Project Proposal

FlyDea

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193.041 Responsible Research and Innovation

Technische Universität Wien
Wintersemester 2018/19

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Introduction

In this document, we want to describe the latest promising innovation for digital signage, *FlyDea*. We will detail several aspects of the project including a market analysis in *Chapter 4*, the goals of the project in *Chapter 5* and our business plan in *Chapter 8*. We also discuss aspects concerning Responsible Research and Innovation in *Chapter 11*.
We chose to approach Speedinvest Venture Capital with this project because of your stellar reputation and outstanding experience and would be more than happy to hear back from you soon.

1. Project Summary

FlyDea is an autonomous drone surrounded by a 360-degree OLED display. It's intended use is a mobile and high-availability information system reaching as many people as possible, as quickly as possible. In contrast to conventional information systems like public displays, FlyDea can be used almost anywhere and does not need preexisting infrastructure. The 360-degree display is tilted towards the ground and thus visible to more people than conventional displays. The content shown can be altered on the fly and there is almost no limit as to what can be displayed.
A mockup of the FlyDea display drone is depicted in *Figure 1* below.

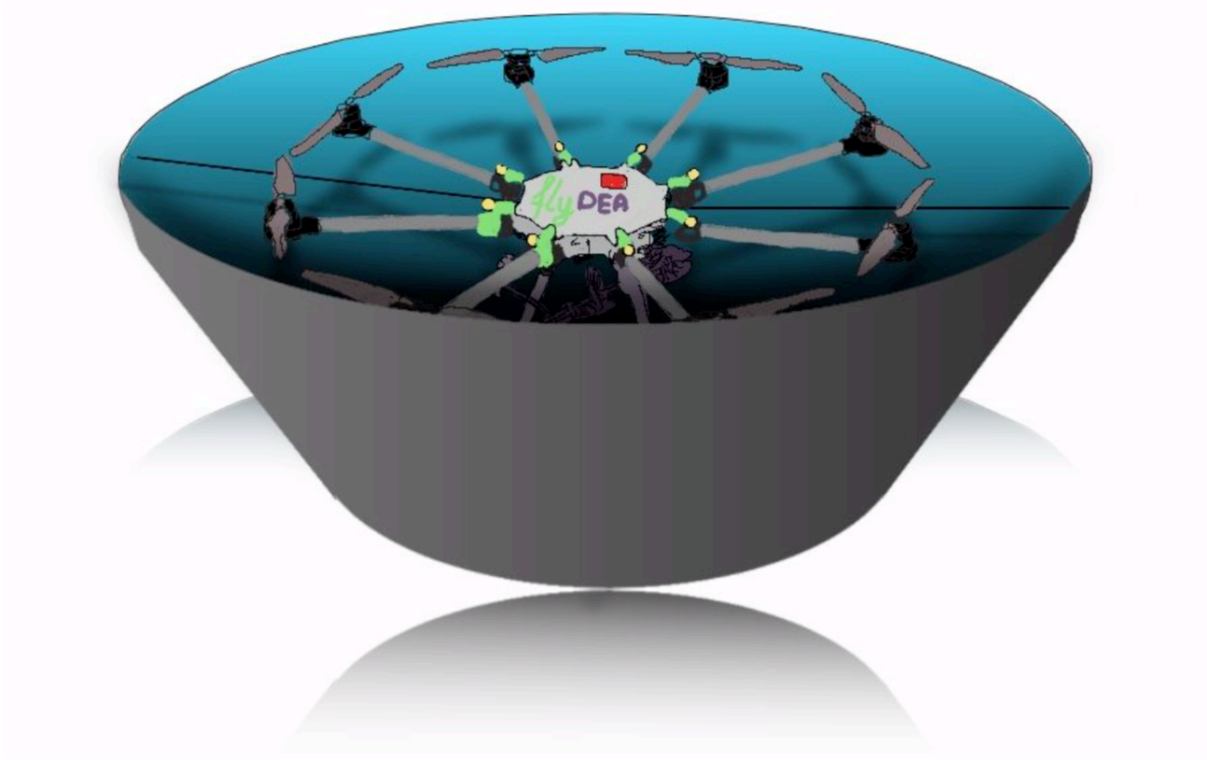

Figure 1: Mockup of the FlyDea display drone.

2. Project Motivation

Below, we describe two exemplary use cases and possibilities how FlyDea will answer to societal needs.

2.1. Organization and crowd control at large-scale events

If outdoor premises have to be cleared, for example at large-scale open-air music festivals, organizers can use FlyDea to inform, instruct and guide crowds faster and more easily while at the same time reaching more people than with conventional information systems. Especially at open-air festivals, being able to communicate with crowds effectively can prevent serious harm and injuries [29]. FlyDea can help achieve this in a reliable and flexible fashion.

2.2. Crisis-coping and first-aid for remote areas

Another use case for FlyDea would be the application of the system for coping with crises. After natural disasters, FlyDea could be used to locate, guide and instruct people in remote locations which would otherwise be unreachable. In later stages of the project, a heavy-duty version of the system could even be modified to carry first-aid-kits or food. However, the remainder of this proposal will focus on the creation and use-contexts of a non-load bearing version of FlyDea, since this is the next step for the project as per our business plan (See *Chapter 8*).

3. State of the Art

While autonomously flying drones still face several issues [1], the knowledge to build and operate them already exists. They can navigate to a destination, circle a certain area and find back to their home base without the interference of human actors [2]. Furthermore, there have already been experiments with mounting OLED displays to drones [3].
One project related to FlyDea is “Displaydrone”, [4] a pico-projector equipped multicopter which projects SMS messages received at a smartphone to a wall, thus enabling inter-audience communications. Here, the drones were controlled manually. “SmartCopter” [6] on the other hand, is a quadcopter which uses a smartphone to autonomously navigate buildings.

4. Market Analysis

The global digital signage market was valued at USD 16.04 billion in 2016 and is anticipated to reach USD 31.71 billion by 2025. North America and Europe will have the market lead in this time period and the demand from the retail industry in these areas grows at a considerable pace [7]. However, today digital signage products consist of mostly stationary systems like public displays. FlyDea would overcome these boundaries and enable location-independent and highly mobile digital signage.

The Unmanned Aerial Vehicle market (flying drones, including military applications) was valued at USD 18.14 billion in 2017 and is projected to reach USD 52.30 billion by 2025. The worldwide interest in flying drones is considerable and prognoses say that this interest will only grow in the near future [8].

5. Project Scope and Goals

Eventually, the goal of the project is to create and carter to a market for high-availability, airborne information systems. Since the project is still in early stages, intermediate goals will be developed and worked towards incrementally. The theoretical preassessment (*Chapter 3*)

and market analysis (*Chapter 4*) concluded that the project can and should be developed further.
The next goal is to create a physical prototype and test said theoretical knowledge. For this next stage, we require capital (See *Chapter 10* for a detailed overview), which is why we apply for funding.
In even later stages, higher volume production will be outsourced while the marketing and service provision will be retained in-house. At this stage, additional use cases such as the one described in *Chapter 2.2.* will be explored further.

6. Innovative Aspects

While many possible applications for autonomous drones exist, the use of drones as universal information systems is not yet explored thoroughly. The potential for drones to not only deliver wares but also news and other important information to remote places could be beneficial to society. For example, drones are being discussed for disaster management already [9], but most of the time their intended use is as search tools, covering remote terrain and finding people. FlyDea could not only achieve this, but by displaying messages on the 360-degree display also facilitate communication between the victims and members of search teams.

Lastly, FlyDea could be used interactively. Connections could be facilitated through a web-application which users can reach via their smartphone. Once connect to FlyDea, they can react to existing content or submit their own. Several approaches at creating such interactive displays have already been trialed, most of them using Bluetooth, [10] but none of them were mobile.

7. Exemplary Scenario

An exemplary use case is the operation at large (music) festivals. When artists have to cancel their performance on short notice, the information and updated time table is usually made available on the festival's homepage, social media and – if available – public displays in the core festival area. Especially at larger festivals, there is no information infrastructure in the camping areas, and cell phone infrastructure providing access to the internet is notoriously overloaded.

Imagine you are in the camping area of a large festival, hanging out with your friends. You are waiting for an upcoming act. Meanwhile, the artist is stuck in traffic and runs late – the show is delayed for two hours. You cannot reach the festival's homepage because too many people try to access the cell phone network at the same time. There is no way for you to know of the delay, so you walk to the stage where the performance is supposed to take place. As soon as you get there, you are informed that your walk in the burning sun was in vain. Now you have the choice to wait out the remaining two hours in the crowded core festival area or make the long journey back to your tents.

With FlyDea, as soon as the message of the delay is received, a swarm of FlyDea display drones make their rounds over the entire festival area, covering even the remote camping zones. FlyDea autonomously navigates the festival area in several meters' height and on designated pathways which are non-accessible to visitors, thus preventing injuries should the system crash. The message and the updated schedule move around the display so that

it is readable from all angles. The font size is large enough to be read even from several meters away and on such information flights FlyDea will be moving slowly so that bystanders have enough time to notice and read the message.

Now you and your friends can plan your day accordingly. You can even interact with the drone as it passes you via a festival-specific smartphone app. The WIFI-connection necessary to do so will be provided directly by FlyDea which acts as a mobile router. Content you share is filtered manually before it is visible to others to prevent the spreading of hateful or dangerous messages. Content and drones are managed by an on-site, central system overseen by a base station operator who is present on the festival site at all times. If necessary, the operator will adapt the paths for the drones to follow or even take manual control over the FlyDea units. All drones return to this base station for charging and inspection after each flight.

8. Business Plan

The first step in our business plan is the formal foundation of the “FlyDea Digital Signage GmbH” and the registration of a patent for FlyDea both of which ensure legal protection for us as product owners during the development- and testing phases to come.

As stated earlier, our next goal is to create a working prototype. During the prototyping phase, several user research methods, including focus groups, interviews and surveys will be conducted. Through this integration of stakeholders in the development phase, we want to ensure to meet their expectations as best as possible. The stakeholders include potential users of FlyDea such as festival organizers and -goers, but also legal- and ethics-experts as well as policymakers. We want to ensure that even the first prototype can already deliver a safe, enjoyable experience which complies with all legal requirements for unmanned aerial vehicles in Austria.

While the insights of these methods will be continuously integrated in the prototype during its development and tested, we plan to acquire partners for an extensive pilot project. One opportunity might be to partner with a big music festival that is already well established and receives coverage in mainstream media. We would then offer to provide our services for free in order to gain valuable insights from this real-world scenario. While this will be FlyDea’s first public appearance, the ongoing testing during the development phase will ensure visitors’ safety while the integration of policymakers and legal experts will guarantee the compliance of FlyDea with all relevant regulations.
The festival organizers could use FlyDea to display changes in the lineup (like delayed or cancelled acts) and other information as described in *Chapter 7.*

The success of such a pilot project in a self-contained environment (festival site) and within a non-threatening, cultural context could provide an opening of the market which in turn enables a broader usage of the system in the future. Besides other festivals and similar events, “flying info-screens” in cities, operated by the local government, and even emergency management are possible fields of application for FlyDea. (See also *Chapter 2*).

We eventually plan to provide different sales models to cater to these varying modes of use. Besides buying the whole system, which is suitable for organizers of periodical festivals,

renting out the system for smaller festivals will be one option. In this case, the day-to-day operation will be carried out by an in-house team, which will also set up the system on site. A sharing model, where cities or other public institutions such as schools or universities buy the system at a reduced price and make them accessible to their citizens or students is also planned. This way people with smaller funds such as artists or students gain the possibility to work with FlyDea.

9. Anticipated Risks

As with any project of this size, there are several risks associated with its realization. In this chapter, we describe some of them, as well as several possible solutions.

9.1. Light- and noise pollution

FlyDea may sooner or later be used as a mobile advertising medium in urban areas, which is shown by patents such as those of Wigell [11]. Up until now, advertising is mostly bound to the floor level. Systems like FlyDea would change that, affecting even inhabitants of higher-level apartments in urban areas. According to the platform Statista [12], the market for outdoor advertisement in Austria grew in the past years, pointing out the relevance of such “around the clock”, mobile advertisement. Held et al. [13] and Kobler [14] name luminous advertising as an important factor in light pollution and identify insomnia, night activity and concentration problems as symptoms of intense light pollution.
Another concern is noise pollution. Beck [15] considers the characteristics of proposed package delivery drone for the German company DHL [16] as an example. ‘The Guardian’ [17] reports on negative effects of drone flights in national parks where scientists have proven that wild animals’ abilities in orientation are affected.
According to Ising and Kruppa [18], exposition to noise pollution over extended periods of time also leads to severe health risks and behavioral disorders in humans. These negative consequences should first and foremost be prevented through regulations by law, which forbid an excessive or inappropriate use of such systems.
As of now, FlyDea would not be allowed to operate in inhabited areas, making this concern more of an outlook into a possible future. Right now, our drones are not intended to be used in such a way that it could create said problems, but if a time comes where drones are allowed to be used in cities, we recognize our responsibility in the matter and heavily discourage customers to use FlyDea in irresponsible and harmful ways.

9.2. Environmental pollution

FlyDea is an autonomous drone and there is always the risk of a crash through unforeseen system errors or unpreventable impacts. If such a crash happens, leaving the remains at the crash-site would lead to environmental pollution through non-degradable and electric materials. This is why we eventually want to offer a service to recover crashed drones in remote areas, which would not only decrease the ecological burden introduced by FlyDea, but also provide the opportunity to salvage intact components and materials. These components can later be used as replacement for malfunctioning drones, which in turn, would reduce the negative impact of our product on the environment.
However, with our current focus on music festival as the target use case, crashes in remote areas are not likely.

9.3. Terrorist attacks

'The Guardian' [19] reports on the abuse of drone systems for terrorist attacks. Explosives or other dangerous goods could be transported and used for planned attacks. Therefore, the drones' starting- and landing-zones have to be surveilled to ensure no critical substances are transported with the drone.

9.4. Vandalism

With intended use cases such as at large music festivals, vandalism is a serious threat to the system. Members of the audience could try to damage or even destroy FlyDea, for example by throwing objects at it. When falling from the sky, drones can seriously harm humans [20].
Of course, in an ideal scenario, the drone detects the object being thrown at it and swerves accordingly. However, there is no guarantee that the system will never crash while airborne. For such cases, a redundancy module is installed, enabling autonomous flight even if the primary system has failed. Hexa- or octocopters, which we intend to use as a base for the system are furthermore less likely to crash than conventional drones, even when several rotors stop working. If any parts of the drone are damaged mid-flight, an immediate emergency landing has to be executed, during which the drone lands on the nearest patch of empty ground in the designated flying corridors, avoiding obstacles and people. Preventing and managing crashes will be one of our main focuses during the research and development phases to come.

9.5. Harming people due to accidents

Regardless of the safety measures implemented (discussed in *Chapter 9.4.*), the risk of a drone malfunctioning and crashing persists – and with it, the danger of hurting people.
As of now, drones are not allowed to fly in inhabited areas or above large crowds. When using the drones on festival sites, specific flying corridors have to be designated, where no people are allowed, and the drones are free to move around. If a system failure happens, FlyDea would crash onto empty ground, greatly diminishing the risk of hurting people.

9.6. Spreading of hateful or dangerous messages

Making public displays interactive always bears the risk of spreading dangerous or abusive content. Inappropriate images or harmful texts will be posted sooner or later. However, this is already the case with traditional, non-mobile public displays, where a popular solution is to filter all content manually before publishing it. We plan to implement a similar safety measure as described in *Chapter 7*.

10. Budget Estimation for Prototyping

This section will focus on the estimated budget for prototypes and thus cover the first phase of the business plan proposed in *Chapter 8* from a financial point of view. After this point, high volume production will likely be outsourced as described in *Chapter 5*. However, estimating costs for these later stages of the project exceeds the scope of this proposal.

For the prototype, we decided to 3D-print all non-electronic parts ourselves. For this endeavor, a professional 3D printer has to be purchased: While renting one would be an option as well, we decided buying would be more convenient, since it allows rapid prototyping and iterations as well as making adaptions to certain parts whenever necessary.

FlyDea is planned to have a diameter of 1.5 meters, which the chosen printer's construction volume should reflect. One cost-efficient candidate would be the "SainSmart CR-10 Plus", providing a construction volume of 500mm^3 at a price of about 800€ [21]. We furthermore anticipate a budget of 200€ for printing materials.

Non-printable components for prototypes comprise the rest of the non-personnel costs, including the flexible OLED display surrounding the drone. Using OLED displays like this one [22] from Shenzhen Duobond Display Technology Co., Ltd, some 31 pieces for a respective price of 200$ (about 176€ [23]) would be necessary to surround the 1.5m diameter drone body. The cost of one display would then equal 5,456€. Of course, these costs will be significantly lower per piece once we place larger orders of custom-made displays at designated display-manufacturers.
For the development of the prototype, we would use a pre-built base-system drone with most of the sensors and capabilities for autonomous flying already included. An example for such a system would be the DJI M600 Pro [30], which costs 5,699€. To be able to operate this system legally, as per the regulations by Austro Control ("Kategorie A"), a redundancy-module (e.g. the DJI Naza N3 [31]) (369€)) has to be included.
To replay media and actually show content on the display, as well as facilitate communication with the base station, the prototype will use a simple smartphone (about 200€) with video-output connectivity. To further support autonomous navigation, sensors to measure flying height (e.g. Sensors "HC-SR04" [34]) as well as distances to other objects (e.g. "Micro Epsilon Typ ILR1191-300" [35]) will be included in the prototype.
Further technical components include replacement brushless motors, rotors, sensors, and a PC workstation (base station) for administrators. Altogether, the projected non-personnel costs for the first prototype are 17,000€.

During the production of said prototype, we will act as product managers and developers. First, we estimate to work for two month each to research and develop detailed specifications regarding software and hardware. We will then hire one programmer and one electrical engineer to assist us in implementing said requirements. Including training, we estimate a workload of three months for each of them. During this time, two of us will help in developing the necessary software, while one of us will continue to work as product manager and one as a project manager and user researcher. The most important tasks of the project manager and user researcher will be organizing interviews, workshops and other meetings with stakeholders, legal- and ethics-experts as well as policymakers.
The average monthly salary (pre-tax) for experienced programmers in Austria is 4,252.74€. For electrical engineers it's 4,703.85€ and for project managers 4,011.18€ [24]. In total, we estimate nine person months for software development and testing, three person months of hardware engineering and 12 person months for product/project management and research. Finally, we allocate 15,000€ in salaries for the consultants and external experts named above as well as payment for participants of our user research. The total personnel costs thus amount to about 115,000.00€.

We will need to rent a premise large enough to allow for testing and production as well as office areas. The facilities will have to be equipped with internet and electricity as well as desks and other office supplies. Services like InstantOffices [25] offer such fully equipped offices for fees as low as 900€ per month. Five months will thus approximately amount to approximately 5,000€ including service fees.

Other costs include legal support and representation which helps us found a GmbH (see *Chapter 8*) as well as registering European and international patents (4,300€ / 2,800€). In total, we estimate about 15,000€ in legal expenses.

Finally, we anticipate several miscalculations and problems during the production of the first prototype which is why we want to take out an extensive insurance and additionally allocate an emergency fund of around 20,000€. The size of this emergency fund may seem overboard at first, but it is calculated so that if necessary, it will cover all expenses for a second prototype. The fund will be paid back in full if it is not needed.

Overhead (3D printer and materials):	1,000.00€
Non-personnel costs (parts):	17,000.00€
Personnel costs:	115,000.00€
Office rental (including internet, electricity, office supplies):	5,000.00€
Legal expenses:	15,000.00€
Emergency fund (including insurance fees):	22,000.00€
TOTAL:	**175,000.00€**

11. Relevant Responsible Research and Innovation Dimensions

In this chapter, we want to address RRI. We identify relevant dimensions and discuss them by answering concrete and palpable questions regarding our project.

11.1. Ethics

Ethics is a vastly important topic regarding any autonomous system. We want to shed some light on topics regarding ethics by answering the following questions:

What are possible ethical considerations for your R&I practices?
With autonomous systems, considering situations like the “Trolley Problem” is a must. Even more so with autonomous drones. In contrast to the conventional Trolley Problem, which is important for autonomous cars and the like, drones are airborne, in effect adding a third dimension to the Trolley Problem [26]. Questions arising in this context include “If a crash is inevitable, but the system can choose to either crash into a child or an elderly person, should it make an informed decision? If yes, which one should it chose?”
To answer such questions, we refer to the final results of the “German Ethics Committee on Automated and Connected Cars” [27] and adapt their findings accordingly. We then plan on implementing the recommendations as closely as possible.

Who is involved in ethics-related reflection and decision-making for your R&I practices, and how?
We plan to cooperate with TU Wien's ethics expert Dr. Marjo Rauhala during the further theoretical development and user research- as well as testing phases to assure high standards for ethics will be kept at all time.

Who should be responsible for the impacts of R&I?
We want to very clearly communicate our responsibility as developers of the system and plan to permanently hire an insurance company to always make sure compensation is paid, should any harm be caused by the system.

11.2. Gender Equality

We feel compelled to develop the system in a way that promotes and incorporates gender equality.

What are your organization's gender equality practices regarding staff and working conditions?
Since at this point, we are self-organized as a small start-up, we do not have any employees. When hiring employees (See *Chapter 10*) it is our policy to hire women over men whenever candidates are equally qualified.
Of course, these practices will have to be extended in the future, for example to accommodate gender-neutral parental leave policies that enable and encourage co-parenting when the company grows and employs multiple people.

11.3. Governance

Governance is an important topic, especially so since we apply for funding to develop our prototype and thus aren't fully independent anymore.

How are views from other research or societal groups included in your R&I practice?
We plan to employ user research methods extensively in the creation and testing of the prototype (See also *Chapter 8*). An important goal will be to identify and implement the needs of various societal groups as well as ensuring the compliance with ethical and legal standards and regulations.

How do you ensure your R&I practices can adapt to unforeseen results or societal changes?
After completing said user testing, we plan to adapt and incrementally develop our prototype accordingly. Owen et al., 2013 [28] define Responsiveness as a key factor for successful and responsible innovation. Ongoing evaluation of the system and frequent adaptions will be necessary, especially in earlier stages of the development.

What resource allocations allow responsible improvements to your R&I practice?
For the current phase, the development of the prototype and its testing, we allocate a lump sum of 20,000€ to experiment, fail and learn and finally incrementally adapt our prototype according to our findings from user testing.

11.4. Open Access, Public Engagement and Science Education

The principle of Open Access plays a vital role in bridging the Digital Divide. However, providing truly open access to FlyDea is impossible at this stage of the project since the overall marketing of the project is meant to be for-profit. At later stages in the project, we plan to offer heavy discounts for public institutions such as cities, schools or universities. Thus, we also want to indirectly foster Public Engagement and facilitate Science Education, two other dimensions of RRI we deem relevant.

How transparent is the ownership of your work outcomes? AND
With whom do you share the results of your work?
We plan to transparently publish all our funding as well as all relationships with our sponsors on a project-web-page as well as in all publications we will produce.
Another important aspect is the fair handling of user data. To autonomously navigate, FlyDea will need audiovisual data which are provided by its various sensors. However, all of this data will be processed on-board an none will be stored, processed further or even shared or sold. The same goes for user-generated and shared content. If no personal data are gathered or stored, according to the “Datenschutzbehörde Österreich“, [33] there are no legal implications.

How do you involve stakeholders and the public in your work?
As mentioned earlier, we plan to employ several user research- and testing methods such as focus groups, interviews and surveys during the development of the prototype. We want future users of FlyDea to feel heard and their needs met. Additionally, we want to work closely with policymakers as well as legal experts to ensure compliance with the EU Data Protection Regulation (EUGDPR) and regulations regarding unmanned aerial vehicles (UAVs).

How do you tailor R&I processes to include stakeholders with different genders, ethnicities, classes, ages, routines, experience, or levels of power?
By inviting members of different societal groups as well as policymakers, legal- and ethics-experts to participate in our user research, we try to be as inclusive in our development as possible.

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