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Foreword

It is with great pleasure that UNIDIR publishes this volume on *Sensors for Peace: Applications, Systems and Legal Requirements for Monitoring in Peace Operations*.

The role of sensor technology in peace operations is an under-reported topic in the general literature and this volume goes a long way in attempting to redress that imbalance. The key role of technologies in the various operations executed by the United Nations and others in order to keep the peace is often only well appreciated by those peace-keepers who use the equipment. The importance of reliable and robust equipment that can be easily moved and is user-friendly cannot be underestimated.

This is a vastly underdeveloped field of study. There are many openings for the thoughtful use of sensors in monitoring wide areas for a number of differing peace operations. This volume looks at the future possibilities in addition to the past experiences of the use of sensors in maintaining the peace in a wide range of difficult situations. In addition to the technical hardware the legality of sensors in such operations is also considered.

In addition, the publication of this volume by UNIDIR gives me great personal pleasure. Several years ago, long before my appointment at UNIDIR, I took part in the early stages of the Bochum Verification Project. The Project has gone from strength to strength and the quality of the work, building on the early days of inquiry into the various available technologies and their characteristics, speaks for itself.

The Bochum Verification Project has demonstrated the capabilities and potential applications of sensor technologies that are already in existence for disarmament agreements and now for peace operations. It is now up to the international community to respond to this research and look to see how peace

operations could be made more efficient and cost-effective by increasing the judicious and interoperable employment of off-the-shelf sensor technology in conjunction with peace-keeping personnel.

Patricia M. LEWIS
Director
UNIDIR
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Preface

This book is the outcome of an international and inter-disciplinary research effort initiated by the Bochum Verification Project and carried out together with the Centre for Arms Control and Verification, Eindhoven, The Netherlands, and the Institute for International Law of Peace and Armed Conflict, Bochum, Germany.

The Bochum Verification Project (BVP) was founded in 1988 at the Institute for Experimental Physics III of the Ruhr-Universität Bochum, Bochum, Germany, nearly simultaneously with the Institute for International Law of Peace and Armed Conflict (IFHV) of that university. The IFHV is a central research unit of the Ruhr-Universität Bochum. The BVP aimed to study the possible use of automatic sensor systems for the verification of disarmament agreements. From its beginning it collaborated closely with the IFHV.[1] During international conferences and workshops, the BVP also came into contact with Brig.Gen. (retd.) Henny van der Graaf, then with the Center for Verification Technology of Free University, Amsterdam, The Netherlands, now at the Center for Arms Control and Verification of the Eindhoven University of Technology, Eindhoven, The Netherlands. A continuing collaboration ensued.[2]

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[1] The first two Volkswagen Foundation grants to the BVP were under the auspices of the IFHV. The BVP publication series "Verification - Research Reports" is a sub-series of the IFVH series "Bochumer Schriften zur Friedenssicherung und zum Humanitären Völkerrecht". One result of the interdisciplinary cooperation was a joint publication by a lawyer and a physicist: O. Schäfer and J. Altmann, *Draft Protocol on Sensor Verification—Proposal for a Legal Framework for the Use of Ground Sensors to Verify Limits on Military Land and Air Vehicles*, IFHV-Studien No. 2, Bochum: UVB, 1993.

[2] This concerned mainly the holding of international workshops on verification. See J. Altmann, H. van der Graaf and P. Lewis, P. Markl (eds.), *Verification at Vienna—Monitoring Reductions of Conventional Armed Forces*, New York: Gordon & Breach, 1992. One other notable outcome was the 1992 international BVP experiment with military vehicles, held in the Netherlands.

With the end of the Cold War, peace-keeping gained in importance. The BVP included the use of sensors during peace-keeping operations as part of its purview. When it prepared a corresponding research proposal in 1994, for work which should be directly application-oriented, it turned to the Center for Arms Control and Verification at Eindhoven for the requirements and operational aspects, and to the IFHV for the juridical issues. The proposal was drafted in common; we should like to thank the Volkswagen Foundation, Hannover, Germany, for the support of our project.

As the first step, a questionnaire was developed which was to be sent to blue-helmet commanders and other officials with experience in peace-keeping. We want to thank the United Nations Institute for Disarmament Research (UNIDIR) in Geneva for its permission to use the *Practitioner's Questionnaire* of its Disarmament and Conflict Resolution project as a model, and for providing us with the addresses of past peace-keeping participants.

In addition to our contacting of these former peace-keepers, the United Nations Department of Peacekeeping Operations (DPKO), New York, sent the questionnaire to many active peace-keepers. This contributed significantly to the unexpectedly high questionnaire return rate of almost 50%. We are particularly grateful for this support.

At the end of the two-years project, in April 1997, we presented our results to the United Nations DPKO during a seminar in New York. We should like to thank the DPKO for this opportunity and for the comments made there. They have been taken into account in the final writing of this book.

Finally, we want to thank UNIDIR for publishing the results of our project in its report series. Special thanks go to Steve Tulliu of UNIDIR for the help with the production of this book.

The editors

Chapter 1

Introduction

Jürgen Altmann, Horst Fischer, Henny J. van der Graaf

1.1 The Problem

United Nations peace operations have a tradition of several decades.[1] With the end of the Cold War however, their scope has increased widely, not only in terms of regions affected or number of forces deployed, but also with respect to transcending the traditional role of relying fully on the cooperation of all parties to a conflict.[2]

Monitoring has been and continues to be a vital aspect of peace operations, of the traditional as well as of the extended type. Agreements (or United Nations Security Council resolution demands) to withdraw behind a cease-fire line, to keep a buffer zone demilitarized, to ban heavy weapons in control zones or around safe havens, all require that compliance is checked reliably and impartially. Since gaps in monitoring could in principle be used by one faction to gain an advantage over an adversary, they tend to keep factions motivated to keep or increase their military presence even if the agreement stipulates otherwise. Thus, the more comprehensive the monitoring, the greater the expected compliance. In practice, however, the area to be monitored is very

[1] See *The Blue Helmets: A Review of United Nations Peacekeeping*, 3rd ed., New York and Geneva: United Nations, 1996; W. J. Durch (ed.), *The Evolution of UN Peacekeeping: Case Studies and Comparative Analysis*, New York: St Martin's Press, 1993.

[2] See S. R. Ratner, *The New UN Peacekeeping: Building Peace in Lands of Conflict after the Cold War*, New York: St Martin's Press, 1995.

often so large that United Nations peace-keeping units cannot be present in all important places continuously. In these cases, personnel is usually merely deployed at control points on the most important roads. Where a designated line is crossed by minor roads—and all the more so in rough terrain—patrols normally do spot checks at intervals, such as once a day. This spot-check system however, creates many possibilities for secretly crossing a demarcation line while avoiding permanent road controls.

There is a technical remedy for this problem: unattended ground sensor systems which can be deployed at the places of interest, and which sense movement or the presence of vehicles, persons or weapons in their vicinity and signal an alarm. This alerts peace-keepers in a monitoring centre or command post, who can then immediately send a rapid-reaction patrol to the appropriate site to confront the intruders, to try to stop them, or at least to document the infraction unequivocally. Through the use of sensors thus, continuous watch of minor roads, of rough terrain well-suited for clandestine passage, and even of a designated demarcation line of several hundreds of kilometres, is possible. Sensors can also assist in other monitoring tasks such as the monitoring of depots and other enclosed areas.

Whereas the concept is technically simple, ground sensor systems have not been widely used in peace operations up to now. A number of armies belonging to industrialized countries have introduced sensor systems for use in armed conflict, but in the conduct of a peace operation, these armies have restricted the use of such systems to their national contingents only.[3] For international use of sensor systems in peace-keeping operations, there is only one important precedent: the monitoring with ground sensors of two mountain passes in the Sinai during the Egypt-Israeli disengagement process from 1976 to 1982 (carried out by the United States).[4] Generally however, ground sensor systems have

[3] For instance, the United States Army has used the REMBASS system and its precursors since the 1970s, while the British Army and later several others have similarly been equipped with the CLASSIC system. However, during the Cold War, these States did not usually contribute peace-keeping forces.

[4] See S. Koulik, "'The Sinai experience'," in R. Kokoski and S. Koulik (eds.), *Verification of Conventional Arms Control in Europe: Technological Constraints and Opportunities*, Stockholm/Boulder CO: SIPRI/Westview, 1990. The most comprehensive technical description is given in M. G. Vannoni, *Sensors in the Sinai: A Precedent for Regional Cooperative Monitoring*, Albuquerque NM: Cooperative Monitoring Center, Sandia National

neither been acquired by most countries participating in peace-keeping, nor have they been used in the majority of recent United Nations peace operations.

Several developments warrant a reassessment of the situation:

- the technologies of processing and communicating sensor signals have advanced considerably over the last 15 years;
- cooperative technical means are increasingly used in the verification of disarmament treaties; and
- peace operations have become more important after the Cold War, and their number is expected to remain high.

Thus, the time is ripe to take a fresh look at the potential of unattended ground sensors. This book aims to analyse the requirements, technical aspects and legal framework for usage of such systems, and to propose options for their wider use.

1.2 Definitions

According to its technical definition, a *sensor* (often called a "transducer") is an element converting some quantity which is not suitable for direct use as a signal into a signal which can be further processed.[5] Technical sensors (the only ones discussed here) usually convert a (physical, chemical etc.) quantity into an electrical one. A combination of a sensor with the appropriate elements for operation (e.g. power supply, pre-processing) is often called a sensor unit; here, this will usually be comprised in the notion of a sensor. The term *sensor system* will be used for the combination of sensors, communication and processing equipment up to the presentation to the final user, the human observer/controller/operator. A sensor system can span distances from metres to, theoretically, thousands of kilometres. Usually, a sensor system is divided into subsystems arranged on several levels.

A *ground sensor* is a sensor which is deployed (semi-) permanently on the ground in the open, the deployment mode varying from buried, to surface-

Laboratories, April 1996.

[5] See Sensors and Transducer Elements (in German), in C. Reuber (ed.), *Handbook of Information Technology and Electronics*, Vol. 8, Heidelberg: Hüthig, 1989.

mounted, to poles or masts-mounted. Other types of sensors—such as sensors for inside use, airborne or satellite-mounted sensors, and sensors for different forms of mobile operations—will not be covered here. An *unattended* sensor works autonomously, without requiring human attention for its operation. This is different from, for instance, a hand-held photo camera which does not work if someone does not point it or presses the shutter button, or a magnetometer where a needle deflection has to be observed. (If both were to be deployed without an operator and were to take pictures/measurements autonomously or by remote control, they would be considered as unattended sensors.)

There is a general understanding of what a *peace-keeping operation* is and should be, though definitions have changed with respect to the actual practice and are still under constant discussion in the literature and relevant bodies of the United Nations and regional organisations. The definition given in the *Peacekeeper's Handbook* is often used: "The prevention, containment, moderation and termination of hostilities between or within States, through the medium of third-party intervention organised and directed internationally, using multinational forces of soldiers, police and civilians to restore and maintain peace."[6]

In general, three categories of *peace operations* can be distinguished:[7]

- *Peace-keeping*: Operations carried out with the consent of the belligerent parties in support of efforts to achieve or maintain peace, in order to promote security and sustain life in areas of potential or actual conflict. The classic example is the United Nations Peace-keeping Force in Cyprus.
- *Robust or wider peace-keeping*: Operations carried out with the consent of the belligerent parties but in an environment that may be highly unstable. Under this definition the United Nations peace force could use force if needed to implement the mandate. Example: the United Nations Protection Force in Former Yugoslavia.
- *Peace enforcement*: Operations carried out to restore peace between belligerent parties who do not all consent to intervention and who may

[6] *Peacekeeper's Handbook*, Vienna: The International Peace Academy, 1994.

[7] Definitions taken from *UK Army Field Manual*: *Wider Peacekeeping*, 4th draft, London, 1995.

be engaged in combat activities. Example: Unified Task Force (UNITAF) Somalia.

In this report, we shall normally use the term *peace operations* if the different types of peace missions are to be encompassed.

1.3 Aims of the Book

The authors have set for themselves the goal of analysing the use of unattended ground sensor systems in four broad areas, and of providing recommendations on the employment of sensors in peace operations:

- *Operational Aspects*: How do sensors fit into the different tasks carried out by peace forces, and how do sensor systems and personnel requirements interact? (Chapter 2);
- *Questionnaire Evaluation*: What do practitioners (blue helmet officers) think about the need for, and requirements on, sensor systems? (Chapter 3);
- *Technical Aspects*: What is the potential of technology, what would be optimal systems, what capabilities are provided by systems already available on the market, what are the costs of such systems, how should systems development proceed? (Chapter 4);
- *Legal Considerations*: How is the use of unattended ground sensors viewed by international law, and what would be the best legal framework for regulating this use? (Chapter 5).
- *Recommendations*: Options for decision makers and policy recommendations for the United Nations as well as for contributing States (Chapter 6).