Interactive Devices: Ultimate Friendly Object (UFO)

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As the general use of Unmanned Aerial Vehicles (UAVs) becomes increasingly common, their public perception presents as a significant obstacle to becoming widely accepted amongst the general population. For example, it is well-known that the mechanical appearance of a UAV and its moving components incites scepticism and even fear in most end-users within close proximity to it. Although several pieces of background HCI research have offered insights into how off-the-shelf drones impact user experiences during up-close interaction, there is very little research or design contributions to investigate how the appearances of UAVs impact end-users' willingness for it to land and take off from their body. We contribute to this research by conducting co-design and bodystorming sessions with users to identify user needs and opinions about drones. Through discussing and testing how different factors affect the willingness of users, along with allowing users to build their rapid designs, we discover that the users are more likely to be comfortable with a drone in close proximity if it is *"cute", has well-guarded blades and has a clear indicator of direction.* Also mentioned is the preference for a landing pad to be used to avoid contact with skin. Based on the qualitative data gathered in these user studies, we designed and built a drone that encapsulated the main requirements: guarded propellers, LED indicators, a utilised on-body landing pad and a cute, user-friendly "sun and clouds" visual design. We then evaluate our UAV variant by comparing the results of participants' comfort levels when in close proximity to the redesigned drone. We aim to open up the field for UAVs to allow for more close-up applications of human-drone interaction and to encourage drone designers to consider the most important factors that affect comfort and safety for potential end-users when a drone lands and launches.

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1 INTRODUCTION

The rapid introduction of drones to the global market has benefited a wide range of industries and organisations while also being distributed to recreational users. Drones are commonly associated with the military, primarily for reconnaissance missions and surveillance, but are also used more in emergencies by the police and fire brigade [1]. In emergency situations, drones save time and resources by providing visual support at a location and communication to the users interacting with it. By 2030, it is estimated that 900,000 drones will be operating in the UK's skies alone [2]. As the amount of drones populating the skies increases in the coming years, the external negative perception of drones from non-users also becomes an obstacle to address. The main concerns of modern-day drones are drone-related accidents and injuries, and privacy violations as a new way of committing crimes such as non-consensual surveillance and stalking [3]. Therefore, designing drones requires understanding human factors and concerns, and correctly addressing these problems in the design itself [4].

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Current Human-Drone Interaction (HDI) research has investigated drones landing and taking off from a human body, with a particular focus on determining which parts of the body are best suited for these actions [5]. The studies raise research questions that we can apply to our own study, most importantly: "how is landing acceptability influenced by drone design?". From the data gathered from previous research along with our own user studies, we deduce which body part is the best and safest landing domain, and which design features and applications to include in our design to achieve optimal user acceptability for the landing of a drone on a human body. HDI research has also looked at users' perception of drones, analysing users' levels of concern when drones are in flight and have the potential to have a collision [6]. This research offers insight into design considerations drone designers need to be aware of, such as the need for propeller guards and security mechanisms. From these findings we design prototypes based on achieving a safe method of landing a drone on a human, while also fulfilling users' comfort levels and enjoyment.

Our paper expands on current HDI studies, gathering user data to understand potential users' needs in a drone, and then designs and fabricates a friendly drone suitable for landing and taking off from a human user. We consider multiple human factors that contribute to the acceptability of drones in modern society, testing dummy prototypes on user groups to gather feedback and recommendations for our final design. We conducted co-design sessions and allowed participants to design their own drone prototypes according to what would make them the most comfortable in close proximity. We also carried out a bodystorming session to simulate flight scenarios using cardboard prototypes with a variety of different shapes, sizes and visual designs. These sessions inspired the goal of designing a drone which satisfies user requirements identified in our user studies and maximises user comfort when interacting with the close-proximity drone.

Our contribution opens up the opportunity for drones to be a widely accepted technology, and allows for drone usage to become more prevalent in daily life. Designing friendly drones that can land on a human body expands on concepts such as flying companion robots for social and health benefits and rapid deployment and recall of drones in emergency situations. Our design contribution opens up different approaches to drone design, especially focusing on becoming more interactive with humans, considering the appearance of the drone and safety components. Our implementation progresses drone design by encouraging future designers to consider human concerns and needs as a priority when distributing to a wider range of users.

2 RELATED WORK

In this section, we highlight background research in the field of Human-Drone Interaction. The related work explored below covers areas such as the human body as a landing location for drones, human concerns with today's UAVs, and how drone distances affect user comfort.

2.1 The Human Body as a Domain for Landing

Recent Human-Drone Interaction researchers have started to delve into testing parts of the human body as a domain for landing and launching drones. User studies have been conducted into finding appropriate locations on the body that users would be comfortable with and locations that can guarantee safety. Some design implementations have attempted to land a drone on a human user, although prioritising the mechanics of landing itself instead of making user-friendly design choices for optimal comfort.

2.1.1 Understanding Drone Landing on the Human Body. Methods conducted in this research [5] examine the suitability of different landing locations, such as the upper back, arms, head and legs based on user surveys. The answers from the surveys brought up a range of different factors addressing drone landing sometimes being unsuitable, including the risk of mechanical parts having the potential to cause harm or injuries and the size, shape and weight of the drone. Another key factor that is shown to impact the suitability of a drone landing on a human is the overall visual design choices made. In the study, users deemed drones unsuitable to land on them based on a militaristic appearance or an insect or spider-like character [5]. From our own user studies and the research conducted in this paper, there is a common trend that a friendlier, less intimidating design is the best for making the drone more suitable in the proximity of human users.

From evaluating results in user studies, the research addresses the most important themes in the drone landing scenario. These themes are broken down into safety, comfort and appropriateness, convenience and restrictions, visibility, drone capabilities and interaction and control. The themes represent the key user concerns and most important elements that need to be addressed in a landing drone's design. Users from the study had the opinion that the drone was unacceptable to fly around areas with *"too much risk of getting severely hurt"*, and more acceptable areas were body parts with less risk to vital organs and the hair of the user. Convenience was also uncovered as an important factor for users: for example, the leg would be an inconvenient area to land a drone as it carries the whole weight of the user's body. Users also wanted the drone to be visible when it lands and takes off, which would lead us to believe the back isn't the optimal choice. Also, users gave technical considerations to the drone itself, preferring drones to land on body parts that are horizontal, with the extra requirement that it stays stable when the user is walking.

2.1.2 SwarmCloak. The use of landing pads as a format of landing a drone on a human arm has been briefly explored [7], utilising sensors to ensure a safe landing. The two different prototypes built in this study are made for the arms or hands on a human body. The photo-transistors in the landing pad are faced upwards to detect light emitted from the array of LEDs built in to the bottom of drone, which indicates that the drone is therefore safe to land. The testing of this study showed that using autonomous detection proved to be an accurate way of landing the swarms of drones on the different launch pads.

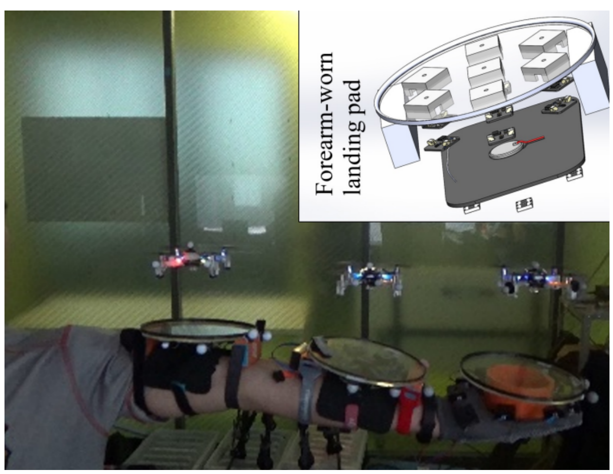


Fig. 1. SwarmCloak: Landing of a Swarm of Nano-Quadrotors on Human Arms [7]

What this design approach does not consider is the appearance, shape and safety concerns of the drone itself, as a default drone is used in testing of the prototype. SwarmCloak allows for a swarm of small drones to land simultaneously on the user's arm on different landing pads along the cloak. However, the design is very large and reduces the user's mobility with their hands, with the cloak having many mechanical components such as sensors and landing plates from their fingertips all the way up to their elbows. As the demand for drones increases in the future, a design such as the SwarmCloak could be seen as unfriendly and inconvenient to the everyday user.

2.2 Human Concerns with Modern Drones

Drones have been designed to cater to various aspects of human life, including the film and photography industry, emergency response, as well as the package delivery industry [8]. Despite the potential of drones to enhance convenience in our daily lives, their usage by the general population remains limited, rendering them an uncommon phenomenon [9]. The following discussion endeavours to examine the factors that hinder widespread adoption of drones and propose a design concept to address human apprehensions associated with drone use.

2.2.1 Safety Concerns: The Risk of Drone Collisions.

The paper, *"A Drone Nearly Hit Me! A Reflection on the Human Factors of Drone Collisions"*, highlights a significant obstacle to the widespread adoption of drones, namely the public perception of drones as unsafe and potentially dangerous [9]. Owing to several notable incidents and the risk of causing personal injury or substantial property damage, drone crashes are a prominent concern among the public [10].

The aforementioned paper presents a study that examined the effects of controlled drone collision exposure on a sample of twenty participants, who were subsequently interviewed [9]. Zhu et al. proposed a novel method to safely simulate the use of drones with participants, involving a specially designed experiment that incorporated a net to protect participants from any potential harm caused by the drones [9]. According to the findings of this study, the drone's propellers are a significant source of concern for users, with the noise they produce also attracting some attention [9].

Research indicates that predictability is crucial in reducing the perceived risk associated with drone operations, fostering a greater sense of comfort among individuals [9]. Concerns were raised about the unpredictability of fully autonomous drones, leading to fears of potential collisions. Consequently, features that help users discern the drone's flight direction could potentially alleviate apprehension associated with drone usage.

2.2.2 Factors Affecting Users' Comfortable Distance in Interacting with Drones.

Recently, there has been a growing interest in determining the appropriate distance between a drone and a human during human-drone interaction. Proxemics is a significant factor to consider in the design of Human-Robot Interaction (HRI) as it affects users' sense of safety [11].

Most state-of-the-art drone studies incorporate the observation of the user's preferred distance for comfortable interaction with drones. In a study that involved stimulating an autonomous functional drone with participants, researchers found that all participants were comfortable with the drone in their social and intimate space, rather than keeping it at a public distance [12]. This finding is consistent with multiple studies that have shown participants' comfort with drones at close proximity [13]. A noteworthy finding from a study examining the impact of varying drone altitudes on participants' heart rates indicates that altitude may not be a substantial factor [14].

Nonetheless, although participants expressed a willingness to allow drones in close proximity, there exists a specific threshold distance at which users perceive a sense of safety when engaging with drones [13]. It is important to note that aerial robots exhibit a greater distance threshold compared to their terrestrial counterparts [13], while robots designed to resemble human appearance demonstrate a reduced threshold [13].

It is hypothesized that participants will exhibit higher levels of anxiety when drones approach them compared to when drones move in other directions. The study conducted by Alexander Yeh et.al investigates the impact of voice notifications on users' perceived comfortable distance when approached by a drone [15]. Specifically, the study aims to determine whether the addition of indicated voice notifications during drone approaches can reduce the level of anxiety experienced by participants [15]. This study showed that the proximity deemed acceptable by users is decreased by 30% when a friendly voice is employed [15].

2.3 Gap in Literature and Aim Of This Study

Outlined above are several areas of research that are directly related to human-drone interactions and the general perceptions of modern drones.

Previous research has explored comfortable body areas for drone landing [5], but there remains a gap in addressing the issue of drones inducing fear due to their unfriendly appearance. Studies have also estimated comfortable distance thresholds, suggesting that drones with a more humanised appearance have a larger threshold [13]. Drawing from these findings, our research aims to identify additional visual attributes that are perceived as friendly, beyond merely human-like characteristics. To achieve this, we plan to undertake a user-centered design process to develop a more agreeable drone appearance, informed by data garnered from our user studies.

Another key insight from the literature is that drones equipped with technologies indicating their next flight direction enhance user safety [15]. Current technologies for notifications, such as voice alerts, can be easily overlooked in both noisy environments and in the presence of the noise generated by drones themselves [15, 16]. To overcome this, we propose a visual notification system to make the drone's movements more predictable to users. Additionally, we plan to integrate this visual notification system with our designed drone appearance, aiming to create a more user-friendly overall design.

Building upon existing research, our primary objective is to enhance the drone's user-friendly. This will be achieved by focusing on two key aspects: developing a approachable exterior design and incorporating visual notifications that assist users in anticipating the drone's movements.

3 INITIAL USER STUDIES

Our initial user studies consisted of one codesign workshop and one bodystorming session. We chose to use these two methods to get a variety of feedback from our participants, informing the design of the drone based on their thoughts. Codesign workshops are beneficial for both designers and future users, as they ensure the end-user's voice and input is heard from the beginning of the design process and allow designers to work with a better understanding of users' needs.[17] Bodystorming is a method of user study particularly suited to movement design, as it allows participants to engage in "embodied ways of thinking" from an early stage in the design process.[18]

3.1 Codesign Workshops

3.1.1 Participants. We ran the codesign workshop twice, with the same method but different participants. Codesign Workshop A involved five participants (A1-5), while Codesign Workshop B had two (A6 & A7). Our participants were selected using convenience sampling, with each team member reaching out to their peers. This allowed us to recruit participants easily and efficiently, but risked our sample group not being fully representative, with a possibility of researcher bias [19].

3.1.2 Procedure. Each 45-minute codesign workshop was divided into halves. First was the discussion/focus group, where we asked the participants several questions about their experience with drones and what they would want from a drone that landed on them. Second was the design section, where we gave the participants access to modelling clay, paper, and pens, asking them to use the supplies to think about what shape they would want a drone to be.

In order to interpret the responses of our participants, we recorded audio throughout both sessions, then manually transcribed them for analysis. We used thematic analysis, "a method for identifying, analysing and reporting patterns (themes) within data,"[20] to analyse the transcripts, deductively identifying a number of codes. See codebook in Appendix for full list of codes.

In the first session, the larger number of participants (A1-A5) prompted more discussion, with participants bouncing ideas off each other, though this did lead to more unrelated discussion. The second codesign workshop had only two participants, A6 and A7, which meant the participants took more time to think about their responses and gave longer answers.

3.1.3 Results.

Initial Background. Of the first group, the participants did not have much prior experience with drones, with only A1 mentioning that someone they knew owned a drone. The two main factors named in their lack of experience with drones were the cost of drones and not being sure what to do with a drone if they had one. Neither A6 nor A7 had any personal experience with drones, but immediately acknowledged some of the issues with them – that they create “a lot of noise” [A7]. They also mentioned that using them in a crowd [A7] or near an airport [A6] could be dangerous, as well as expressing concerns about drones “invading privacy” [A7].

A2 also mentioned privacy concerns, not liking the idea of drones “looking in people’s windows”. A4 worrying about drones “getting caught in hair” prompted agreement from all the other participants. The participants also listed the threat of drones to commercial aircraft [A1], the military applications of drones [A3], and the risk of their batteries exploding [A4].

Applications of Drones. The group initially discussed using the drone for deliveries or carrying shopping, before suggesting a “companion” drone, which could make noises in response to the user or follow them around and play music. The “cuteness” of the drone was important to most, A3 confirming “that’s the main thing.” Both A6 and A7 focused on a visual/camera application, A6 suggesting that they could offer “multiple perspectives of the same thing”, while A7 mentioned “taking videos on a grand scale”.

Proximity. Responses were mixed regarding proximity – some participants [A1 and A3] seemed unconcerned with “small robots” flying nearby but were concerned with the risk of drones getting tangled in their hair, while A4 said they would prefer drones staying much further away – 2-3 metres. A6 again brought up the factor of hair length but said that as “drones tend to be quite well protected”, they would be comfortable with a drone coming “quite close”. A7 said "if I don’t know who is operating a drone and what purpose it is for... as far away from me as possible... more than five meters."

A4 brought up that they would want to know any drone flying near them was being piloted by someone who was in control and would respect their personal space, stating that they would like to see “a culture around don’t send your drones near other people without their consent”. They referenced seeing incidences of drones “just straight up flying into people,” either due to user error or ineffective self-piloting, and described the “erratic” movements of drones as a worrying factor.

Size. The size was also a factor in comfort levels. A3 initially liked the idea of a drone the size and shape of a dragonfly, but changed their mind after another participant pointed out a drone that size would be used to spy on people – "that's the only thing you could do with a drone that small". A1 said they would be unsure how any drone wider than 1ft would feasibly land on them, while A5 noted that if a drone was "too small", there would be a risk of them not knowing it was there.

Discomfort with Drones. A2 said that "drones are inherently terrifying". One of the key reasons for this, as stated by A1, A2 and A4, was privacy, as well as "vague risk of injury" [A1]. Identified risk factors included the mechanical parts [A7] and drones being typically solid and mechanical [A6]. A6 believed that rotating parts of a drone being visible is intimidating, comparing it to getting too close to a fan.

Making a Drone Friendly. A3 suggested that it was mostly the purpose or regulation of drones that was worrying, and that if a drone design was small and "animal shaped", it would be less scary. A1 thought "a lot of people can find small electronic things cute". A6 said product design would be a big factor, and that a drone with a "cute" look to it or a more "docile appearance" would be less threatening. A7 said they completely agreed - "making it look cuter might be less intimidating".

To counteract unpredictability, participants suggested a slower-moving drone [A4] or a drone with indicator lights [A1]. A2 said that giving a drone a "face" would give it a clearer direction of movement.

A6 said that making the drone "feel less mechanical" would make people more comfortable. A6 also suggested that giving the user "something it could land on", that the user could put wherever they wanted, would give "a sense of reassurance". They also mentioned a "sense of customizability" to make the user feel the drone was "specifically catered" to them."

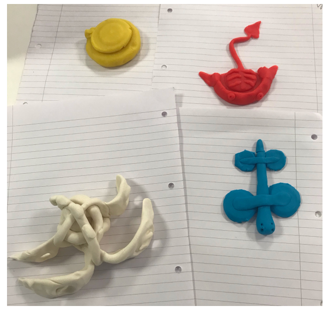
Drone Landing on Body. A1 said that they would be comfortable with a drone landing on them if it was their own drone and they knew that it could do so without injuring them, while A3 simply stated "if it's consensual and predictable". A4 echoed the concept of consent, stating an aversion to a drone being landed on them without permission. A5 specified that "if it came anywhere near my face, I'd be instinctively just swatting it".

Discussing areas of the body that would be comfortable landing spots, the group identified arms, shoulders, and the top of the head, though A4 pointed out that landing on the shoulders would return to the issue of propellers getting tangled in hair. They pointed out that if the drone landed on the user's hands or arms, it would require active consent from the user in the form of lifting their arm for the drone to land on. A3 mentioned that if it used a "landing dock", a user carrying one could be "taken as implicit consent for a drone to land there". A7 said they would be most comfortable with a drone landing on their head, "because that's the most stable". A6 pointed out that there would be "a lot of factors it could get stuck in on your head", and suggested shoulders might be better, but "the hair thing still stands". A7 suggested the arm, and A6 agreed that that would be the "next best".

Regarding the landing mechanism, A6 said they would want "something satisfying to show it has gone into place", either magnets or a gripping mechanism, though the latter "might feel a bit clanky."

3.1.4 Modelling. In the modelling/design part of the workshop, the participants were shown some photographs of existing drone models for inspiration. A4 specifically mentioned that one of the designs looked too much like an actual bird, especially if it was moving at high speed, and that it would prompt a "fear response".

Fig. 2. The models produced by (clockwise from top left) A4, A1, A3, A2

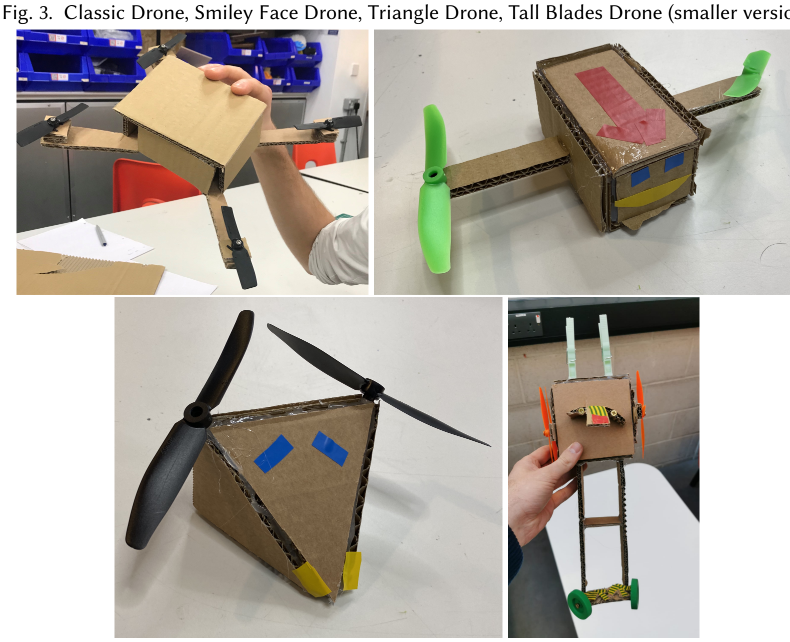


3.2 Bodystorming Workshop

For our bodystorming workshop, we planned to use cardboard prototypes to assess the comfortable range of proximity of a drone to a user.

3.2.1 Prototypes. We prototyped four different drone designs out of cardboard and plastic propellers, using the ideas gathered from our first user study for inspiration.

Fig. 3. Classic Drone, Smiley Face Drone, Triangle Drone, Tall Blades Drone (smaller version)



Classic Drone. Our first prototype was created to resemble a "standard" drone design as is currently available commercially, with no decoration or guards around the propellers.

Tall Blades Drone. We created two variants of the same design – a drone where the propellers were attached at the top of long stalks, for it to be able to land on a person's shoulder while the blades remain far away. The initial prototype was larger than expected, so we made a smaller version of the same design to compare.

Smiley Face Drone. This design was like the Classic Drone in that it had a blocky shape and propellers on arms, but we tried to create a more ”friendly” appearance by giving it a smiling face design. We also added an arrow to indicate its direction of movement.

Triangle Drone. This design was smaller and had a triangular shape, with two propellers on the main body of the drone.

3.2.2 Procedure. The bodystorming part of the session was executed in a "Wizard of Oz" fashion – one team member holding the cardboard prototype and moving it closer to the participant while playing drone sounds using a mobile phone speaker. The participants were asked to speak up at the point when they felt uncomfortable with the drone's proximity. After the bodystorming session, we would ask participants to fill out a questionnaire to quantify how much each factor affected their opinion on the drone's proximity.

3.2.3 Results. Although we planned to run the bodystorming session with four participants, only one showed up at the scheduled time, and due to constraints with room booking we were not able to reschedule. Our single participant stated their opinions on each of the drone prototypes and offered more general insights.

Drone	Opinion
Standard Drone	Not very safe, a lot of dangerous areas which may create discomfort
Tall Blades Drone	Safer than standard, appreciates that blades are far away
Smiley Face Drone	Feels reliable, appears friendly and therefore more comfortable, small and visible
Triangle Drone	Cool design, propellers are in a small area which reduces the risk of damage, indicates where it is going

The participant named a number of other factors that came to mind during the study:

- You feel less scared of a drone when you can see it
- Drone needs to feel steady when it lands on you
- Arm feels safer and more controllable than shoulder
- The drone needs a friendly design to increase the comfort levels
- Drone needs to be small and appear steady
- It needs to indicate where it is going as well as make an impression of a fully functional device

4 DESIGN AND IMPLEMENTATION

4.1 Overview

This section presents the design and implementation of our drone prototype. We describe the decision-making process that took place during the conceptualization and iteration stages. We explain the rationale for incorporating safety and user-friendly features into the design, as well as the modifications made to balance safety concerns, versatility, and functionality, making the drone suitable for a range of applications. Moreover, we ensured that the drone's aesthetic is approachable and the appearance of the drone visible, making it welcoming to users. The insights gained from the data collected in the previous user study have informed our design decision-making process.

4.2 Initial Research and Design Considerations

This section provides an introduction to the initial stage of the research in the design process. We integrated the research insights discussed in this section with the data gathered from user studies to inform our design decisions.

Lightweight materials for the frame, such as carbon fiber, plastic, or aluminum, not only improve flight performance but also facilitate the implementation of biomimicry-inspired design elements in drones [21]. Biomimicry drives innovation in safety, efficiency, dexterity, and versatility of drones [22]. For instance, researchers emulate bird-like maneuvering and hovering capabilities to enable drones to execute complex tasks and adapt to varying flight conditions [23]. Ornithopters, biologically inspired aircraft that fly by flapping their wings, may offer advantages in versatility, safety, and noise reduction [24]. Pufferfish-inspired designs with flexible frames can absorb shock upon impact, minimizing damage and improving drone safety. Incorporating emotional and anthropomorphic design enhances Human-Drone Interaction (HDI) [25], as drones with features such as eyes, curvy lines, and animal-like attributes are perceived as more friendly, trustworthy, and likable [26]. Using materials like silicone or mimicking animal appearances and textures can create a less intimidating design [27]. The GearQuad drone [28] features a carbon fiber cage and densely packed plastic wire grids to ensure safety during operation. Similarly, a tiny quadcopter UAV incorporates an elastic membrane sandwiched between rigid plates for a flexible yet durable frame [29].

The existing research on drone building technologies has inspired us to incorporate features such as lightweight materials, maneuverability for stable landings, and aesthetics and symbolism into our designs. This led us to design a drone with an outline of a sun above clouds covering the propellers and a landing pad. This sun-like drone not only embodies the essence of nature's brilliance but also symbolizes the positive mental support that sunny days can bring [30]. A vivid color palette of bright yellow or gold evokes feelings of warmth, hope, and energy[31]. Additionally, LED lights on the propellers create a brighter glow in darker environments, further enhancing the drone's visibility. These design concepts have the potential to enhance the drone's user-friendliness by incorporating indicators of positive effect and implementing the notion of a stable landing through the inclusion of a landing pad.

The initial design concept for the drone was nature-inspired, drawing upon various bird species, particularly parrots, which can act as a friendly companion by perching on the user's shoulder. However, after conducting user studies, the acceptability of this feature was found to be contentious. While some participants believed that the bird-like design was appropriate as both drones and birds can fly, others expressed concern regarding the bird-like appearance. Consequently, we decided to change our approach and opted for a "sun and clouds" themed drone design as our final concept.

4.3 Method: User-Centered Design Approach

The approach of User-Centered Design has been proven to be effective in improving the usability of products during the design phase, as noted in Mao's research [32]. Given the project's focus on user experience and incorporating user-friendly features, this method is highly suitable for this project. The basic concept of this method is to involve users in design phases. User-centered design methodologies we employed, such as body-storming and co-design workshops, provided valuable inspiration and feedback for drone design improvement. These methods were applied in the design process to ensure that the final product meets the requirements and expectation of the target user group.

4.4 Design Workshops and User Feedback

The user studies generated ideas for safe and user-friendly drones. They highlighted the importance of indicating drone movements and maintaining a safe distance from the user's face, while participants voiced privacy concerns and other possible dangers caused by drone use. As a response to these safety concerns, we decided not to incorporate features related to the drone camera.

Furthermore, the participants emphasised the need for stability when a drone is landing on the body. While the head was rated the sturdiest alternative, worries regarding barriers such as hair were highlighted. As a result, the team decided to construct the drone to land on the arm, which provided a more accessible and stable landing surface.

A drone's design must strike a balance between safety features, aesthetic appeal, and usability. Throughout the design phase, intensive user testing and feedback sessions were conducted to gather feedback from the target user group and guarantee that the final product met their expectations. Our drone design's implementation phase was centred on addressing the main issues and preferences discovered through user research and focus groups. We were able to construct a drone that suited the demands of its target demographic by iterating our design consistently.

4.5 Component Selection and Manufacturing

Drone appearance can affect user trust and comfort [33]. Friendly-looking drones are preferable, which can be achieved by using rounder shapes, bright and natural colours, and incorporating friendly faces (see the result in previous user studies, 3.1.3). Lightweight and safe decorative elements can be created using vinyl decals, paint, washi tape, foam sheets, fabric, and 3D-printed parts. Movement and status indicators improve user understanding and comfort. LED lights showing movement direction, 3D printed loops guarding propellers, and internally lit components displaying temperature status are potential solutions. Selecting safe, lightweight materials is vital.

4.6 Propeller Containment and Safety

It is possible to construct a drone that is not only safe and practical but also enjoyable to use if one employs user-centered design approaches and modern manufacturing techniques in the production process [34]. It is essential to place a priority on safeguarding users and their experience as drone development continues to advance. This will pave the way for a broader acceptance of drones for usage in a variety of applications.

A primary consideration is propeller containment to reduce injury risks during collisions [9]. Options include lightweight propeller nets or cases made from foam or soft plastic mesh, which can be attached using screws, clips, or other mounting methods. Another approach is horizontally containing propellers, reducing contact risk but potentially increasing drone weight and reducing maneuverability. Horizontal propeller guards are one solution for containment, improving safety and allowing a friendlier drone appearance. Alternatively, a semi-circular shell encasing the drone offers more protection but may impact performance due to added weight. Colour choice depends on drone visibility and context. Bright and natural colours are recommended, although they may present challenges at higher altitudes or resemble other objects, like birds.

To improve safety, drones equipped with unshielded propellers can be enclosed in protective cages, but these structures face trade-offs when it comes to their designs. The frame is stiff enough to carry the drone's weight and withstand the thrust of its propellers but softens during collisions to avoid permanent damage [25]. Following this, we used cutting-edge manufacturing methods to produce a drone that was attractive and useful. We created unique propeller guards and flexible frames using 3D printing that were motivated by natural forms like pufferfish, bats or hummingbirds. These elements enhanced the drone's safety while also giving it a more natural, nonthreatening appearance [35]. A soft, net-covered landing pad surrounding propellers offered increased user comfort.

4.7 Aesthetic Elements and Interactive Features

Landing pads with a magnetic effect that turns on or off based on the drone's position and intention simplify attachment and detachment [6]. A friendly overall drone design, including round shapes, warm colors, and a rounded 3D printed cover for internal components, creates a non-threatening appearance. Movement indicators, such as LED lights or visual cues, prevent accidents by signaling the drone's intended direction. Audible or visual malfunction signals allow users to address issues quickly.

We prioritised the selection of high-quality components such as motors, lightweight materials, and batteries. We chose a powerful yet energy-efficient motor to provide the drone with optimal speed and maneuverability. We opted for high-capacity batteries to extend the drone's operational time, addressing the concerns of our focus group participants. To create a childlike and playful design and appearance, we aimed for relatable and highly interactive features.

Focus group participants discussed the importance of product design and suggested making the drone appear less mechanical and more organic. Incorporating round shapes, we spray-painted the drone with bright yellow colors all over and added a friendly contour of an emerging sun to contribute to a more approachable drone appearance for increased visibility. We covered the propellers with hand-sewn clouds resembling toy pillows, which were made of cloth on the outside and filled with cotton wool inside. The circular covers were painted in a warm yellow, and the drone was topped with a yellow half-sphere dome, 3D printed to create the impression of a sun. The drone's arm guard was created using a sewing machine, while the rest of the components were hand-sewn.

The drone is equipped with an Arduino board for processing commands and an HC-05 Bluetooth module for communication with a mobile app for Bluetooth terminal. The LED lights can be manipulated through the mobile app, where we send commands 1-5, setting the Arduino code for different actions. Commands 1-4 are for directions, causing the LEDs to flash separately, while command 5 causes the LEDs to flash together, indicating the drone's intention to land. A camera was incorporated underneath the dome, preventing users from capturing aerial footage and images. Users were concerned about privacy issues, thus it was decided it was best to disable the ability to minimise the possibility of unintended security concerns. The 3D printed components included the sphere, dome cover, battery case, and propeller guards, while circuits were soldered onto stripboard and cut down to fit the drone. The remote controller allowed for easy operation of the drone, with additional features such as LED manipulation and camera control accessible through the Bluetooth-connected mobile app.

5 EVALUATION

5.1 Evaluation User Study

In order to evaluate our design, we have conducted a primary user study based on the initial appearance of the drone, and a follow-up user study with a redesigned drone. Eight users participated in the group discussion, which consisted of two parts. In the first part, we carried out a bodystorming session regarding safety distances when flying the drone; in the second part, users were asked to evaluate the drone with respect to its appearance, design and functionalities. After collecting feedback from users, we have modified our design based on the Aesthetic Design Theory as set out in [36]. Although the framework consists of seven elements, however, we have selected a few which are relevant to our project. After some modifications to the drone, we conducted a follow-up user study to evaluate the final product, where nine users participated in the group discussion. The results from both user studies are compared in the following sections.

5.2 Safety Distances

The main objective of the bodystorming session was to evaluate how users feel when the drone approaches them, and at what distance they start to feel uncomfortable. In the first part of the session, the drone was flying towards the users at different levels: eye, above head, and waist; in the second part, the drone was approaching the users from sideways.

In the first part of the primary user study, all users expressed that they felt unsafe and concerned as the drone was approaching them, no matter the flying height. When the drone was approaching the users at eye level, two users felt unsafe as they worried the propellers would cut their faces, and six users felt concerned as they thought the propellers may get tangled in their hair. During the experiment, the average distance when users started to feel uncomfortable as the drone was approaching them was 80cm. However, the drone was able to get about 20cm closer to users when it was flying at the waist level; all users expressed that they felt much safer when the drone was flying at a lower level. Two users explained they could just push the drone away or be able to dodge in time in case of an accident, three users explained that seemed less of a threat. On the other hand, the results of flying the drone above head level were controversial. Four users welcomed the idea as long as the drone was flying far above head level, as this felt like the drone was not coming for them; two users expressed strong opposition against the entire idea, as they worried casualties may be caused in case of a mechanical failure.

In the second part of the study, we experimented with the drone approaching the users from the side. The safety distance increased by 10cm to 90cm when the drone was flying at eye level. Two users mentioned that was the distance when they noticed the drone with their peripheral vision. Three users expressed the concern that they would not be able to react in time before the drone got too close. Similar to the first part of the study, users expressed less concern when the drone was flying at waist level, and did not like the idea of it flying above head level.

With the above results in mind, we have redesigned the drone with the ideas as set out in Section 4, then conducted a follow-up user study to evaluate it. In the first part of the follow-up user study, all users expressed positive feelings towards the redesigned drone. Two users stated the redesigned drone has a more friendly and appealing appearance, making it more approachable to users; other users gave the general comment that the drone now looks "cuter" and "nicer".

During the experiment, the distance when users started to feel uncomfortable as the drone was approaching them had largely decreased by 50cm, to an average of 30cm. Six users expressed that they would allow the drone to get even closer to them when it was flying at waist level, and three users expressed that they would not mind the distance at all, and felt completely fine even if the drone crashed into them. Despite the safety distances for flying the drone at eye and waist levels largely decreased, five users still did not welcome the idea of the drone flying at above head level, one user expressed that it has to be far above head, and only two users did not mind.

In the second part of the study, we experimented with the drone approaching the users from sideways. Due to the cuter and more approachable appearance of the drone, all users stated the safety distance remains the same as it was approaching from the front.

5.2.1 Landing Pad. One of the most important features of our design is that the drone lands on humans. The landing positions of the shoulder and forearm were compared in the user studies.

In the primary user study, two users expressed discomfort when the drone landed on their shoulders as it was too close to their faces; two users were fine with it. However, all users expressed that the drone landing on the forearm would be much better as it felt safer, and users can always control the distance between the forearm and the body. With this in mind, we created a landing pad on the forearm and had it evaluated in the follow-up user study.

In the follow-up user study, all users expressed that the landing pad felt comfortable on their forearms as they could barely feel it. Three users pointed out that the use of magnets made the drone land more stable on the landing pad, and two users mentioned they could still move their arms freely even with the drone landed on them. Among the nine users who participated in this user study, only one user expressed the feeling of unbalanced weight when the drone landed on the forearm.

5.3 Appearance

In the primary user study, many users had negative feedback towards the initial appearance of the drone, and we have picked out the following three points that all users expressed concern to work on. Firstly, there was no protection from the drone with respect to the propellers. Users worried that the propellers would cut their faces and eyes, and get caught in the hair. Secondly, the shape of the drone was too angular with many mechanical details left seen. Users pointed out that having a more rounded design would make the drone look *more user-friendly* and *cute*, which are essential elements of being a companionship robot. Thirdly, the current colour scheme of the drone (i.e. red and black) does not look friendly at all. Users suggested using brighter or more natural colours, such as yellow and pink. A user remarked that the colour of the drone should make it stand out from its surroundings as a safety precaution - for instance, a blue drone might blend in with the sky when it is flying high up in the air.

After taking users' feedback into consideration and referring to the aesthetic design framework as mentioned above, we decided on a sun and cloud design. The new design includes the upper hemisphere of the sun covering most of the mechanical parts of the drone; guards were added to the propellers as sunbeams to prevent them from hurting users by accident and clouds were added to the propeller guards. The redesign adopted *formal* and *radial* balances, which are more appealing to the eyes.

A major element in the redesign is the LED lights in the clouds, which was proposed by users in the user study as a safety precaution. With the indicator lights on each propeller, users are able to tell which direction the drone is heading, so as to prevent crashes from happening. As the redesign only has two elements and colours, we believe it is a *simple* and *clean* enough design.

In the follow-up user study, all users found the redesigned drone cute and looks friendly with an appealing appearance, making them more willing to have it approaching them. Four users pointed out the use of yellow distinguishes the product very well from its surroundings, one user expressed that the colour stands out so much that the product will not be lost. One user questioned why were the propeller guards not in blue as the hemisphere resonated with the sun, however, this is as designed because we did not want any part of the drone to blend in with the colour of the sky; and this design idea was realised by another two users.

5.4 Functionalities

With the aim of designing a companionship robot, this is an important message to be conveyed to users.

In the primary user study, users were asked to describe the intended functions of the drone. Users tend to think of it as a functional robot, for instance, two users thought it could help to carry deliveries, and four users expressed that they would use it to take pictures. This clearly shows that the idea of creating a companionship robot is not obvious to users.

The follow-up study was carried out after the redesign, and the message of creating a companionship robot was well received by users. Six users thought it looked like a final product now when compared with the initial drone, three users expressed that it looked like a friend now, and one user found the redesigned drone "pettable". Overall, we believe the redesign was a success, as it has turned most negative feedback into positive one; and we have also successfully implemented a new design with ideas as suggested by users.

6 CONCLUSION

6.1 Main Contributions

Design: user studies and research. The main contributions of this project were made by conducting several user studies as well as workshops to determine different aspects of a drone flying near people. The first part of the process was to determine the best shape and different aspects of the components that would be most comfortable for a close-range interaction with the drone. Our studies have found that:

- **Safety measures**: the drone needs all of the safety measure that are possible, to decrease the level of discomfort when the device approaches a person
- **Indicators**: the drone needs a way of communicating its plans and movements, which can be done with indicators. This will make it predictable and therefore increase the level of trust between the device and the person.
- **Appearance**: the drone needs a way of making itself appear less dangerous, additionally decreasing the level of discomfort of it approaching a person. This can be done by implementing some sort of a friendly-looking, soft cover for any pointy parts of the hardware.
- **Visibility**: the device needs to be made with a set of colors or shapes that will make it very clearly visible, making it less intimidated.
- **Head area**: our studies have also found that no matter how many safety and predictability measures we have taken, it was found that the users never feel comfortable with the drone being around the users' head. This should be considered in any designing process of a drone interacting with a person.

Implementation: software and hardware. After our user studies were done and the data analysed, we used the main conclusions, listed in the previous subsection, to create and implement a number of additions and modifications to our drone. We used various methods in making the drone safer and more comfortable for interaction with the drone. To show what can be done with a drone made for safe interaction between itself and a person, we also designed and created a prototype of a "landing pad" which is used for landing the drone on a human body, typically a forearm. The contributions to hardware and software, each reflecting the conclusions from the user studies, of the drone is listed in below:

- **Safety measures**: 3D printed propeller guards and a overall cover for any mechanical parts, as well as any wires and exposed mechanical parts.
- **Indicators**: LED lights on each of the propeller guards,m clearly indicating the direction of movement of the drone
- **Appearance**: We designed the cover for the drone was made to resemble sun and clouds, which were mounted around the propeller guards, additionally making it softer and safer.
- **Visibility**: We spray painted any 3D printed parts in a yellow color, which contrast well in most of the backgrounds and makes the drone clearly visible.
- **Head**: Our landing pad was first meant to be placed on a shoulder. but after we have found the head area shouldn't be considered, we decided to place the landing pad on a forearm.

Evaluation: user study. Through research and conducting user studies, this paper contributes to developing principles for safe human-drone interaction. User studies played a significant role in this project, as our redesign ideas were heavily dependent on users' feedback. The below highlights the most important feedback we have received from users from the user studies, which we believe to have a huge contribution to this project:

- **Safety distance** — In the primary user study, the safety distance was about 80cm from users. The initial, unmodified appearance of the drone made users feel reluctant for it to get closer. However, after the redesign, the safety distance has significantly decreased to 30cm.
- **Appearance** — The key factor to the reduced safety distance is due to the improved appearance of the drone. In the primary user study, users found the drone being too mechanical with all the electronic parts left exposed. Users expected a drone to look *cute* and *friendly* in order to be approachable, therefore, we have redesigned it accordingly.
- **Functionalities** — In the primary user study, the idea of a functionality robot was perceived by users, which was not what we intended. Therefore, through redesign, we successfully conveyed to users that we were trying to build a companionship robot.

6.2 Current status and evaluation

We believe this project has been a success, as we have met our initial objectives, as well as implemented a redesign according to the feedback collected from the user studies. The following highlights our major achievements in this project:

- Users' perspective of a drone has changed from being functional and mechanical which they felt uncomfortable with as it approaches, to feeling safe and friendly and welcoming as it comes closer with our proposed redesign. The drone is also able to interact with humans, which brings along many benefits. One of the major achievements of the redesigned drone is to convey the message of positivity with uplifting modifications.
- With the project being heavily dependent on users' feedback, we have incorporated most feedback collected into our redesign. To further enhance the redesign, we have taken into account other design guidelines which were meant to aid creation of an interactive-friendly drone.

Despite achieving the objectives mentioned above, we highlight two features we did not achieve:

- Our drone was not allowed to actually fly. The UK rules for flying a drone state that the weight of a drone must be less than 250g if it is flown without a licence [37]; however, our drone was above this weight limit due to limited available resources while building the redesigned drone.
- Noise reduction features were not implemented. As reflected in our user studies, one of the major concerns is the potentially loud noise created by the drone while flying. However, as we did not have suitable materials, this feature was not implemented. Coincidentally, the noise created by the drone as it was flying was actually quite low. Therefore, although the feature was not implemented, users' concerns were reassured.

6.3 Future development

6.3.1 Limitations of the project. One of the key flaws of our current implementation is the weak magnets connecting the drone to the landing pad. Due to budget limitations, we had to make a trade-off between strong magnets which attaches securely to the drone and weak ones to allow for easy takeoff. The ideal solution to this would be to make use of electromagnets, which would allow more precise control of the drone's takeoff and landing. With the ability to activate and deactivate the electromagnets when required, the drone would be attached securely during the landing process and able to move freely for takeoff.

As of the completion of the project, the drone is currently operated by remote control. A way to increase the precision of the drone's flight, takeoff and landing could be to make use of artificial intelligence in order to make the drone autonomous. The device could, on its own, precisely take off and land on the pad, without the need for a human controller, and complete different tasks given to it by the operator. Operation of the drone could be completely "hands-free", with the ability to command the drone by voice or gesture. However, introducing AI to the drone can carry a lot of different risks and potential dangers, so it would have to be carefully researched in order to reach the highest level of safety and not endanger the user or anyone around them.

An area of design that we were not able to fully explore was how the shape of the drone affected its aerodynamics and motion. We lacked the aeroengineering knowledge to consider these factors in depth or the time to investigate and experiment further, but future development could investigate how the speed and efficiency of a drone affects user comfort with its proximity

Limitations of the user studies. One of the key constraints to our user studies is the inability to operate the drone close to users, due to the risks associated with operating a drone indoors and the LiPo battery required to operate it. We mitigated this by conducting the user study with the "Wizard of Oz" technique, where we simulated the drone moving in the air, usually with an invisible thread hanging from the ceiling and operated by one of us. The sound of the drone was also played from a hidden speaker. This allowed the users to experience the most significant features of the drone in close proximity: its appearance and sound.

Due to a limited time period in which to recruit participants, we struggled with a notable lack of diversity in our user sample. Our participants mostly consisted of STEM students from the University of Bristol, which did not constitute a representative sample of potential users of the drone. In future research and studies, a wider range of participants is recommended, which would improve the likelihood of finding a fit-for-all drone design.

We were unable to evaluate a functional aspect of the drone in our final user study, which was aimed at improving users' mental health status. One of our design goals was to provide users with positive visual patterns, such as "sunny weather," in order to potentially have a positive impact on their mood. However, the effect of this mental health indication requires long-term observation [38]. Given the limited time frame of this project, this feature would require further data collection in the future.

6.3.2 Potential applications. The development of a drone with precise and rapid takeoff and landing capabilities broadens the spectrum of possibilities significantly. This technology finds potential application in myriad scenarios where human lives are at risk, capable of conducting swift reconnaissance and equipping operators, such as rugged terrain rescuers, with invaluable situational awareness. Traditional drones, which require suitable terrain for takeoff and landing, may not be practical or beneficial in such circumstances. Our device, however, addresses these limitations, offering a solution for these challenging situations.

6.3.3 Room for future development. Our drones leave some room for potential upgrades and modifications for more advanced engineers, who can develop drones for more specific tasks while still retaining the user-friendly design features informed by our research. The design principles could be applied to existing utility drones, such as those that can carry deliveries, or to a "companion" drone, which would use its friendly appearance to form a bond with the user and assist with household tasks.

To make it suitable for the emergency rescue scenario suggested above, the drone could be adapted to a "handsfree" application, where instead of landing on a user's arm, the drone could land on a backpack-mounted landing pad. This will allow for quick deployment and even quicker landing in moments we need to act decisively in any kind of terrain, such as checking for the presence of a criminal during police operations or when looking for a way into a burning house during a firefighting situation. The backpack could also be adapted to be a light and portable charging point for the drone, allowing it to charge while "parked" attached to the backpack. Such a device could be used by multiple sectors of public service and engineering, saving time, energy, and money, by shortening the process of getting information or completing tasks.

6.3.4 Future. Once this research develops and expand, with new conclusions and principles emerging for building a safe human-drone interaction, a wide range of possibilities opens up. The research will help people be able to comfortably use drones during everyday life, but it will also have potential to be used in many different areas, such as saving lives in emergency situations, helping vulnerable people, and acting as a potential future development of the smartphone.

This paper aims to counteract the existing fear of drones as being untrustworthy and dangerous for people, and by doing so will introduce the promising possibilities of using these devices for everything from helping vulnerable people to benefiting our daily lives. We are excited to see how future research will continue to improve our technology and the innovative ways it will be used in a lot of different areas.

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A APPENDIX

A.1 Teamwork Diversity/ Inclusivity work

Our team made a consistent effort to communicate with each other and remain well-organized. We used multiple platforms for sharing information, such as Microsoft Teams and WhatsApp, which allowed us to share any essential content of our work, including photos, graphs or comments on any progress. The paper was written in the Overleaf software, where we were collaboratively working on our project. We set a strict timetable for group meetings, three times a week for at least one hour each meeting. After each meeting, we constructed a "To-Do List" so that each team member knew what their next steps were. Thanks to being consistent with the tasks we have set for ourselves, we were able to see continuous progress made throughout the timeline of the project.

Each of the team members came into the project with differing skill bases, so we needed to co-ordinate and be realistic about our abilities to do certain tasks, as well as being willing to learn new skills when required. Tasks were assigned to the person most suited to complete them, while making sure each of the team members had an equal share of the workload.

The diverse situations of our team members posed some challenges to our progress over the span of the project. One of them was the fact that we were working from different locations and time zones during university breaks. We addressed this issue by setting a temporary timetable which set the times of our meeting to the most comfortable option for all members, and having a flexible strategy for in-person meetings.

A.2 Video Link

https://www.youtube.com/watch?v=hJ6iqxISW_g&ab_channel=MarthaBaylis

A.3 Arduino code

```
#include <SoftwareSerial.h>

const int ledPins[] = {2, 3, 6, 7};
const int numLeds = 4;
const int bluetoothTx = 10;
const int bluetoothRx = 9;

SoftwareSerial bluetooth(bluetoothRx,bluetoothTx);

void setup() {
  pinMode(A1, OUTPUT);
  digitalWrite(A1, HIGH);
  Serial.begin(9600);
  bluetooth.begin(9600);



  for (int i = 0; i < numLeds; i++) {
    pinMode(ledPins[i], OUTPUT);
    digitalWrite(ledPins[i], LOW);
  }
}
```

Fig. 4. Arduino Code Part 1

```
void loop() {
  if (bluetooth.available()) {
    char command = bluetooth.read();
    Serial.print("Received command: ");
    Serial.println(command);

    switch (command) {
      case '1':
        toggleLed(0);
        break;
      case '2':
        toggleLed(1);
        break;
      case '3':
        toggleLed(2);
        break;
      case '4':
        toggleLed(3);
        break;
      case '5':
        blinkAllLeds();
        break;
      default:
        break;
    }
  }
}
```

Fig. 5. Arduino Code Part 2

```
void toggleLed(int ledIndex) {
  int ledState = digitalRead(ledPins[ledIndex]);
  digitalWrite(ledPins[ledIndex], !ledState);
  Serial.print("Toggled LED ");
  Serial.println(ledIndex + 1);
}

// //can edit the delay time and times of shining in this function
// void blinkAllLeds() {
//   int blinkDelay = 200;

//   //maybe change 3 to 5 to match the landing time
//   for (int i = 0; i < 3; i++) {
//     for (int j = 0; j < numLeds; j++) {
//       digitalWrite(ledPins[j], HIGH);
//     }
//     delay(blinkDelay * 2);
//     for (int j = 0; j < numLeds; j++) {
//       digitalWrite(ledPins[j], LOW);
//     }
//     delay(blinkDelay);
//   }
// }
```

Fig. 6. Arduino Code Part 3

```
void blinkAllLeds() {
  int blinkDelay = 200;

  for (int i = 0; i < 3; i++) {
    digitalWrite(ledPins[0], HIGH);
    digitalWrite(ledPins[1], HIGH);
    digitalWrite(ledPins[2], HIGH);
    digitalWrite(ledPins[3], HIGH);
    delay(blinkDelay);

    digitalWrite(ledPins[0], LOW);
    digitalWrite(ledPins[1], LOW);
    digitalWrite(ledPins[2], LOW);
    digitalWrite(ledPins[3], LOW);
    delay(blinkDelay);
  }
}
```

Fig. 7. Arduino Code Part 4

A.4 Codebook

Theme 1: Current context of drones

A.4.1 Concerns about drones.

Description: Participant mentions a concern they have with drones as a concept

Example: "The most terrifying thing about drones is how they're going to get used for capitalism."

A.4.2 Association with dangerous situations.

Description: Participant mentions a scenario when a drone would be dangerous

Example: "If you put them on charge and then it's like the hoverboards and they just explode randomly."

A.4.3 Past experience with drones.

Description: Participant describes their personal past experience with drones.

Example: "I've never actually used a drone, no."

Theme 2: Design of drone

A.4.4 Appearance.

Description: Participant mentions how the appearance of a drone affects their perception of it, positively or negatively.

Example: "It needs to be cute. That's the main thing."

A.4.5 Size.

Description: Participant comments on the size or dimensions of a drone

Example: "Anything larger than like a small dog, I think would start to bother me."

A.4.6 Sound.

Description: Participant mentions a sound a drone does or could make.

Example: "If I can make weird noises and it makes weird noises back at me, that's all I need."

A.4.7 Feature.

Description: Participant mentions a specific feature a close-proximity drone could or should have

Example: "I would like it to have a landing pad on my desk where it can sit and charge."

Theme 3: Behaviour of drone

A.4.8 Functionality.

Description: Participant suggests functionality a drone should have

Example: "Oh my god, could it carry the shopping?"

A.4.9 Distance/speed.

Description: Participant mentions how close they would be comfortable with a drone coming to them.

Example: "I would say two meters, three meters, something like that."