Chapter 3

An Escorting Swarm

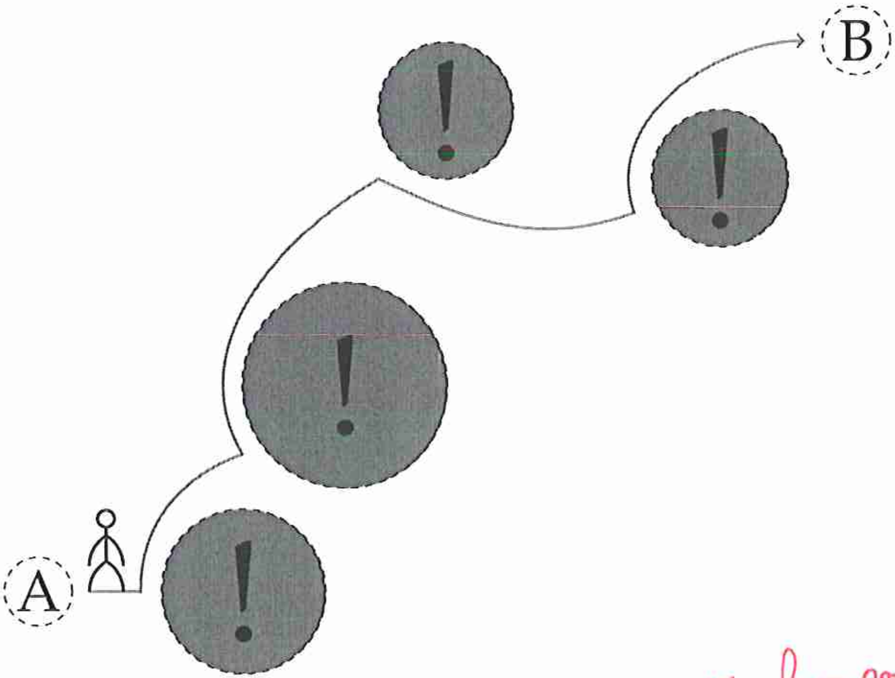
In This chapter, we will ~~explore~~ present the investigated problem ~~faced~~, and ~~its~~ the proposed solution, ~~with~~ at a high level of ~~abstraction~~ description. In The next chapter, we will ~~go deeper in~~ describe the details ~~and explain how everything was implemented~~ implementation.

3.1 The Problem

Since the early days, man has tried to explore new territories to expand their control and get a better understanding of the world surrounding them. Among those new landscapes, some were relatively safe and some were dangerous. To address this issue, we have invented armours, shield, and other kinds of protections. This work tries to contribute to the study of these solutions. Aren't those for war?

Fig 3.1 shows a graphical representation of a possible scenario. ~~To get a better insight, let us imagine a world where~~ The dangerous areas are circular. The human, ~~as depicted on figure 3.1~~, must travel from point A to B without being hurt. ~~The problem is that~~ the human ~~has no clue where~~ cannot see or perceive the dangerous areas ~~are~~. ~~The person cannot perceive them.~~ They could be radioactive areas, mine fields, or any other invisible threats. The protection created should prevent the user from going inside those areas. by what?

Exploration is not the only real application that comes into mind. Rescue in disaster areas would also benefit from it (evacuation of people to safe zones, etc). The system created should be able to constantly protect the person using it, and constantly provide feedback. It should be robust and fit to the destination environment.



move from point A to point B

Figure 3.1 – Unknown Dangerous Environment: This image illustrates an ~~unknown~~ environment, observed from above, in which a human must ~~evolve~~ while avoiding invisible dangerous areas. ~~This figure represents a path to follow from *A* to *B* in a dangerous zone to stay safe.~~ *A* is the start location and *B* is the goal. The red circles represent dangerous zones ~~whose size can vary~~. This thesis ~~explores~~ a solution to guarantee safeness in such circumstances. Applications for this type of problems ~~already exist:~~ mine fields, radioactive areas, etc.

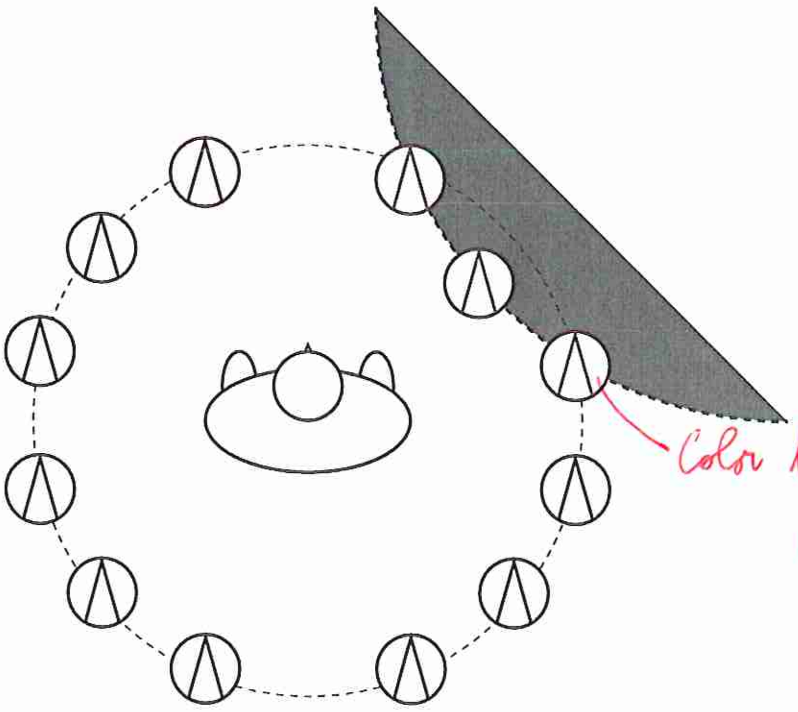
Possible solutions? provide are → These are not applications

3.2 Solution

The solution proposed involves the use of a swarm of robots. Swarm robotics seems fit to this kind of application, since it is compatible with unknown environments thanks to its flexible, robust and scalable characteristics (Brambilla et al., 2013). In case of failure of one or a few robots, the system would continue to provide sufficient performance thanks to its scalability and robustness.

The swarm ideally forms a round shield around the user to ensure a 360° protection. All the robots try to stay at the same distance from each other and the person. To achieve this, the final solution relies on the pattern formation theory widely used in swarm robotics. The corresponding techniques will be

Parler du flocking et pattern.



Color the circle of red

e.g.,

Figure 3.2 – Swarm Prevention: This figure is a representation of a human helped by a swarm. The circles with a triangle inside are representations of a robot. The swarm tells the human that a dangerous zone is located at the front right by visual communication (here the robots change their colour to red). The swarm stays at the boundary to form a 'shield'. The direction taken by each individual in the swarm is given by the triangle inside (here heading north).

explained in the next chapter with more details. If the ~~amount~~ number of robots is not high enough to form a complete circle, an arc is formed at the front to always shield the most critical zone.

As ~~seen on~~ shown in figure 3.2, the robots in contact with a dangerous zone will reflect the danger through visual communication with the human. Here the robots light on their ~~turn~~ red LEDs and stay on the boundary of the zone to prevent the ~~user~~ human from getting into it. Since the human cannot see the danger, and only the robots can, we can see that the swarm is increasing the perception capabilities of the ~~user~~. human

One big issue that had to be resolved was the detection of the human by the

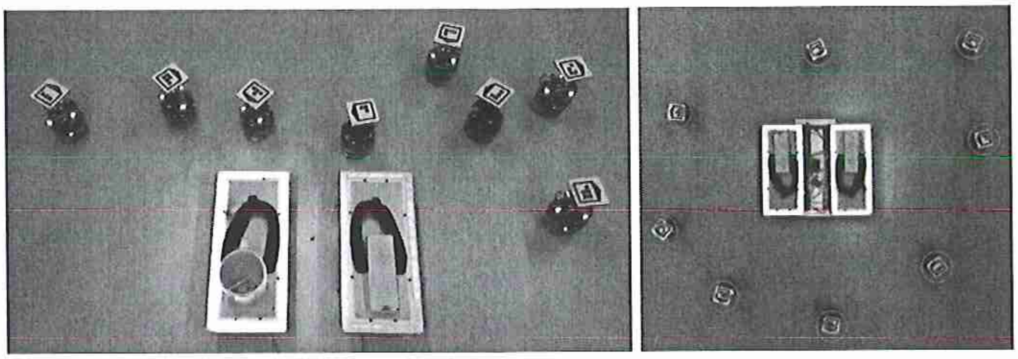


Figure 3.3 – The Shoes: This picture shows a prototype of the shoes viewed from above, and the robots interacting with it. The interaction is realised through the recognition of the colours, one for each shoe, indicating left or right side. This pair of shoes enables the robots to locate the user, allowing them to evolve at the target distance from him/her. On the left image, the robots are still in the process of placing themselves in a correct circle. The right image depicts the situation after a 3 minutes experiment where the robots were initially placed in lines around the shoes. Objects are put on the shoes to close the lights switch.

robots. As Podevijn et al. (2012) suggested, the interface between the human and the robots swarm should be restricted to the strict minimum because in the field the infrastructure needed to operate the swarm might not be easy to build. ? The swarm should handle the communication on its own. Furthermore, any centralised control system would break the distributed and robust feature of swarm robotics. We thus ~~imagined~~ designed and implemented a wearable device that ~~would~~ allows ~~the~~ a human to be recognised by the robots: a pair of shoes.

~~The~~ The Figure 3.3 illustrates the use of the shoes (no user is wearing them to ~~increase visibility~~ do not occlude the picture's field of view). On the left side, the robots have just recognised the shoes thanks to the LED system inside and begin to move to their target position. The right side is an example of one configuration obtained after 3 minutes, viewed from the ceiling tracking system. ?

This thesis objective ~~was~~ is to present an innovative protection using swarm robotics. We consider the final protection robust. The results obtained ~~at the end of the thesis~~ with real robots ~~will be detailed~~ are presented in the chapter 5, ~~but one can already say they are convincing~~. An article will be written during summertime !?! to expose this research to the rest of the swarm robotics community.

not here.
If you want
put in the introduction
chap. 1