by the product. I think it is a good product and it could be a big hit on the market – but for that there needs to be further improvements, like I do think the robot could go faster, and maybe leave a little bit of a bigger gap between the person and the robot.

8. Were there any features that you particularly enjoyed or disliked about the car? If so what were they?

I liked the fact that the robot followed me and that it is noticing I am a human being by the infrared sensor – I was quite amazed by that. The robot could use a general casing or sth that just makes it look "prettier" and covers the electronics and cables.

9. Rate the follow speed at which the product goes from 1 to 10, 10 being too fast and 1 being too slow and 5 being optimal. Explain your reasoning:

I would give it a 3, because in normal scenarios, the car would have been too slow for me. I feel like with the robot moving at this speed it is not possible to go for a run for example.

10. How likely would you be to use the product whilst walking on a scale from 1 to 10?

I would give it a 6. I really like the idea behind it, having something like a following shopping car behind you all the time. But as I mentioned earlier, for me it is too slow at the moment, and for

example to store your shopping stuff inside – it is too small too. For just walking around carrying a drinking bottle, wallets, keys… it is quite useful and the space is perfect. It just has a limited range of use at the moment.

11. Rate how aesthetically pleasing the product is from 1 to 10. Explain your reasoning:

I would give it a 5. It all looks too “prototypey”, with all the wires and the technical stuff visible underneath the box. I feel like it needs a casing that woud cover all of the parts, maybe shaped like a little cute animal or a movie character or sth ?

11. Do you have any other comments or suggestions on how we could improve the car?

I mentioned most of it at the respective sections. One thing though, it definitely needs to be waterproof in order to be able to function in lite rain or tough puddels.

Questionnaire 2 (User 2)

1. Did you understand how to interact with the car?

Yes, I was given clear instructions on how the car functions and how I should interact with it.

2. Can you provide some specific features of the car (physical or behavioural) that gave you an idea of how it worked?

The cars wheels indicated to me that the object would be moving. The storage box that sat on top of the vehicle had a clear ‘lid’ function, that was intuitive to use. As I started to interact with the car it became clear to me that it was attempting to follow my movement.

3. Can you describe any visual or auditory cues that indicated how you can interact with the car?

The primary visual cue was the movement of the vehicle. As I took a few steps away from the car it immediately began to reorient itself taking a moment before it moved towards me again.

The wheels also made a whirring sound as they began to move, indicating to me that the car was switched on and functioning.

4. Were you able to adequately store your items in the car? Is there anything you wouldn't put in the car?

The storage container was large enough to fit my phone and keys. The space is comparable to the size of an average purse/handbag and could be used in a supplementary manner. For obvious reasons I would not store any liquids within the container as they may leak and spill onto the electronics.

5. Do you think the car's ability to follow you could be improved? Were there any specific moments where it failed to do so?

Yes, the cars ability to follow me did need improvement. Although it was able to track and follow my movements most of the time, there were occasions where it was unable to detect my location and either bumped into me or a neighbouring object.

6. Do you think the maintained gap between the product and user should be increased/decreased? Why? Why not?

I think the gap between the car and the user should be increased by about 20cms or so. I think this modification would allow the car more space to stop before bumping into the users feet.

7. How did you feel whilst testing the car? What features do you think prompted these feelings and at what part of the experience were they? (annoyed, happy etc..)

Using the car was an overall pleasant experience. The novelty of engaging with a small moving robot invoked feelings of excitement and amusement. There were moments during the test where the car failed to read my location and proceeded to drive past me, this caused some slight frustration.

8. Were there any features that you particularly enjoyed or disliked about the car? If so what were they?

I particularly enjoyed the small size of the car. I found its miniature proportions to be almost cute and pet-like.

9. Rate the speed at which the product follows from 1 to 10, 10 being too fast and 1 being too slow and 5 being optimal. Explain your reasoning:

I would rate the cars speed a 6. Whilst it ran at an appropriate speed, slightly slower would have been more comfortable. The experience did cause me to feel slight anxiety about the car crashing into my feet.

10. How likely would you be to use the product whilst walking on a scale from 1 to 10?

I am frequently in a position where I have too many things to carry, especially when transporting my belongings from my car to my front door. The car makes an excellent set of 'spare hands', and would be very useful when making these short-term trips. I would rate the likeliness of my using this product a 6/10.

11. Rate how aesthetically pleasing the product is from 1 to 10. Explain your reasoning:

I would rate the cars appearance a 7 out of 10. As mentioned earlier, the miniature proportions of the car appear cute to me, and the container sitting above the car is well-made. If the car was going to be further developed I would suggest an encasing that would conceal the batteries, wire and motor from the users view.

11. Do you have any other comments or suggestions on how we could improve the car?

Yes, as previously mentioned I would suggest an encasing that would conceal the batteries, wire and motor from the users view. **I** would increase the gap between the car and the user to allow the car more space to stop before bumping into the users feet Overall it was a pleasant experience.

Questionnaire 3 (User 3)

1. Did you understand how to interact with the car? Placing my items in the box was very straight forward. I just opened and closed the lid. I was a bit confused on how it would follow me

but once it started moving and locked onto me, it became very straight forward on how to operate and interact with the car

2. Can you provide some specific features of the car (physical or behavioural) that gave you an idea of how it worked? I saw the car spinning in circles and then I noticed two eye looking things at the front, and I guessed that was probably what the car uses to search and find me.

3. Can you describe any visual or auditory cues that indicated how you can interact with the car? Visually I saw an empty box on wheels, and based on that I knew where my items would go and then wheels would be used to move around. I did not recognise any auditory cues.

4. Were you able to adequately store your items in the car? Is there anything you would not put in the car? Yes, I only had my phone and wallet with me at the time which fit nicely into the box. Personally, I would not put my phone in there in a practical setting, as I like to always have my phone on me.

5. Do you think the car's ability to follow you could be improved? Were there any specific moments where it failed to do so? Yes, I notice I had to be within a certain range for it to follow me, if I moved too fast it would lose track of me and started spinning like it did at the start.

6. Do you think the maintained gap between the product and user should be increased/decreased? Why? Why not? The distance it stayed away from me was fine however in specific scenarios I can see it needing to be closer or further away from the user

7. How did you feel whilst testing the car? What features do you think prompted these feelings and at what part of the experience were they? (annoyed, happy etc..) Initially I was very curious to see this prototype after a brief explanation. I was slightly let down when it was not functioning as I hoped. I had to walk at a very unnaturally slow pace and when I tried to speed up a bit, I would get annoyed as the car would then lose track of me and start spinning.

8. Were there any features that you particularly enjoyed or disliked about the car? If so what were they? I really liked the searching feature at the start, and I like how it stops when I stop. However, I would like to be able to walk normally and have it follow. Also, would like if there was a lock on the box as it feels unsafe security wise.

9. Rate the follow speed at which the product goes from 1 to 10, 10 being too fast and 1 being too slow and 5 being optimal. Explain your reasoning: 4, Car is just too slow, that I need to slow down my normal walking speed for it to keep track of me.

10. How likely would you be to use the product whilst walking on a scale from 1 to 10? 6, Once it is made practical and the items in the box are securely stored, I would see myself using this product often on walks and in less busy areas.

11. Rate how aesthetically pleasing the product is from 1 to 10. Explain your reasoning: 5, it's a very unique product that makes it naturally cool to look at, however a better job can be done to hide some wires and maybe add some personal customisation for the user to change the wheels, or box aesthetic.

12. Do you have any other comments or suggestions on how we could improve the car? As previously mentioned, I would like to walk faster and have the car follow, I would like it to detect me from a further distance, so I don't need to walk right up to it to follow me. Maybe add some feature where instead of following me personally, it could follow some small chip or device than I can carry with me instead that might make it more accurate. Also too add some customisations and make box for secure.

Questionnaire 4 (User 4)

1. Did you understand how to interact with the car?

Yes, I found it pretty straightforward to interact with the car. And it was clear from the beginning that the car would start following me without requiring any special actions because it just started moving when I got in front of it.

2. Can you provide some specific features of the car (physical or behavioral) that gave you an idea of how it worked?

One of the features that stood out was that it turned to find me and then followed me. So, I knew by the turning that it was trying to find me. This gave me a good idea of how the car operated.

3. Can you describe any visual or auditory cues that indicated how you can interact with the car?

When it started following me, I heard a whirring sound, and the only visual indication I noticed was a light indicating that the car was activating.

4. Were you able to adequately store your items in the car? Is there anything you wouldn't put in the car?

Yes, I was able to store small essential items like my phone, keys, wallet but my water bottle was too heavy for the car to move. So, I think it would be good to have a larger version of the car for storing bigger items.

5. Do you think the car's ability to follow you could be improved? Were there any specific moments where it failed to do so?

While I liked the car's ability to follow me, there is room for improvement. It could be faster, especially when I engage in activities like running. Additionally, I noticed that the car sometimes struggled to follow me when I changed directions too drastically, leading to it losing me and turning in circles.

6. Do you think the maintained gap between the product and user should be increased/decreased? Why? Why not?

I don’t think so, the gap was fine, it just needs to be able to find me if I walk ahead too quickly or make big turns

7. How did you feel while testing the car? What features do you think prompted these feelings, and at what part of the experience were they? (annoyed, happy, etc.)

I was captivated and very amused when I saw it follow me and try to find me but a little disappointed when it lost where I was and it struggled to find me again.

8. Were there any features that you particularly enjoyed or disliked about the car? If so, what were they?

I particularly enjoyed the fact that the car could autonomously follow me, and its ability to detect my presence using the infrared sensor was quite impressive. However, one aspect I disliked was the visible wires and technical components underneath the car. I believe a more aesthetically pleasing casing would enhance the overall appearance and protect the internal electronics and cables.

9. Rate the follow speed at which the product goes from 1 to 10, 10 being too fast and 1 being too slow and 5 being optimal. Explain your reasoning:

I would rate the follow speed of the prototype as a 3. The car felt too slow for example if I wanted to go for a run, at the current speed it wouldn’t be able to follow me.

10. How likely would you be to use the product whilst walking on a scale from 1 to 10?
Probably 5, it would be fun but I don’t think it could follow me accurately the entire way.

11. Rate how aesthetically pleasing the product is from 1 to 10. Explain your reasoning:
5, It isn’t that aesthetically pleasing because the wires are exposed and you can see the tech on the inside

12. Do you have any other comments or suggestions on how we could improve the car?
Make it able to find better when I turn drastically and definitely increase the speed at which it follows so it doesn’t lose me.

Assignment 1 Task 4

Team Alienware

Aims and Objectives

The aim of this user study is to assess the effectiveness of the most important features of an auto following carry case which includes the use of an ultrasonic sensor, servo motor to open the lid, infrared sensor, motor driver, humidity sensor, lcd screen, dc motors, wheels, and its physical implementation. This study's main goal is to evaluate the user experience and identify areas where improvements can be made.

The study's first objective is to evaluate the usability of the auto-follow carry case. We aim to understand how intuitive the auto following carry case is to use and whether participants can easily interact with the various features. This includes assessing the clarity and feedback provided by the sensors and LCD screen, and to evaluate the usability and functionality of the servo motor, infrared sensor, humidity sensor, and LCD screen in controlling the robot's movement and providing feedback to the user.

The second objective is to collect feedback on the physical implementation and build quality of the auto following carry case. This includes the size, weight, materials used, and overall design. We aim to understand whether the physical characteristics of the auto following carry case contribute to the usability and enjoyment of the product, or whether they detract from the overall experience.

During the study we will collect quantitative & qualitative data through observation and follow-up interviews which will provide more in-depth understanding of users' experiences and opinions. The results of this study will be used to inform future development of the auto following carry case. Specifically, we will use the data to identify areas for improvement and inform decisions about the inclusion of specific features. For example, if users find that the lcd screen is confusing or difficult to use, we may choose to redesign or remove this feature.

Overall, this user study will provide valuable information about the usability, engagement, and physical implementation of an auto following carry case. By evaluating the effectiveness of its features and collecting feedback from users, we can improve the design of the product and create a more satisfying user experience.

Participants:

Our participants require to be fluent in English and have some level of familiarity with technology, therefore some people will be excluded. They also must be able comfortable moving around, potentially jog, or run at times. Because of this, we will recruit university students studying at University of Technology Sydney. Students were chosen as they will provide a beneficially constructive analysis of our product, and because most will be fellow peers and will not be after any compensation. Due to the participants being students, the age demographic will be 18+. The participants do not require any experience with Arduino, or any specific technology used in the product. Participants will be both male or female, and range in heights. This is to see if there any discrepancies with the sensors not detecting certain body sizes/shapes compared to others and see to if factors such as long hair on females hinder the sensors' ability to detect when compared to shorter hair on boys.

Design and Procedure:

The observational study will use a mixed-methods approach, utilizing both quantitative and qualitative data to evaluate the robot's effectiveness and usability. The location of the study is a student apartment because it is located very convenient for everybody and has ample space to build a test course for the product. Everything will be recorded with a phone, with participants permission to film, and then stored with the name and the number of the participant. Every session takes about 15 minutes, with four participants that make up 60 minutes. We will ask our participants to navigate the robot in different environments, testing the robot's ability to follow a user while avoiding obstacles, and testing the robot's ability to store personal belongings. Quantitative data will be collected through the following test:

1. Testing the ultrasonic sensor: Participants will be asked to test the ultrasonic sensor by placing objects at various distances from the robot and observing how it responds. This will help evaluate the accuracy and sensitivity of the sensor and identify any potential issues.

2. Testing the servo motor: Participants will be asked to test the servo motor by opening and closing the lid of the robot. This will help evaluate the responsiveness and reliability of the servo motor and identify any potential issues.

3. Testing the infrared sensor: Participants will be asked to test the infrared sensor by moving their hands in front of the robot and observing how it responds. This will help evaluate the accuracy and sensitivity of the sensor and identify any potential issues.

4. Testing the humidity sensor: Participants will be asked to test the humidity sensor by placing the robot in various environments and observing how it responds. This will help evaluate the accuracy and sensitivity of the sensor and identify any potential issues.

5. Testing the LCD screen: Participants will be asked to test the LCD screen by observing the display and interacting with any menus or options available. This will help evaluate the usability and readability of the screen and identify any potential issues.

6. Testing the DC motors and wheels: Participants will be asked to test the movement of the robot by navigating it through an obstacle course or maze. This will help evaluate the responsiveness and reliability of the motors and wheels and identify any potential issues.

Additionally, qualitative data will be obtained through participant feedback after testing, to understand their experiences and opinions and to note down comments and suggestions they might have. (refer to Appendix)

Materials:

To run this study, a working prototype is required. The prototype consists of a chassis made from acrylic plastic, 2 motors dc, 3 wheels, cardboard, motor driver and several arduino inputs and outputs. Ample space is required to set up a course that can be filled with obstacles to test the product in different situations. There will be a phone used to record the participant interacting with the product. A follow-up interview will also take place, and with the participants' permission, will also be recorded. Some specific measures will take place such as the study will take place one participant at a time and each participant

Appendix

Follow-up Interview Question

1. Do we have your permission to record this interview

2. Did you feel like the instructions provided were clear and easy to understand? If not, what could be improved?

3. Was the use of the ultrasonic sensor intuitive? Did you understand how to interact with it?

4. How did you feel about the use of the servo motor to open the lid? Did you find it easy to use?

5. Did you find that the product was not able to accurately follow you? Do you think it was mistaking another object for yourself

6. Do you think the follow speed at which the product goes is too fast/slow
7. Do you think the maintained gap between the product and user should be increased/ decreased
8. Were there any features that you particularly enjoyed or disliked about the auto following carry case? If so what
9. Was the lcd screen clear and easy to read from
10. Were you able to store your belongings easily
11. Was the physical size of the product too big/small
12. Was the product too heavy/light
13. Does the product look aesthetically please
14. Is the product too noisy
15. How could we improve the functionality and usability of the robot
16. Do you have any other comments or suggestions?