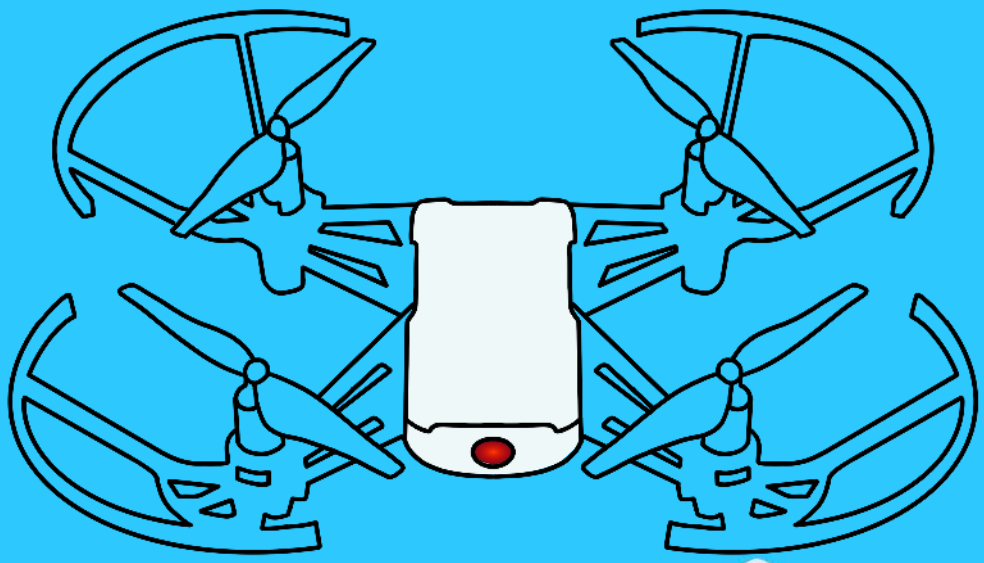
GaiA

The Great Mother Drone



Exploring how social drones with imbued parental instincts can accompany and protect humans.

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Introduction

Mankind has always been fascinated by the aerial dimension. From the stories of Daedalus and Icarus, through Leonardo da Vinci's inventions exploring human flight and the Wright brothers pioneering with the world's first successful motor-operated aeroplane, to flight becoming a normal and essential part of our everyday lives. As technology has improved and found its way into our pockets, the idea of creating entirely hands-free tools by imbuing them with flight has taken over. Drones have carved their way into the lives of enthusiasts and professionals alike, ranging from simple toys to critical life-saving equipment.

In just a few years, rapid advancements in technology have allowed for drones to become smaller, fly for longer, record the world in higher detail and "act smarter" thanks to machine learning. At this moment in time, drones still have to be controlled to some degree by a human operator and are therefore restricted by human perception, processing power and inclinations. If the field of artificial intelligence is able to develop autonomous drones, how would our society react? What if we were able to infuse drones with a desire to nurture and protect, akin to parental instincts, could they learn to care about us? What can be achieved by doing so?

This essay explores the concept of GaiA, a protector drone which has been imbued with parental instincts in order to serve humans more efficiently. From a prototype focused on companionship, through the exploration of the social role of Mother and the effects of emotions in machines. In the end, it highlights the importance of discussions regarding technology, by looking at possible future scenarios, as well as some related dilemmas.

Drones for personal protection

Imagine walking home alone at night. You've probably felt the grip of anxiety while passing dimly lit areas or small groups of strangers. Depending on subjective past experiences and social differences, you have probably also felt safer if security guards or the police are patrolling the area you are in. You might have also felt safer when walking past lit storefronts with visible security cameras. Such experiences are especially relatable to women, who generally feel more unsafe in public (Condon, Lieber and Maillochon, 2007). No matter if you recognise yourself in any of these scenarios, you will have felt the grip of insecurity where you're not in control of a situation. Now imagine how these same scenarios could feel like if you knew you had your own personal protector ready to go at a moment's notice. With the aforementioned technological development and research in drone technology, we might not be as far from this concept becoming a reality.

With a personal protector drone small enough to fit in your pocket, you can get it to survey the immediate area for potentially harmful encounters whenever you would feel the rise of anxiety. Practically, in such situations, the most it could contribute would be to document and be present. As a result, it could therefore make you feel less alone and provide a sense of security. The problem with this scenario is how you would control it. If you are in a stressful situation, you do not want to control anything other than yourself. If we assume that it is autonomous, then is it reliant on your vocal commands and gestures? We will explore what effects a higher level of autonomy can have in similar situations later in this paper, but first we will delve into a bit of history and definitions.

Background

Unmanned aerial vehicles(UAVs), or more commonly known as drones, are aircraft without a human pilot on board, and are most often controlled remotely by a human operator (Floreano and Wood, 2015). Though drones stem from military use, their usage in the past years has been widespread in both military and civilian sectors. Small, foldable drones with high-resolution cameras are available for most consumers in their local electronic stores, and professional sectors keep finding new purposes for the technology.

Anatomy of a drone

Drones vary in shape, size, features, flight modes and design, but they all possess some common attributes. At its core are the electronics, batteries and motors, which serve as the organ system to power the entire drone and control its muscles, which would be its mode of propulsion. The latter vary between different types of drones, and will affect the overall design of the drone greatly (Floreano and Wood, 2015). As an example, rotorcraft and fixed-wing drones, which are the most used designs, have varying attributes and challenges due to their designs (Floreano and Wood, 2015). As they are entirely wireless, all drones must have receivers in order to receive and process signals, and might have transmitters to establish a two-way communication channel to provide feedback. Connected to this “sensory nervous system” are cameras, which act as the drones’ eyes to the world around them. It can gain even greater sophistication in combination with computer vision and machine learning, and thus gain vision. Finally, supporting and protecting all of the above components just like a skeletal system, is the chassis.

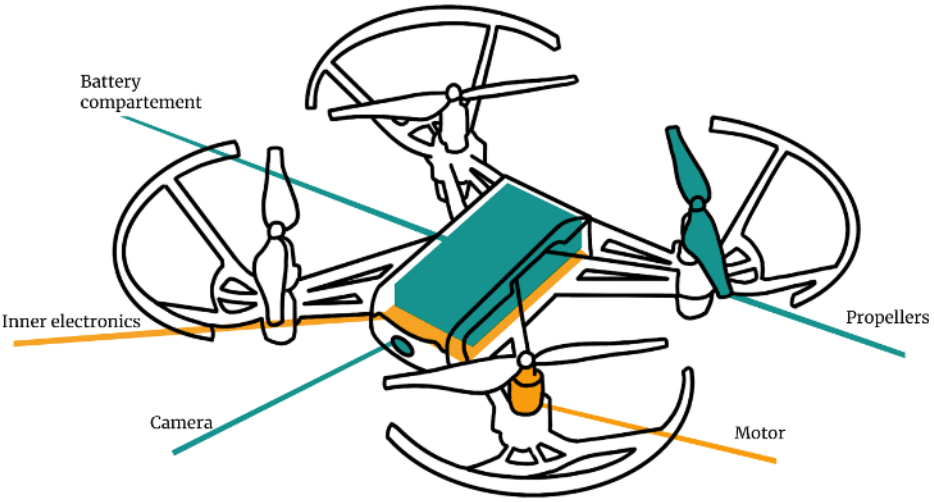

Fig. 1: Anatomical drawing of a drone.

The most popular, or at least the more commercialised version is the quadcopter, which can be viewed in figure 1. This has four motors with rotary wings, and is generally stable no matter how large or small it is scaled. The main selling feature of this model is its ability to hover in place, and therefore can operate in closer proximity to humans as it can fly slower, and appear calmer. The popular nickname derives from the male honeybee, “a drone”. Likely, this is due to its persistent buzz of the machines as well as the more figurative meaning of an idle worker (Etymonline, drone).

Evolution of Drones

Drones have their origin from warfare, as a lot of technology that surrounds us today. From the 1800s and through the world wars, drones evolved from incendiary balloons used to besiege a city, to practice targets to train military personnel (Hallion, 2003). In the decades since, in parallel with a rising technological society, drones have become more advanced and adapted for diverse use cases. While military missions regarding warfare and reconnaissance are still highly relevant, other fields such as agriculture and media production have claimed drones as a

significant tool, due to its potential to carry out both extremely dangerous and incredibly mundane tasks with ease.

The recent, rapid technological development has enabled us to explore drones small and advanced enough to benefit us in close proximity. The characteristics that have allowed drones to become an everyday thing for anyone to use, are defined by Paddy Scannell as affordability, utility, reliability, durability and safety (2014). Then what can we make of the future? Imagine, your morning paper is now dropped by drone right on your lawn, as well as your dinner being delivered at your porch. Private, pilotless flying taxis can now bring you most anywhere, making buildings establish secondary entrances on their top floors. Rescuing services now utilize drones both to locate, provide resources and to transport those in need of aid. Cities built upon this aerial technology will have hardly any need for roads, as the main traffic happens in the air.

Defining Social Drones

What differentiates today's technology and that of the sci-fi worlds, is that the fictional ones embody emotions, ideas and desires. Even though machines can learn by themselves, albeit guided, we are still just simulating intelligence. Because of this, all behaviour in robots and drones today have been programmed with a certain state in mind. If we are to go beyond this stage, where all the goals and behaviour of a machine has already been determined, the field of artificial intelligence (AI) will have to lead the charge. The main goal of AI is for machines to operate entirely on their own with as little human interaction as possible, as in become autonomous. Current technologies used to pursue this goal include computer vision, natural language processing, deep learning and machine learning. These work by building machines with algorithms that are meant to infer meaning from data, and learn from it. In relation to drones, valuable data is collected from their cameras and other sensors. The faster, more powerful and lightweight these processes become, the more independent drones will become.

How do we go about creating drones to aid and protect us in our everyday life? By its very definition, they would be soaring through our public spaces vigilantly and always watchful, with the goal of protecting their pack. Drones with sufficient autonomy who operate in an environment inhabited by human users have gained the nickname of social drones, coined by Baytas et al. (2019). In their report, “The Design of Social Drones”, they analyse and report on the state of the art of research pertaining to social drones, and how they should be designed in order to be beneficial in human-inhabited environments. In total, they have identified twelve design concerns for how drone aesthetic and behaviour relate to humans, divided into drone design concerns (DDC) and human-centered concerns (HCC). Some of these will be explored further throughout this paper.

Autonomy in Drones

Autonomy in cybernetic machines, or more specifically digital robots, is defined in them being able to achieve their goals and make decisions, independently of humans (Brooks, 2003). In relation to drones, this would mean without a human operator controlling its every action. We strive towards imbuing technology with autonomy in order to perform tasks safer, faster, with more precision and with less manpower. In recent years, it has become increasingly relevant partially due to the emergence of self-driving cars, or cars with autonomous driving systems, because of its promise to reduce car accidents (NHTSA, 2020). While it is, as mentioned earlier, extremely prevalent in science fiction, our actual autonomous technology is still pretty primitive. Our real world environments are chaotic and unpredictable, and we expect that autonomous technology should be able to maneuver these spaces expertly without causing harm.

In defining social drones, Baytas et al. explains how the term social can encompass autonomous embodied agents in an inhabited space (2019). So in order for drones to reach the level of

“social”, they require a certain level of autonomy. A three-level definition of increasing autonomy for small drones has been proposed by Floreano and Wood, which encompasses sensory-motor autonomy, reactive autonomy and cognitive autonomy (2015). Each of these builds upon, and requires, the one before it, with cognitive autonomy being the most advanced of the levels.

Sensory-motor autonomy relates mainly to coordination, and how it translates commands such as GPS coordinates or a specific trajectory into controlling the drones angles and speed. The next level, reactive autonomy, expands upon this by adapting and reacting to the environment around it. This encompasses collision-free navigation, maintaining set distances from the ground, stabilizing itself in windy conditions and coordinating with other moving objects. At the very top is cognitive autonomy, which provides the machinery the ability to learn, plan, simultaneously localize and map, as well as to resolve conflicting information in real-time. Where the former ones need little to full supervision, the latter requires none.

Cognitive autonomy is the baseline for social drones as its required advanced features are needed for them to operate in close proximity to people. The measurement of autonomy is based on human cognition, and we can therefore relate to their attempts at reasoning, language processing and problem-solving. Imagine then if AI goes above and beyond our current perception of its capabilities, what could it be able to do? Would it be able to become aware of itself, as well as its surroundings? Could it gain a sense of consciousness, fueled by its own sense of morality and intrinsic motivations? Sometime, there might be a level above cognitive autonomy, which we for now will call conscious autonomy. At this stage, social drones can act with intent, and therefore can in some capacity be held responsible for their actions.

GaiA aka Mother Drone

Initial concept: The comPANions

In order to explore the relationship humans can form with autonomous drones, my group for the MIX301 course, “Media Technology: Theory and Development”, created a trio of friendly drones named the comPANions. Each comPANion will bond with one friend, which they will follow, engage with and protect. Our main focus was on how the drone could move, and use its movement to convey its current state of being; which is either happy, sad or confused. Examples of how it moves are how it turns around periodically when it can’t perceive their friend, or how it does backflips in a sporadic manner to show off when it is “happy”.

Their bodies are that of a quadcopter, specifically a Tello Edu drone, which has been modified to emulate a flying bug in order to further push the idea of unusual companions. As seen in figure 2, Buzz is modeled after a bee, Zac is modeled after a dragonfly, and Cam is modeled after a butterfly. As most explorations of social drones, the autonomy is faked with a Wizard of OZ methodology, in order to provide bystanders with a feeling that it is acting on its own volition (Baytas et al., 2019). The initial concept for our prototype was to create a drone that would enforce social distancing rules in open indoor spaces, inspired by the current pandemic. This inspiration is still apparent in the final prototype’s name, even though the intended functionality proved too complicated for this project.

Fig. 2: The three comPANions, with their names in overlayed text.

The word companion has, over time, gained the meaning of “a person or animal with whom one spends a lot of time or with whom one travels” (Lexico, Companion). The concerns identified by Baytas et al. are especially important when exploring social drones as companions for humans, as they relate to why we would want to spend time with them (2019). They identify both what can be manipulated in design, which is the DDCs, and the HCCs which you want to control, but can not. The former mostly relate to its physical features and behaviour such as flight, form, sound and control methods, while the latter refer to concerns such as ergonomics, tactility perception, intuitive comprehension and -control. The most central human concern relates to appeal, and how we can accept, trust and feel safe while cohabiting the same environments. In essence, they have to be small, quiet, communicative, stable, smooth, clear in order for the users and bystanders to accept social drones.

Instinctual care

In the existing market, home security providers have started exploring autonomous drones as private flying security cameras, such as Sunflower labs’ Bee, Ring’s latest camera and Nightingale security. A personal security drone would cover you in your own homes, as well as in public spaces. In order for us to desire such a thing, the concept of it being personal implies that it must provide us with something meaningful. This might just be the task at hand, or it might entail the relationship that exists as a result of the job.

Relating back to the personal protector drone, and how its goal is to provide safety both passively and actively. How can it truly watch out for you, and distinguish possible threats from innocent bystanders? Donald Norman emphasizes the importance of machines needing emotion in order to operate entirely without assistance in our complex world (2003). He claims that machines with emotions would perform better in their tasks, as it is a vital component of the way

humans interact, cooperate and learn. Now, he doesn't mean that we are to insert genuine human emotions into our machines, but to construct "emotions that fit the need of the machines themselves" (Norman, 2003). Then, if we are able to imbue this protector drone with emotions that result in a maternal instinct for you, its designated human, would it be able to truly care for you? And would this result in it protecting you more efficiently?

One of the results of providing it with emotions, would be that it would learn to recognize you and your mannerisms. If it can care, then it could react to sudden changes in your behaviours. For instance, if you were upset or distressed, it would comfort you. Or, if you were glowing with happiness, it would partake in your joy and celebrate with you. From you, it could learn what your values are, what you prioritize and therefore what should be considered urgent in certain situations. While its main goal is to protect you from external threats, its advancement could lead to it gaining empathy for you. If it was genuinely worried about you, would it not perform better?

If you let yourself be convinced, you would bond and form a relationship. Former experiments show that something is triggered within us when interacting with machines that appear to have emotions that make us respond accordingly as if it had actual emotions (Brooks, 2003). Now these effects are short-lived, but nevertheless interesting. Even though there are countless variables to consider, it would be interesting to see just how easy it would be to form a bond with an emotional drone, and how long it could last.

Expressing Emotions

Imagine giving a verbal command to your personal protector drone, and it responds by flying off in a direction. How can you be sure that it received and interpreted your words, and intend to follow them? Is a blinking light with different colours enough? Communication and interaction

are essential. We need to feel comfortable with whatever is protecting us, in order to trust it to do its job.

Integral to a drone is its ability to move in all directions, and this movement can be used to convey moods, intentions and emotions through its mimicking of postures and stances. Other elements used to provide interaction would have to be laid on top of the movement, work with it and be difficult to misinterpret.

Visual aids, such as screens or lights could enable it to express from great distances. The visuals could replicate popular symbols and associations in order to communicate efficiently by taking advantage of our learnt cultural connotations. Examples could be red for stop, as well as for danger. With an attached screen, the drone could show which direction it is leading you in before it turns. Coloured lights would have to be easily distinguishable and interpretable for all, and therefore have to accommodate for colour blindness, perception across far distances and cultural context.

Speech and sounds would allow humans to not always have to keep their eyes on the drone, and therefore be able to interact over greater distances or through obstacles. Speech could make any message clearer, as “it enables communication of emotional state through its natural prosody - pauses, rhythm, pitch inflections, hesitations, and repeats (Norman, 2004). ” We are already living in a world filled with smart assistants, who are ready at a moment's notice by the sound of a certain keyword. Children are growing up having natural interactions with such interfaces. As technology improves, this technology might not be far from including all these elements of speech that Norman describes. In difficult situations, the protector drone could emulate sirens and alarms in order to scare others away.

Social Role

If autonomous drones are to become an integral part of our everyday life, we need to be able to interact with them both naturally and efficiently. Additionally, in order to fully make use of them, we need to feel safe being surrounded by them. With a general interpretation of these flying machines as either toys or for warfare, is it realistic to envision a future with personal protector drones? If so, how would we view them?

One of the human design concerns uncovered by Baytas et al. was the perceived social role of the social drone, and how we can associate their behaviour to existing conventions that infer our experiences with them (2019). Though the roles of “assistant” and “toy” have been explored for social drones, it is the role of “pet” that people are the most comfortable with and inclined to use. Our interpretations of drone behaviour are based on what we expect of animal behaviour, and therefore we can form similar attachments as if with a pet through human-drone interaction with voice and gesture (Baytas, et al., 2019). Then how can we view drones as protectors who we would trust enough to follow us, and even make decisions on our behalf? As any social perceptions, they will vary in different cultural contexts. Known social protector roles most of us can relate to, at least through its usage in popular culture, is the parent, a big brother or a guardian dog. A guardian such as these gains the role of protector once it either prevents harm or injury, or intends to keep someone safe from it (Merriam-Webster, Guardian).

Considering the already existing association of drones as pets, the natural starting point would be for them to act as a guard dog that will protect when you and yours are intruded upon. An even more direct connotation, at least while this technology is considered novel, would be between drones and breed of pit bulls, as there’s a similar stigma with both. They are often perceived as scary or threatening from the outside, but heavily adored by owners and enthusiasts. Another metaphor would be for a more widespread protector drone, where it could act as a sheepdog who

is responsible for a group of people, instead of an individual. They could be of use for a family, a school class, journalists in the field and political entourages.

Though dogs are often engulfed in their human owner, the problem with this metaphor lies in this very bond. As much as it is a relationship, it is one based on a social hierarchy with the owner in a dominant role giving commands. While we can imagine training drones to become the perfect protector, there might be a more efficient metaphor.

Greetings, GaiA

As have already been hinted at, I believe one of the most fitting metaphors to be the one of the Mother. We are all familiar with the nicknames of mother hen and mama bear who are given to those who might be overly caring, but who can go to extreme lengths to protect who they care for. Fierce when needed, but otherwise nurturing and loving.

Throughout the exploration of this concept, I have envisioned a series of these Mother drones that could be named after matronly figures throughout time. Then it is only fitting that the first concept would be named after the greek primordial goddess Gaia, who was considered the ancestral mother of all life. She is well known as a personification of our earth, and through the Mother Earth title of an earth goddess can be viewed as a personification of motherhood (Smith, 1873). Coincidentally, the abbreviation for AI is naturally found in the name as well.

With all of this in mind, I want you to meet GaiA, the Mother Drone.

Futuristic Scenarios

Your Personal Mother Drone

Your GaiA can now fully act as your everyday companion. As long as you have it by your side, you know you are safer, and can focus your energy and attention elsewhere. Additionally, it aids you in your everyday life by delivering and retrieving items, as well as keeping you company.

You can carry your GaiA with you everywhere, as they have been integrated into wearable accessories like hats and backpacks. In these compartments are charging stations, which means that the drone is always deployable and alert. At a moment's notice, it can be activated by a simple vocal command, a swipe gesture on a clock or through cybernetic implants. It is always ready to help and protect.

As your companion, the Mother drone will provide directions to where you are going and motivate you on hikes and jogs. Its care for you extends into ensuring you are the best version of yourself. You feel less alone, and always have someone to confer with when needed.

In tense situations, the Mother drone would aim to de-escalate in order to avoid any harm. Imagine GaiA as a companion for a child at elementary school, that has been bullied for some time. Their parents have provided a GaiA for them in order to make sure they are treated nicely. One day, it is called on by the child as they are being surrounded by their usual harassers. The drones presence is enough to make some back off, but not all. For the remaining aggressors, GaiA will try to calm them down, or prompt them to reflect on why they are acting as they are. If the situation were to escalate still, it would try to attract attention from any adults in charge.

In a dire situation, it will generally let any assailant know that it is recording, and that they have notified emergency services. If needed, it would sound an alarm and make itself more visible with lights and movement, in order to encourage the offender to disengage. GaiA will act on its own volition, even without any commands. While it is loyal to you, it might even act against your word if it believes it is prioritizing more to your needs than you.

The drone might not seem as threatening by a group of people, and would therefore have to adjust its tactics. Using knowledge and algorithms adapted from law enforcement, maybe especially from hostage situations, it could either defuse situations more carefully, or find the less harmful way of protecting you. For example, if it notices one member of a group hesitating, it might latch onto it and try to weaken them further. Of course, it would have to ascertain what risk you are under threat by and act accordingly.

Now, imagine if everybody were to have their own protector drone. Would the mere presence of countless drones make our society safer to traverse? Would it lessen crimes, or could it have the opposite effect? You might gain a sense of security just by being near one, even if it is not your own. Depending on just how extensive the usage is, you might also feel pressured to acquire one, in order to keep up with the times and not stand out. If we expect them to become as common as cars today, transforming from enthusiast's toys and tools to personal assistants and companions, how would that affect our society as a whole?

In order to become widely used they would have to be affordable and easy to acquire, and therefore most likely available through local electronic stores. Akin to what has happened in the mobile phone industry, there would arise niche businesses geared towards maintenance, repairs and customization of these drones. Considering the basis of a bond between a human and their GaiA, both would benefit from caring for each other.

Societal GaiAs

GaiAs are now no longer personal, but societal. They patrol and monitor statistically exposed areas and events, and act almost as a neighbourhood watch. They periodically form swarms in order to share data, create displays and to carry things or people together. By sharing information as a network, they can report and act fast on information from others. Logistically, such a network would also provide the benefit of if individual drones were injured or fails, the rest of the swarm can carry on with the same information. There will always be at least one available in urban areas, and there are integrated charging hubs within streetlights in parks and public spaces.

In the case of emergencies, nearby drones could be activated to arrive at said location before first responders are able to show up. By doing this, they can provide more data for them, provide safety by their presence and possibly intervene in a situation before it gets too out of control. If assistance is needed by a GaiA, then they can be called upon from a physical station or through a digital application.

In meeting with criminals, the presence of the drones might be enough to scare them off based on their reputation and what they would represent. Building upon the conflict handling tactics presented earlier, there is an added concern to consider. Even if we base our idea on these drones being experts at understanding human nuance, they might still escalate difficult situations by making an offender feel cornered, and thus more likely to act recklessly.

Moral and Ethical Dilemmas

For a long time, popular culture has been saturated with stories of a futuristic world in which humans live besides, through or dominated by technology. With a major focus on the latter, concerns of safety and privacy are central in the discussion and involvement of drones. The topic of discovery in this essay is one that will raise eyebrows long before delving into the concept of mothering instincts in social drones. No matter if it is likely to ever become a reality, it is an interesting aspect to explore through the scenarios. If we continue to uncritically build and improve upon the technology around us today, then we might not be as far from this far-fetched idea of our future.

There are many issues with this concept to say the least. Privacy as we know it could cease to exist. It is downright terrifying to imagine what normalised mass surveillance by conscious drones would entail. Would we be herded through our everyday chores by drones acting like sheepdogs? It could bring us into a “Big Brother” style dystopian future, where we live under watchful eyes of drones who might serve others with immoral interests.

In the wrong hands, this surveillance could escalate or even endanger people in abusive situations. Abusers, or even organized criminal gangs could utilise the drones for spying or more unfavourable means (Bowles, 2018). Relating to how this technology came to be, is also the ever present danger of it being used in warfare in order to gain information and accomplish goals while decreasing human casualties. Worries about the perceived less risk in warfare might actually just lead to relocated risk and more reckless behaviour, or as Michael J. Boyle describes it: “ a condition in which someone increases their risk-taking behavior because they feel insulated against the consequences” (2020). Overall, we will probably see more wars being fought by all sides of a conflict with disposable autonomous drones and information. All of this

is deeply disturbing, and it is without touching upon any political issues that may emerge as a result from such situations.

There is also the question about what happens with the data, as in how it would be stored and what it could be used for. Drones like these would take advantage of big data for training, as well as produce its own share through recordings and communication. How could we ever manage to make access to such personal data secure enough? What then if the drones themselves were hacked? Could others take control of another one's drone, influence it with specific training data or even steal the already recorded data itself? All of these scenarios are serious in and of themselves, but how would conscious drones react to such an act of violation?

And last, but not least, is the question of how it would affect us and our wellbeing. With a personal GaiA drone providing a greater assurance of our personal safety, you may not be as worried about potential robberies, assaults and such. You might even have become so dependent on having the drone by your side, that you are unable to live outside of your home without the sense of security it provides. Or, you are opposed to having a drone while being surrounded by them. Fear and anxiety might control your days, especially if you are unable to escape from the pervasive drones.

Conclusion

The case of GaiA provides an interesting exploration of how Mother drones, protector drones imbued with parental instincts, could serve and protect humans. Throughout this essay, we have explored how such drones can provide companionship, support and protection in both personal and societal use cases. Even if we enthusiastically explore the ways in which drones can benefit us with good intentions, like shielding humans from dangerous work environments, it would be naive to presume the same technology will never be used to harm instead of aid. Dilemmas such

as mass surveillance, data management and security as well as our psychosocial health prove that we are well within our minds to fear such an evolution as presented here. There is no doubt that developing advanced autonomy and emotions for machines are not to be taken lightly, as the threat of technology taking over our lives is ever present.

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