Paramedical Drones

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***Abstract*—This paper contains information about problems with paramedical drones and how to overcome them. I use already existing concepts as examples, like a blood transport drone from Zipline. At the end I am going to talk about a concept that our team is planning to use at the Ecer 2019.**

***Index Terms*—Autonomous systems, Emergency services, Rescue robots, Robots**

I. Introduction

Dangerous disasters happen everywhere. Often there are no warning signs so those affected are usually unprepared. Victims of the calamity often need aid by other countries, but most of the time it is difficult to find people willing to risk their life in order to safe someone in need. That is a situation where drones would come in handy. They can reach places inaccessible to human aid and they are not afraid to be destroyed. In order to make this vision a reality various problems have to be solved, when solved a lifesaving drone can be developed.

II. Drones as paramedics

If Drones can be such a help, why are they not used yet? How difficult could it be to create paramedical drones or drones that support paramedics? Do laws exist that prohibit these autonomous objects from being used? Last but not least, will our society readily accept non-human help? These fundamental questions need to be answered for us to further humans understanding of society. Maybe at some point in the future disasters might cost less human lives than they do now.

A. Acceptance problems

A majority of people dislike drones that monitor society, even if it is just for safety. This is the reason why many believe that it is very likely, that the public will not welcome the help of roboters as paramedics. More people could die as society might not trust robots to help them. This unease will eventually fade over time, but it should still be accounted for when developing medical drones or robots. If scientists give the world enough time to adapt to the idea of paramedical drones, then less ethical problems will arise. An abrupt change like having mechanical paramedics tomorrow would result in lots of panic, creating more issues than necessary. Humans fear the unknown and thus fear a concept which they do not understand. We need to familiarize society with them. Especially older people who will be the main recipients of medical treatment. One way to start building up trust is to first build supportive Drones that support paramedics. This will help to minimize the distrust in autonomous paramedics.

B. Legality of drones

Some countries forbid drones in urban environments. This includes the most important type of medical drone, a paramedic drone. Which means that those who would be able to work in habituated areas are not allowed to be operated. These laws should make an exception for paramedical drones, as it would decrease response delays due to traffic and lower mortality rates. Making urban environments more secure. [2]

C. Technical limitations

Drones are very complex, especially ones for medical use. Thus they cannot be built and programmed very easily. Another problem by introducing complex new technology is that a lot of experts in this field would need to learn how to use the drones. This might endanger lives and thus the process of introducing such technology should be over many years.

D. Types of Drones

Types of Drones: When using drones or robots to solve a problem, one must first take a look what problem you want to solve. In regards to drone types most of the time the choice is between quadcopters and plane drones. While the quadcopter has more precise movement in the air, it also needs a lot more power to work. Thus they usually have lower flight times. Plane drones on the other hand can move long distances, mostly in a singular direction, without consuming lots of energy. But they need more space for simple maneuvers like turning. They also cannot lift off that easily. At last there are Hybrid Drones that combine aspects of the quadcopters and plane drones. This can be used to solve complex problems which need properties of both drones. After you choose the drone type you usually end up building a prototype, test its functionality and work out the kinks. Afterwards you improve upon the design and finalize the concept.

III. Concepts for paramedical drones

Paramedics do many different things and so different drones have to be used for different tasks. The following paragraphs are going to shine light on a few concepts that have already been tested, built and are out there saving lives. This paper also features a few drone concepts which are either in development or have just been thought about.

A. Drones for mountain rescue

Mountain rescue after an avalanche is almost always very dangerous for the rescue team. To make things easier for them, drones with special sensors could be used. A short rundown on what current concepts have in mind when designing them. The drones usually measure the radio signal sent by an avalanche transceiver and act accordingly. This should drastically decrease the time a skier spends being buried under snow, decreases response time and also shortens reaction times as drones can be more easily and readily deployed than helicopters. Thus increasing the survival rate of victims.

There is also a second way a drone can be used for mountain rescue. Very often climbers get stuck on walls they are unable to ascend. When something like this happens one usually calls a mountain rescue team to get help. They now have to find the climber and to help with that a drone with a thermal camera can be used. As humans send out infrared radiations this can quicken the rescue process. This type of drone is used during many mountain rescues for example in the UK. The picture shows the setup of a drone for mountain rescue. [3]

Fig. 1. Picture of a Scotland drone test provided by dronebelow.com

B. Drones for cardiac arrest first aid

There are several drones that can be used for rescue missions. One concept which was developed by Alec Momton, together with the TU Delft. This project created a drone which is able to fly at top speed to the place of an accident. The drone has a built in defibrillator and thus can help provide first aid for a victim with an cardiac arrest. It has a lot of advantages compared to a normal ambulance as it can fly over buildings and thus can avoid traffic.

There are of course other concept to provide first aid quickly. For example in Vienna many public places are equipped with a defibrillator. These are freely accessible for anybody. These publicly accessible are faster than the drone but they are not everywhere so to minimize the death rate by cardiac arrest both concepts should be used to provide first aid everywhere. One advantage of the drone however is, that an expert is checking through the drone via a camera if the defibrillator is attacked correctly before the drone activates the device, which takes away some of the pressure of the person that attaches the defibrillator.

Method	Time for arrival	Survival rate
Drone by TU Delft	2 minutes	80%
Ambulance	11 minutes	8%

[a]Data provided by diepresse.at and TU Delft

Even though the drone is faster, as seen in the table, it should not be the sole measure of rescue. It should be used in combination with dispatching an ambulance as victims usually need to be taken to the hospital for aftercare. The following picture shows the applying of the pads. [1]

Fig. 2. Picture of the drone in fielding provided by TU Delft

C. Drones for blood transport

Hospitals need to store a lot of expensive medicine, but most of them need to be thrown out because they expire. Zipline wanted to create a drone which allows to store the needed medication centrally. They engineered a drone which is able to serve hospitals within a radius 80 kilometers. Using this technology, the country of Rwanda has currently stored their blood reserves and other medicine in a central place. It is the most efficient and secure way to transport packages via drone. This technology can be set up within a few weeks and thus is able to serve countries in need or can avoid supply problems caused by floods or similar disasters.

Fig. 3. Picture of the drone while dropping a package

How does it work:

The drone consist of four different parts: a package containing the ordered supplies, a base, wings and a battery pack. Which allows for easily swapping parts when one of them is damaged.

The drone will be shot into the air with a catapult, accelerating it to 100 km/h in less than 0.5 seconds. Now a GPS System, which is connected to the local phone network, shows the positions of the drone, allowing corrections in the flight course. While flying over the destination for the delivery, the drone drops its package attached to a parachute, as seen in the picture. This allows the package to land safely with a precision of up to 3 meters next to the designated drop point. Finally the drones flies back to a landing station, with decelerates the drone using a string. [4]

IV. Our concept

Of course, my team learned a few things from these existing technologies and tried to create their own. The European Conference on Educational Robotics is an event which features multiple competitions, one of which is a flight drone competition where we want to use a drone. To achieve the best possible result in the competition the drone needs to be able to search for supplies and transport them onto a mountain. We came up with some sort of combination using the blood transport drone and the mountain rescue drone.
They perfectly fit the task of finding supplies and then transporting them to a different place, but actually creating something like this comes with hardships. A drone like this needs to change direction in order to move towards the supplies, pick them up and then maneuver towards the destination. So we cannot use a plane like drone. We would also need to rely on the maneuverability of a quadcopter, which consumes a lot more energy and is unable to travel as fast as the other design but this those not matter to us. So we therefore of course decided to use a quadcopter.
For finding the supplies we are using a camera since the supplies have a different color compared with the floor. We decided to add a raspberry pi zero on top of the drone so that we could connect a standard raspberry pi cam to it. The other option would have been infrared to determine the position of the supplies. For transporting the supplies we used an electromagnet (actually just a nail with wire wind around it) to activate it we designed a small circuit with a mosfet to then activate with our raspberry pi zero. This worked really good but we had problems with the battery life of the drone since the raspberry and electromagnet was added to it. Since the drone is quite small we couldn't add a normal AA or AAA battery because the additional payload we could add was too little. We could solve this problem by using a small Crazyfly battery which we could conveniently borrow from a team which participated at the ECER a few years ago. Other ideas we had for picking up the supplies were adding a grabber to the drone or just using a hook.

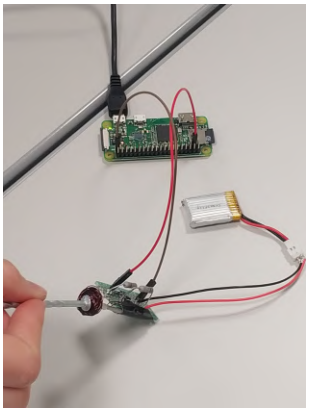

Fig. 4. Picture of our electromagnet

Concluding this, our drone should use elements from a quadcopter with either a camera for color tracking or infrared sensors for thermal detection. To transport the supplies we use a electromagnet. This picture shows how it should look at the end.

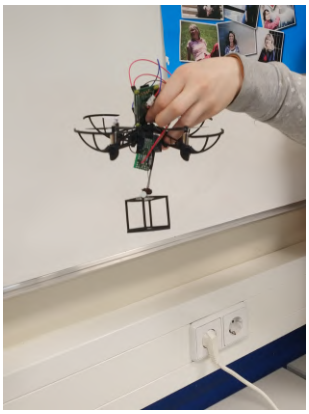

Fig. 5. Picture of our drone while lifting a supply

V. Conclusion

To conclude if or when drones are going to be used as paramedics in more than just a few rare cases is just a matter of time. The only thing that stands in the way of building more helpful paramedic drone is time and creativity. Everything from ethical to technical Problems was already addressed before and thus it seems very unlikely that drones will not be accepted as medical helpers.

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