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研鑽タイトル　Research Title

Application of the congestion level to extreme crowd scenarios

渡航先　Visited Institution

University of Navarra (Pamplona, Spain)

渡航期間　Traveling Period

From February 22nd, 2020 until March 9th, 2020.

研修概要 Research outline

A researcher (Dirk Helbing) experimentally showed almost 15 years ago that evacuation time from a room (during emergencies) can be reduced by placing an obstacle in front of the exit (like a chair or a pillar, for example). Given the counter-intuitive nature of his discovery, a lot of attention has been given to his work and many researchers have tried to replicate the results and formulate numerical models to explain the phenomenon. However, while some experiments showed that obstacles have indeed a positive effect in reducing evacuation time, others found the opposite, i.e. that evacuation is hindered by the presence of obstacles (which would be the most intuitive result from a first-hand analysis). Because of the contrasting results obtained over the years, this topic has become one of the most controversial among researchers working on pedestrian traffic (or safety science) and it is often a major reason of debate in international conferences.

The group of Iker Zuriguel (from the host institution; the University of Navarra) has been investigating the effect of obstacle for many years and has performed a number of high-quality experiments obtaining valuable data to investigate the topic. In one of the latest experiments, the army has been involved to allow reaching conditions very

close to emergencies without putting participants at risk. Also, they developed a method to track pedestrian position with high accuracy, also under very crowded conditions (when people get occluded). Both the experimental data which they possess and the knowledge on how to process and analyze the data, make them one of the best research group to study this interesting and controversial subject.

Evacuation without obstacle

Evacuation with obstacle

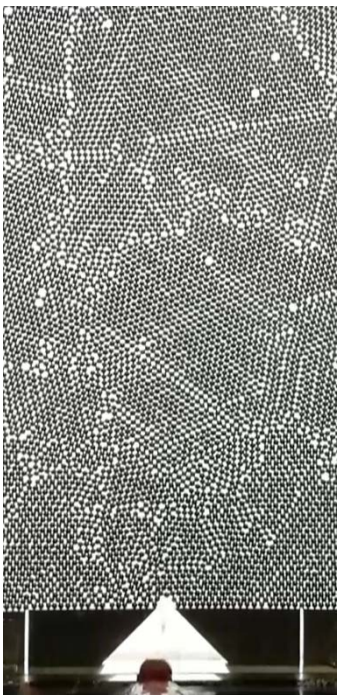
In my previous research I developed a method which can be used to quantify congestion or measure the level of jam in pedestrian crowds. The method has been published in one of the world's best ranked journals in the field of traffic research (Transportation Research Part C) and has been positively welcomed by fellow researchers during its presentation at the international PED2018 conference.

Among those researchers was Iker Zuriguel, who hoped that the method I developed could help understanding the reasons why obstacles are useful in some cases but not in others. We also personally met during the TGF2019 conference which Iker organized in Spain and had interesting discussions on the topic. Already, at the beginning of 2019 I started working with Iker, but due to the time difference and the distance it has been difficult coordinating the project.

研修先について About the laboratory visited

The group of Iker Zuriguel is well regarded for their contributions in the field of pedestrian traffic and has a long tradition of research in the field of granular materials. In fact, the group of Iker Zuriguel started doing research on granular materials and later used their experience to study the motion of crowds which has some similarities with granular flows, especially in the case of evacuations. The particularity of the laboratory

I visited is that they performed similar experiments using completely different “particles”, ranging from grains, sheep and humans (including students and soldiers). The originality of their works made them particularly famous and their rigorous approach in the analysis of the experiments helped them becoming an important member of the research community I belong.



Granular material

Sheep

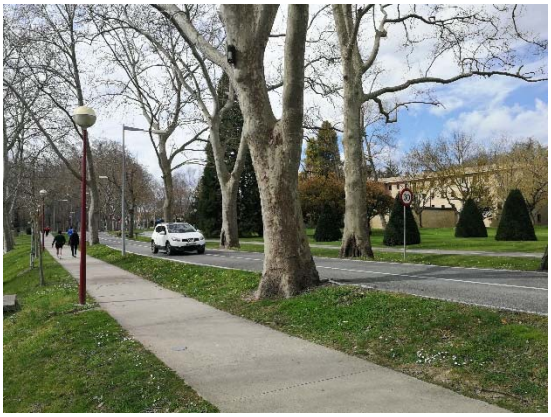
Humans

The University of Navarra is located in the city of Pamplona, in the North-East of Spain, not far from the French border. It is a small university mostly famous for its university hospital which is one of the more well-regarded in Spain. Given the small size of the university, all departments (except for medicine which is comparatively large) are also small, with the one of physics and applied mathematics being composed of about 20 researchers and 10 PhD students. The size of the department makes communication very easy and it is possible to quickly learn what other members are doing without having seminars or formal presentations.

The University of Navarra is located in the outskirts of the city of Pamplona (the capital city of the region of Navarra) and it is possible to enjoy the nature while walking inside the campus. Departments are laid down a road passing close to a river surrounded

by gardens and green areas. The city of Pamplona itself is also a small city of about 200’000 people which can be easily visited in a day. Around the city is a long running course which extents for more than 40 km. The small size of the city and the nature surrounding it allows to work in a relax environment and spend little time commuting to the university (or to work). Most of the students live nearby and many also go back for lunch as they live in a walkable distance.

Science department building



The university main road

Granular material experimental equipment

The castle of Olite (close to Pamplona)

One of the reasons which led Iker Zuriguel to study the motion of crowds is the annual San Firmin festival held in Pamplona, when one million people enter the city for the weeklong festival (held in July, when the TGF2019 conference was also held). Large crowds easily form in any part of the city, with the maximum occurring during the inaugural day of the festival when thousands of people gather in the main square to celebrate the mayor declaring the start of the festival. Stampede accidents also occurred in the past (23 people got injured in 2013), leading to a motivation to understand the dynamics of people and prevent further occurrence in the future.

Crowds of people celebrating San Firmin (pictures taken in July 2019 during the TGF conference)

研修内容 What you learned

Although being originally from a European country (Switzerland, which is however not a member of the E.U.), I never worked in Europe as a researcher since I did my PhD in Japan and worked in Japan after finishing it. This was therefore an opportunity to learn about how is like to be a researcher in Europe and what are the challenges. For example, I noticed that there is a lot of cooperation between the different universities even if are in different countries. For PhD students it is also possible to do an “international PhD” in which they have to spend a period abroad and have referees from several countries during their defense. Besides being a small department and a city not easy to reach (compared to big centers like Barcelona or Madrid, for instance), I have seen several visitors coming in only two weeks and I had a chance to talk with them.

From a technical point of view, I got to learn about the science of granular material which is closely related to my research. Also, one of the members of the

department helped me understanding better clustering algorithms and guided me through their selection. Although this was not related to the project I was working on in Pamplona, it was of great help for a different project I am working on.

Also, Iker Zuriguel and his colleagues shared with me the problems they had while performing their experiments. Although all the scientific details are clearly given in their works, the organization of experiments with the crowd requires a lot of practical knowledge which can be only obtained when talking directly with the people involved. It turned out that experiments under competitive conditions are indeed dangerous and even if the army was involved a lot of care was required and several experiments had to be stopped due to safety concerns. This helped me understand how valuable their data are and why so few people were able to perform such experiments.

Finally, I also got the opportunity to learn a little bit more about MATLAB programming in particular in regard to the so-called “optical flow” technique, which is often used to study moving crowds.

研修先で特に印象に残ったこと The most impressive thing

During my time in Spain (and partially during a separate visit I did in Germany as part of a different project) I never noticed a difference between professors or students or people of different positions (except the age, obviously). The head of the department was acting exactly like everybody else and it was easy to speak with any person inside the lab regardless of position or fame.

Iker Zuriguel (right) and me on the last day

Relaxed atmosphere in the lab (Germany here)

Professors would sometimes come inside the room of the students just to have a coffee together and chat a little bit about research, science or simply movies. Nonetheless people would respect opinions of professors with longer experience but nobody was scared of providing a different opinion, especially when talking about something which was not related with research. Although, this should be something normal, I have been quite surprised from the simplicity of the relations in general and how easy it was to talk with everybody.

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