

# Snake robots play an important role in social services and military needs

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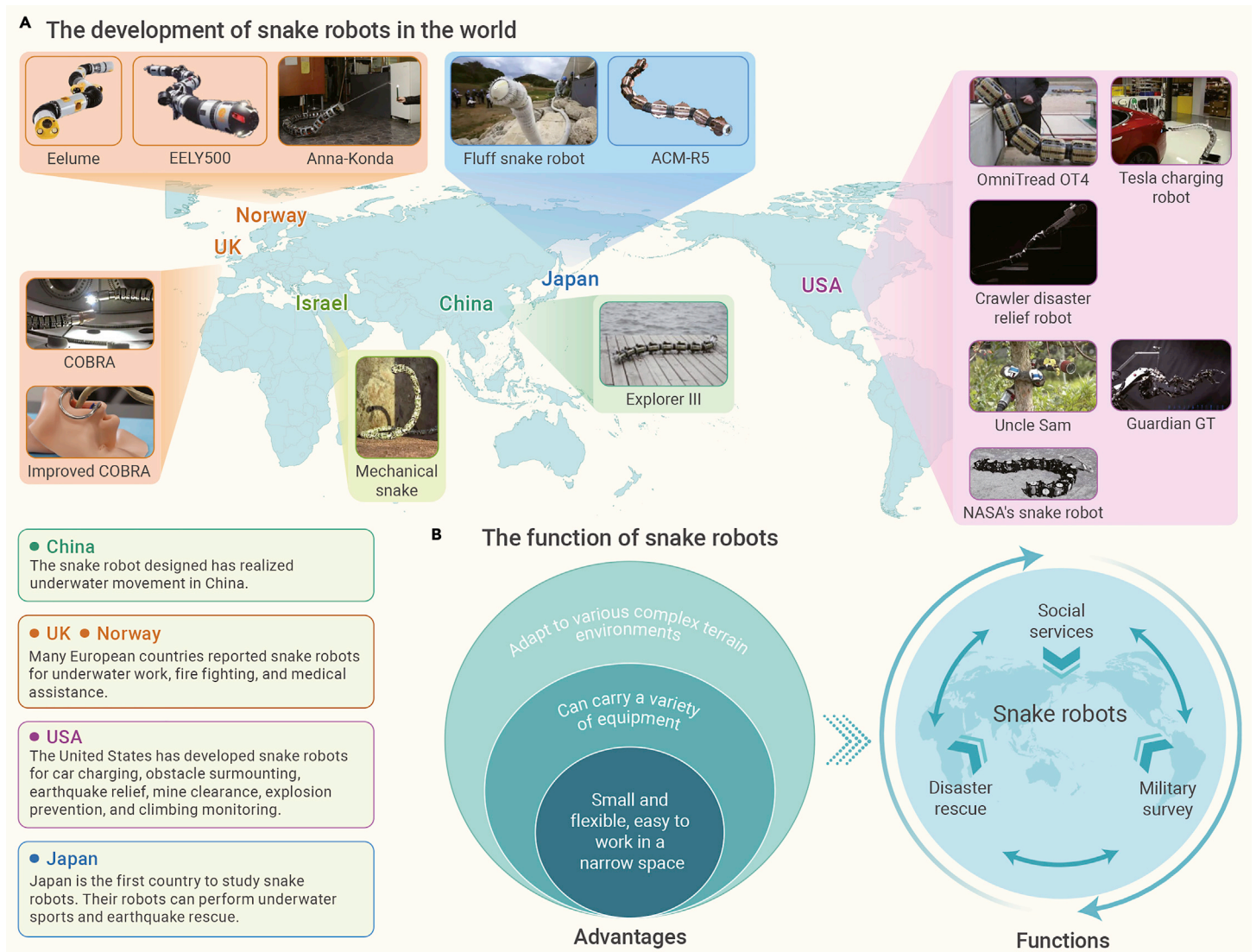
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Intelligent robotic systems have gradually penetrated into the fields of social services and military reconnaissance with the rapid economic development. Snake robots, as multi-redundant bionic robots, play an indispensable and important role in public life and military needs.<sup>1</sup> These robots have been widely favored and highly regarded by the academia and industry because of 1) their small size and flexibility, thereby easily entering small spaces for work, 2) their ability to carry a variety of equipment for disaster rescue and military reconnaissance, and 3) their variety of movement modes, which can adapt to various complex terrain environments.

In marine exploration, the snake robot's inherent elongated body shape and flexible movement gait have broken through traditional underwater robots' bottleneck. These robots can operate at 1000 feet below sea level or even deeper, greatly protecting the life safety of divers. In intelligent medicines, the shrunken snake robot can enter blood vessels to identify the cause of disease and provide safe and immediate treatment solutions for patients. Search and rescue operations following earthquakes and fires are highly difficult and dangerous in natural disasters. Accordingly, deploying snake robots for search and rescue operations can be advantageous. In the military, snake robots can



**Figure 1. Development and application of snake robots** (A) Snake robots have received extensive attention from scholars worldwide. (B) Advantages and application scope of snake robots.

provide reliable military reconnaissance in complex and dangerous battlefield environments.

Snake robots can free people from heavy, unsafe, and monotonous work environments and replace them in dangerous situations to complete operations, as shown in Figure 1. Such robots constantly provide services and convenience to human civilization.<sup>2</sup>

### SOCIAL CONVENIENCE BROUGHT BY SNAKE ROBOTS

With the continuous development of science and technology, people increasingly pursue the convenience and efficiency of life.<sup>3</sup> However, some jobs are still dangerous and are difficult for humans to perform. Accordingly, scientists have developed snake robots inspired by biological snakes to solve such problems. These notable achievements are as follows: 1) Eelume, an underwater snake robot jointly developed by the Norwegian University of Science and Technology and Kongsberg Maritime, can reach deep-sea areas that are difficult for humans to reach and complete underwater equipment inspection, valve adjustment, and pipe cleaning to replace traditional large maintenance equipment. 2) Tesla has introduced a snake robot, given the popularity of electric cars. (3) COBRA, a snake-like robot developed by the University of Nottingham, can be used for aero-engine inspection and repair and can navigate through narrow spaces at will. 4) The magnetically controlled snake-like robot developed by MIT can crawl into the internal tissues of the human body. On-board sensors are used to clear blood clots in patients with aneurysm or stroke. This approach effectively relieves the patient's pain and shortens the patient's recovery time.

Snake robots can solve many societal challenges. However, improving these robots' motion accuracy is a pressing issue.

### SNAKE ROBOTS FOR DISASTER RELIEF

Snake robots have played an irreplaceable role in disaster assistance in several countries.<sup>4</sup> Since 2020, earthquakes have caused 56% damage to dwellings and 300 000 casualties in Japan. In response to this phenomenon, Japanese scientists have developed a fluffy snake-like search-and-rescue robot that can flexibly move in a debris terrain environment. This robot is 8 m long and 5 cm in diameter and can enter a collapsed house to detect the interior. American scientists have developed a snake-like tracked disaster relief robot and the OmniTread4 robot. The OmniTread4 can survey unknown terrain, such as caves, to carry out rescue missions. Anna Konda from the Norwegian University of Science and Technology can immediately detect the source of fire and limit its spread. The world's fire rate has decreased by 27% since 2020 due to the help of snake rescue robots. However, the adaptability of snake robots to complex rescue environments still needs to be improved.

### SNAKE ROBOT IN MILITARY

To adapt to the complex and changing future warfare, the military use of snake robots has become a hot topic of research for a wide range of scholars.<sup>5</sup> Carnegie Mellon University has developed "Uncle Sam," a snake-like robot capable of coiling up in a tree. Sacos designed the Guardian S, a snake-like robot that can perform 18 h of surveillance work. The robot can assist soldiers with bomb disposal tasks by using probes and sensors. In addition, the snake robot can perform demolition tasks. Israeli scientists have developed a 2 m long "robot snake." This robot resembles a snake and can carry explosives to designated locations to carry out tasks. The snake-like robot can replace soldiers in military tasks, reduce casualties, and enhance the military's combat effectiveness. However, the movement efficiency and endurance of the robot should also be further improved due to the military mission execution time limitation.

In summary, snake robots play an indispensable role in various aspects of social services and military requirements and have a broad development space and application prospects. With low energy consumption and zero emissions, these robots not only promote green and sustainable development but also bring great economic benefits. However, the challenge is to improve the payload and efficiency of snake robots to better serve human beings.

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### DECLARATION OF INTERESTS

The authors declare no competing interests.