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## Preface

Most of the articles in the book are reports from researchers engaged in the Japan Science and Technology Agency (JST) program on research and development of sensing technology and access, and manipulation technology to support detection and clearance of anti-personnel mines for humanitarian purposes. The program started in October 2002 and was terminated in March 2008.

It is said that we still have more than one hundred million landmines buried on the earth and more than twenty thousand people are victims every year. On December 3, 1997, the then Foreign Minister Keizo Obuchi signed the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Landmines and on their Destruction (known as the Anti-personnel Mines Ban Treaty in Ottawa) and also proposed the “Zero Victim Program” in his address. On December 2 of the same year, the then Chief Cabinet Secretary Kaneko Muraoka announced the agreement of the Cabinet that under certain conditions, anti-personnel clearance equipment for humanitarian anti-personnel landmine clearance activities is not against Japan’s three principles banning the export of weapons. With that decision, the humanitarian detection and clearance technology of the anti-personnel landmine has been considered and developed in Japan.

Landmine detection and clearance were identified as problems in the reconstruction of Afghanistan at the International Conference on Reconstruction Assistance to Afghanistan held on January 21–22, 2002 in Tokyo. The Ministry of Education, Culture, Sports, Science and Technology (MEXT) founded the Experts Committee on Humanitarian Demining Technology after the conference. Its report “Promotion of R&D for Humanitarian Demining Technology” was submitted to MEXT. This report described the importance of technological development for the anti-personnel landmine detection and clearance using advanced technology to achieve safe and efficient humanitarian demining and provide a basis for their development in Japan. According to the report, JST started the project at the request of MEXT. The topics and researchers were selected from proposals and research and development started in October 2002. In July 2002, the experts from the Ministry of Foreign Affairs, MEXT, the Ministry of Economy, Trade and Industry and the Defense Agency visited Afghanistan to survey landmine detection and clearance activities in the neighborhood of Kabul and Jalalabad, and collect

information from the NGO members in charge of the demining operation. This visit made clear what technology was required in the real landmine detection and clearance operations.

Anti-personnel landmines are cruel instruments used to injure enemy soldiers to reducing their fighting ability by demoralizing combatants and forcing them to take care of the wounded. Most anti-personnel landmines are 7 to 16 cm in diameter and buried around 10 cm beneath the surface. They contain 20 to 200 g of explosives with sensors to the load pressure or the trip wire. The depth is changed and deepened as the climate and environment changes. Demining methods and equipment differ depending on countries or regions. In places like Cambodia, the vegetation must be removed before the mine detection, which accounts more than 60% of the overall demining procedure. In Afghanistan vegetation clearance only accounts for 15%.

The minefield is marked off from the surrounding area by building a safe road around it and is divided into sections. In large areas, a rotary crusher machine is used to break the mines, but more than 15% of the mines are said to be left. Mine dogs are frequently used to detect the possibility of mines. Metal detectors are used to detect the metal mine fuses and to identify the location. When metal is detected, the identified area is prodded and if the mine is found, it is removed manually or brown up. Metal detectors cannot discriminate metal fragments from landmines and generally one landmine is found for every 1000 metal reactions. They do not give metal depth information, which is very important for deminers in determining the starting point for prodding.

Many national mine action bodies in co-operation with United Nations Mine Action Centre (UNMAC) and Geneva International Centre for Humanitarian Demining (GICHD) are trying to develop and/or improve methods, techniques and technologies for humanitarian demining operations. The Croatian Mine Action Centre (CROMAC) has developed a contemporary mechanical demining method in the Republic of Croatia conducted by demining machines of different types equipped with different tools (flails, tillers and combinations of flails and tillers). In this way, mechanical demining in the Republic of Croatia took the primary role in humanitarian demining. Good results were achieved, especially in applying combined demining methods using demining machines, manual mine detection, and mine and UXO detection dogs. CROMAC has also developed an efficient system of quality control over demining process, although there still remains the problem of fast and efficient distinction of different metal wastes, metal fragments of mines or parts of mines buried in the ground. In these cases, each detection has to be dug up manually and identified, considerably slowing down the demining process and quality control of the demined area.

The JST program of developing humanitarian mine detection and clearance technology decided to develop sensors visualizing the underground objects using ground penetrating radars in three years (short term projects) and ones detecting explosives using nuclear quadrupole resonance (NQR), neutron or bio-sensors in five years (middle term projects). The sensors combining metal detectors and ground penetrating radar have been developed by Tohoku University, University of Electro-Communications and Nagoya University with the help of Mitsui Engineering & Shipbuilding Co. Ltd. The sensors were developed to visualize the

underground three-dimensional image by combining sliced two-dimensional images. They are held and operated by deminers or put on the vehicles developed by Fuji Heavy Industries Ltd., Tokyo Institute of Technology and Tadano Ltd. The results of these short-term projects were introduced at the Nairobi Review Conference of the Ottawa Convention in November 2004. In March 2005, experts from Afghanistan, Cambodia, Croatia and GICHD were invited to domestic trials in Sakaside, Kagawa Prefecture. The experts from Afghanistan evaluated that the visual image of the three-dimensional underground information given by the developed ground-penetrating radar (GPR) would not only aid safe and efficient demining, but also provide quality control by storing the measured data in the database.

Some instruments developed by the short-term projects were tested at the trial field of the Croatian Mine Action Centre - Center for Testing, Development (CROMAC-CTDT, CROMAC-related organization) in Croatia. Trials in Croatia showed that GPR systems have an advantage over classic metal detectors in increasing the detection depth and reducing the false alarm rate. Although the systems are still in their development phase, with minimum modifications, they could be used in quality assurance operations during demining and quality control of the demining project. Trial use of two Advanced Landmine Imaging Systems (ALISs) systems has been carried out in Croatia in quality control operations over completed demining projects. The results were more than satisfying. Under the framework of Official Development Assistance (ODA), tests were done in Cambodia by the Cambodian Mine Action Centre (CMAC). These sensors and vehicles have been included in the Guidebook on Detection Technology and Systems for Humanitarian Demining.

The sensors detecting the explosive have been developed by Kyusyu University, Osaka University, Kyoto University and Nagoya University, where Kyusyu University developed the biosensor, Osaka University developed the NQR sensor, and Kyoto University and Nagoya University developed the nitrogen sensors using neutrons generated by D-D fusion reactions.

The middle-term projects thus have achieved the research and development of sensors and access vehicles for humanitarian anti-personnel mine detection and clearance.

We hope that this book will publicize the results of the JST program and that they will be used for people in mine-affected countries.

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December 2008

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