Radio-controlled Electric Vehicles: Issues Relating to the Safety of Unmanned Electric Vehicles and Robots

Shigeyuki Minami [1], Masaaki Doi [2], and Takashi Masuzawa [3]

[1] *Department of Electrical Engineering, Osaka City University, minami@elec.eng.osaka-cu.ac.jp*
[2] *Department of Electrical Engineering, Osaka City University, doi@em.elec.eng.osaka-cu.ac.jp*
[3] *Department of Electrical Engineering, Osaka City University, masuzawa@em.elec.eng.osaka-cu.ac.jp*

Abstract

This paper describes the development and performance of a compact, unmanned, radio-controlled electric vehicle. This vehicle is controlled by radio while it appears that a dog is the driver. The main purpose of this research is to show a dog driving a vehicle in order to conduct traffic safety campaigns, but this paper also describes the diversion of this development of autonomic robots for military purposes and its importance in relation to this research.

Keywords

radio-controlled vehicles, unmanned vehicle, military purpose, traffic safety campaign

1. INTRODUCTION

Today, the R&D of robots is being conducted in every country, and soccer games by robots are often held. These are seemingly useful for the safety and peace for humanity. The Japanese especially still enjoy the praising of peace, and thus regrettably it must be said that their crisis awareness concerning the existence of robots is significantly low. The authors of this paper have been involved for many years in the measuring of high altitude plasma by using sounding robots. These experiences have made us see conditions in relation to operating robots safely and the conditions we have to adopt when we develop robots.

Table 1 Conditions which should be applied to robots, and points for R&D

1. An ID which is equivalent to a human fingerprint must to be built into robots as an international standard. → Development of scanning technology and hardware.
2. In order to arrest a function or stop movements when robots go out of control, a kill-switch-command-system must be built into robots. → Development of this system.
3. For communicating with robots, a radar transponder is necessary. → Development of the transponder and standardization.
4. The necessity of measuring the batteries, functions and other housekeeping (HK) data. → Optimization of a telemetry system for this.
5. A self-defense initiative against robots' attack on the systems of human society. → Development of the system.

Mobile objects which can move to their destinations autonomously are the ultimate vehicles, and there is no question as to the importance of their development in all fields, including land, sea, air, and in space. These mobile objects can be described as a type of robot. A system which operates autonomously is at the core of research in developing robots. And there are some difficult issues which exist separately in the system architectures for land, sea, and air. The system for land mobiles is required to be intelligent enough for them to move autonomously without running off roads or other borderlines. The difficulty in developing the system for airplanes is flight control, in which a three-dimensional degree of stability is required. For ships, the difficulties lie in selecting propulsion systems and communication systems.

However, the development of robots which overcome such difficulties has been conducted for military purposes all over the world, and this sort of development has the highest value in terms of human life. Figure 1 shows a self-propelled combat vehicle which was developed in the USA, and Figure 2 is a hybrid combat vehicle which runs by electricity and diesel. It is certain that one day in the future unmanned hybrid combat vehicles will be built by combining the systems for ve-

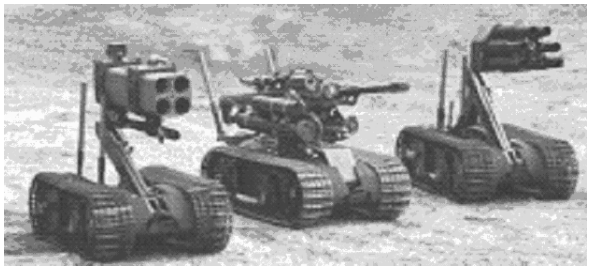

Fig. 1 Unmanned tanks [after Defense Tech 2004a]

Fig. 2 Photographs of M113 Hybrid tanks. The M113A3 (left), hybrid powered vehicle prototype of M113 with about 500 horsepower, versus only 275 horsepower for original M13. A hybrid-electric FCS-W (Future Combat Systems- Wheeled) demonstrator which can travel 5 miles per hour for 30 minutes on level ground using only stored electric power (right) [after Hybrid Electric Drives (HED) for armored fighting vehicles, 2004]

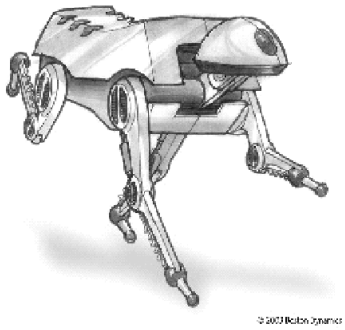

Fig. 3 An illustration of robot dog [after Drone Doggie Built for War, 2004b]

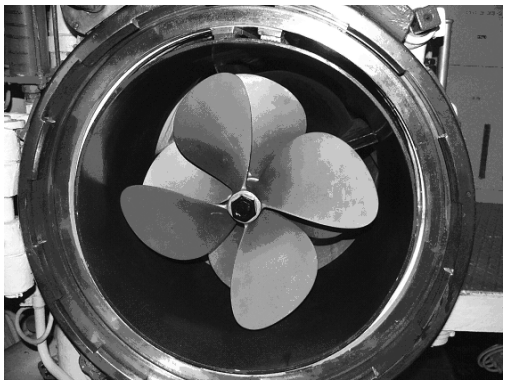

Fig. 4 A photograph of a torpedo with double-inversion propellers which is loaded onto a submarine

hicles shown in Figure 1 and 2. Figure 3 shows an illustration of a robot-dog which can run on fields freely [Defense Tech drone doggie built for war, 2004]. The purpose is to develop a futuristic-style vehicle which can move around more freely, so that it can act alongside soldiers on battlefields.

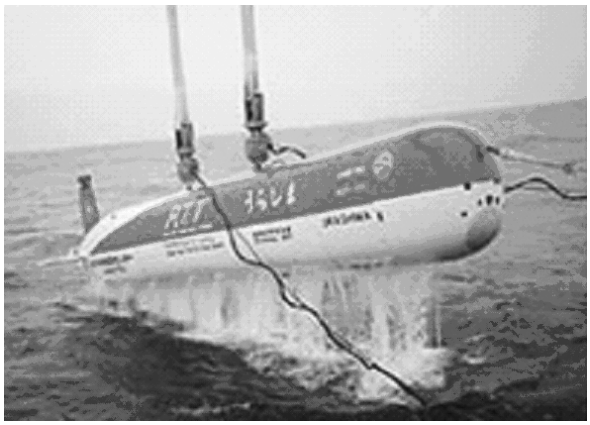

Fig. 5 A photograph of an unmanned vehicle which is a robot submiarine for deep sea exploration [after Yamamoto et al., 2004]

Figure 4 is a photograph of a torpedo with double-inversion propellers which is loaded onto a submarine. Torpedoes are required to move autonomously to their target. It is a high-level system which is controlled by robots. Figure 5 shows a photograph of AUV, automatic underwater vehicle driven on fuel cells (120V, 4kW) with 14.7 MPa Oxygen and H2 stored in a metal hydride and Li Ion batteries. The probe named Urashima, 10 m long, made it possible to explore the deep sea of 3,500 m and cruise more than 300km without remote control. Such a submarine would be able to go anywhere in the sea based on artificial intelligence commanded by some agency or by someone behind in the future. If the systems of Figure 4 and 5 are combined, an unmanned marine vessel will be developed, and this vessel can move around on and in the water autonomously under command for military purpose. Recently an unmanned GPS boat has been commercially available. After people finish fishing, this boat can take fishes boat to a port [Kamome. 2005]. If the development of these systems is completed, this will obviously be a cutting-edge electric vehicle which requires more knowledge of electronic engineering than ordinary vehicles.

2. RADIO-CONTROLLED ROBOTS

The presumption in developing autonomously movable robots is that the robots' high performance and flexible movements are controllable by electronic input. In this sense, the first step in the research of autonomous robots is to build a completed vehicle which is radio-controllable. We have developed a radio-controlled vehicle as a new type of mobile tool for the aging society. [Minami et al., 2005, Masuzawa et al., 2006] as shown in Figure 6. This is a powered mobile unit which can be equipped to a chair as a form of furniture for use in an ordinary home. This mobile tool, named the Mobile

Fig. 6 A photograph of the Mobile Chair [after Masuzawa, et al., 2005]

Chair, has been developed for elderly people who have difficulty walking. The Mobile Chair was built by transforming an ordinary chair into an electrically mobile chair. This was devised in such a way that family members or visitors can also use it without discomfort. This chair was developed from a concept completely different from conventional powered wheel-chairs. The size and design of such chairs were exaggerated in the past. The aim in developing this chair is to sell the chairs at a low price, and thus a practical usage has been sought.

In order to make people understand the value and danger of developing robots for military use, this paper describes the results of developing a compact, radio-controlled vehicle in which a dog can ride. Figure 7 shows photographs of the vehicle produced. Two electric motors are used so that their differential rotations make it possible to move forward and backward. A large-size dog is placed inside so that it looks as if the dog is driving the vehicle. The vehicle is big enough for loading two adults and a large-size battery. The specifications for the radio-controlled robot vehicle are shown in Table 2. In order to make it practicable to control the vehicle from as far away as possible, an FM-PWM-system is

Fig. 7 Photographs of the produced vehicle

used for its radio communication. Two 12V28Ah-batteries are used as the main batteries. Supplementary batteries can be loaded onto a trailer. A smoke device which needs AC power of 700W is mounted in order to make this electric vehicle look as if it is emitting exhaust gas. In order to compensate for the consumed power, it is designed to carry a large-size battery as a range-extender. Figure 7 show photos taken when the vehicle was shown to people at a university. Because it looks as if a dog really is the driver, a huge crowd of people gathered around.

Figure 8 shows a block diagram of this system. Figure 9 is a radio-interface circuit of the vehicle.

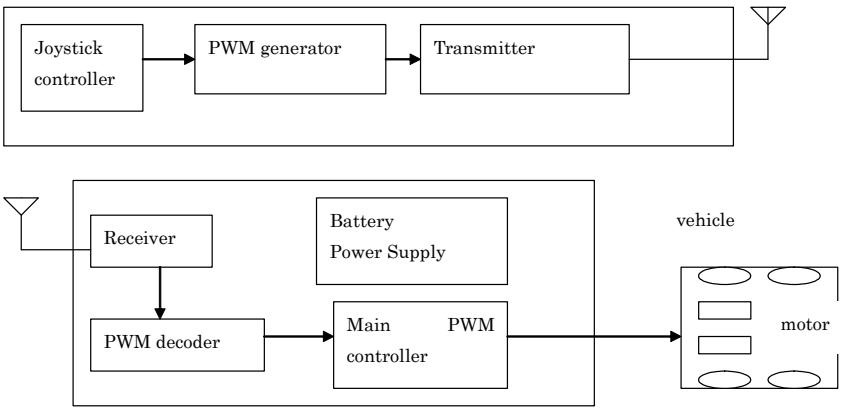

Fig. 8 The block diagram of the system

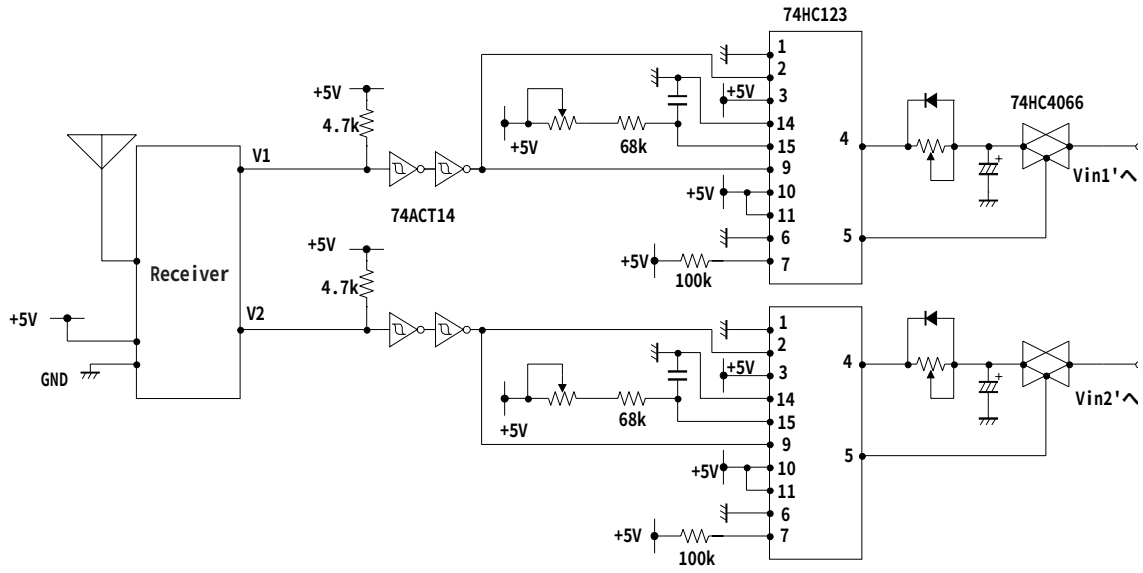

Fig. 9 Interface circuit of the receiver to the main PWM controller

Table 2 Specifications of radio-controlled robot-vehicle

Dimensions	WxDxH mm	450x700x300
Weight	Main body	110kg
	Trailer	25kg
Maximum loading capacity	Main body	80kg
	Trailer	200kg
Maximum gradability		20 degree
Drive-system	Control	PWM
	Motor	DC PM (250Wx2)
Radio control system		FM-PWM
Controllable- distance		300m
Battery	Lead Acid	12V28Ahx2
Travelable time		3~24 hours Depending on load
Speed control	System	3 Presettable speed selections and a variable speed
	Maximum speed	4km/h
Auxiliary Machinery	Smoke-device	700W

3. CONCLUSION

The radio-controlled robot-vehicle described in this paper is controllable from 300 meters away and its performance is stable and at a high level. This vehicle has been used for traffic-safety education by means of a dog, and it has been very popular. The vehicle with a dog on board stops at a red light, and this has been very useful for educating children in proper traffic-behavior.

By making reference to the construction of this vehicle, this paper suggests the importance of realizing the dangers existent in robots. This paper also suggests the necessity of consideration that even robots meant for peaceful purposes should not be used unless they fulfill the conditions shown in Table 1. The developers of robots should have a full understanding of the dangers existent in robots, and they should reconsider whether the development of robots can possibly be limited to peaceful use. Certainly, developing robots which carry

bombs on battlefields has far more importance and significance than robots which run after soccer balls. In other words, robots can be used for the purpose of disturbing the peace and stability of humanity, and thus robots should not be developed without an understanding of their danger. DOD, US Department of Defense, says that robotic warfare may be a reality by the year 2025 [Military Robots of the Future, 2003]. We must know that we are going to make a terrible mistake in studying robots with the childish view that robots are messengers of peace. The biggest achievement in the development of this radio-controlled vehicle where it appears as if a dog is the driver is that this has made us consider the other side of research into robots.

Acknowledgement

The "Mobile Chair" was developed under the support of Mitsubishi Foundation.

References

Armed Robots Marching Into Battle? http://usmilitary.about.com/od/weapons/a/armedrobots.htm, December 2004.

Defense Tech.: December 2004 Archives, http://www.defensetech.org/archives/001126.html, 2004a.

Defense Tech., Drone Doggie Built for War, http://www.defensetech.org/archives/000711.html, 2004b.

Hybrid Electric Drives (HED) For Armored Fighting vehicles, http://www.defense-update.com/features/du-3-05/feature-HED-afv.htm, 3rd issues, 2005.

Kamome, Radio Controlled Boat for Fishing, http://www.coden.co.jp/boat/boat.htm , 2005.

Masuzawa, T., M. Doi, S. Minami, M. Nakaseko, K. Morimoto, H. Ikeda, and H. Ikeda, The design concept of newly developed "mobile chair" and its performance, *Journal of Asian Electric Vehicles*, 3, 777-779, 2005.

Military Robots of the Future, http://usmilitary.about.com/cs/weapons/a/robots.htm, August 2003.

Minami, S., T., M. Doi, M. Nakaseko, K. Morimoto, Development of Mobile chair, *Annual Report of Mitsubishi Foundation*, 2005.

(Received November 8, 2006; accepted December 16, 2006)