

Rats with backpacks sniff for victims under rubble

January 31 2023, by Hilde van Genugten—de Laat



Credit: APOPO, June 2022

Rats are commonly known as pests and spreaders of disease and many people's worst nightmare. Yet they are very clever creatures, and can be trained just as well as dogs. The Belgian aid organization APOPO trains

African hamster rats to search for earthquake victims under rubble, using a backpack on their backs, developed by TU/e students. Bram van Kasteren defended his master's thesis on location determination in late December. This would eventually allow rescue workers to know exactly where to find the victim when the little rat hits the alarm button.

"Rats are small, curious and inquisitive, but above all they can smell extremely well," explains Roel Jordans. He is a lecturer and researcher at TU/e's Department of Electrical Engineering. He supervised Bram van Kasteren during his master's thesis, which was completed just before Christmas.

It is that amazing sense of smell of the rat that inspired the non-profit organization APOPO, which has become known for successfully detecting land mines worldwide as well as detecting the specific odor of the disease tuberculosis in sputum samples. A few years ago the organization received a request from earthquake-prone Türkiye to use the [rats](#) to search for survivors under the rubble of collapsed buildings. That posed whole new challenges, where TU/e's Electrical Engineering department was able to add its value.

Sniffing for victims

Jordans says, "To track down people buried under the rubble, the rat had to be in communication with the [rescue workers](#). For that they needed a system with a microphone, camera, controller, GPS, antennas ... you name it. Exactly the kind of work we specialize in. That's how the project called RescueRats was born."

Student Sander Verdiesen, now a graduate, was the first to pick up the gauntlet. For his 2019 internship, he developed a 3D-printed backpack with the necessary electronics for the rat. He even traveled to Tanzania to test and improve his design. That is where APOPO's training center is

located and where African hamster rats are prepared for their work.

After his internship, he couldn't let go of the project, so he continued to work on the prototype under the guidance of Jordans. Now there is a robust little backpack with improved built-in camera and batteries that last longer. He also added an alarm button under the rat's neck so that the animal can notify rescuers when it has found a victim. Verdiesen says, "That wasn't so easy, because that pull switch has to be sensitive enough to send the signal, but not break when the rat pulls at it with its strong claws."

No GPS under the rubble

Communication proved to be a thorny issue, because below ground GPS doesn't work. Jordans says, "Ideally, the exact location of the rat under the debris is sent in real time to the rescuers above ground. That way the helpers can check a map on their mobile exactly where the rat is with the victim and how far away they themselves are." It was this new problem that prompted Bram van Kasteren to work on for his master's thesis, which he successfully defended in December 2022.

Van Kasteren says, "The chaotic environment of a disaster area makes locating the rat very complicated. You don't know how much concrete and metal is between the rat and the receiver and how much influence that has on your signal, which requires a robust system."

Strong signal encountered few obstacles

After multiple tests, radio triangulation proved to be the best method as soon as GPS is lost. In this, the system monitors multiple measurement points to determine its location. "We place multiple antennas around the debris, and transmit a signal through an antenna in the rat's backpack. The receiving antennas then look for the strongest signal. That best

indicates its direction, because it has encountered fewer obstacles along the way and is therefore less deflected by reflection," Van Kasteren explains.

The software in a central receiver can then determine where the signal is coming from. By combining the lines from all the receiving antennas, a single point emerges where the rat should be. The more receiving antennas are being used, the more accurate the positioning becomes.

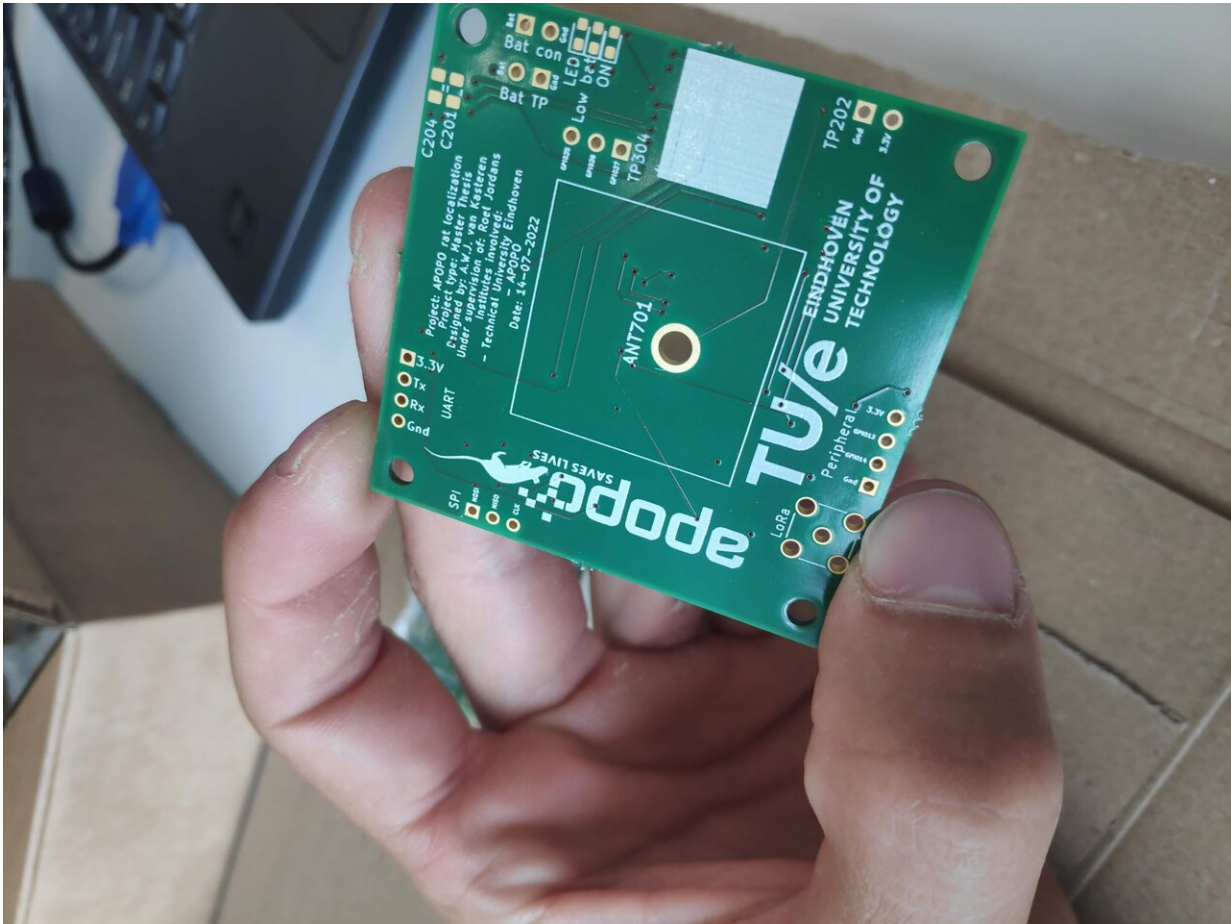
Circuit board

So Van Kasteren built his own circuit board with altimeter, antenna and GPS module. He tested his design on the TU/e field hockey pitch. Van Kasteren says, "We have now designed and tested the circuit board in the open. The next step is to add debris to see how much interference occurs. We are not there yet, which is why I would like to stay involved to continue working on it."

Jordans adds, "Hopefully we can motivate other students to continue working on the antenna modules. We also want to add a kind of walkie-talkie function to the backpack, so that the rescuer can talk to the victim. That requires quite a bit of figuring out because the low signal strength requires strong audio compression. We are also looking for students for this. Both for internships and for thesis projects."

Refrigerator full of distractions

Meanwhile, training the rats at APOPO's training center in Tanzania is in full swing. In a building where a disaster scenario has been recreated with debris, the rat must search for a volunteer without being distracted by a laundry basket of worn clothing or an open fridge full of food.



Credit: Bram van Kasteren

And the work on the backpack has not stood still either. After graduating, Sander Verdiesen worked at Philips for two years, but he has always remained involved with APOPO as a volunteer to continue working on the rat backpack. He couldn't shake off working in a low-resource environment and therefore he now works at the TU/e spin-off GOAL 3, which builds simple and cheap technology for the healthcare system in African countries. Alongside this, Sander takes a more active role at APOPO as a part-time project manager.

Bram, meanwhile, also remains active in the world of disaster zones. He will start his internship in Tokyo next week, where he will work, among other things, on the further development of drones to search for victims during tsunamis and landslides. In four to five months, he expects to graduate and would like to remain active at APOPO.

Next challenges

The rats of the Belgian NGO APOPO, founded in 1998 by two students at the University of Antwerp, have now detected more than 130,000 landmines and other explosives worldwide. Hence APOPO's acronym: Anti-Personnel Mine Demining Product Development. The rat checks an area the size of a tennis court in 30 minutes, while a well-trained deminer takes four days. Additional advantage: the rats themselves are in no danger, as they are too light to detonate the mine.

Since 2007, the aid organization has also been using the rats to smell the specific odor of tuberculosis. The small rodents have now managed to detect tuberculosis more than 25,000 times in nearly 850,000 sputum samples from potentially infected people in African countries. The rat is able to check 100 samples in 20 minutes, where a researcher with microscopy can only process 25 samples a day. Right now, the NGO works on locating victims in disaster areas, as well as searching for contraband in container terminals.

Provided by Eindhoven University of Technology

Citation: Rats with backpacks sniff for victims under rubble (2023, January 31) retrieved 31 May 2023 from <https://techxplore.com/news/2023-01-rats-backpacks-victims-rubble.html>

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