論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Landmine Detection Rate andMetal Fragment Discrimination Performance Improvement Based on Robotic ArmScanning and Spatially Represented MetalMine Detector Signal Characterization
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出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第9454号, 授与年月日:2014年3月26日, 学位の種別:課程博士, 審査員:福島 E 文彦,大熊 政明,小田 光茂,松永 三郎,塚越 秀行
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第9454号, Conferred date:2014/3/26, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻：
Department of 機械宇宙システム 専攻

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申請学位（専攻分野）：
Academic Degree Requested 博士 Doctor of (Science)

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要旨（英文 800 語程度）
Thesis Summary (approx.800 English Words)

This thesis introduces new detection and marking systems and a fast, accurate and on-site method for metal fragments and landmines discrimination based on Spatially Represented Metal Mine Detection Signal. The proposed detection and marking methods reduce greatly the time and workload of tasks done by operators, besides eliminating human factors and keeping similar high performances when as humans. The landmine and metal fragment discrimination method is simple, fast and powerful since metal detector signals are simplified into polynomials which are stored in a database and used for searching. Experimental results showed that the method can estimate depth with average error of 4 mm and maximum 41 mm. Using data from test fields in Croatia, FAR can be reduced to 50% without risks of False Negatives, what is achieved by setting safety margins. The estimation and discrimination are performed in less than 1 s, which comparisons with the database are done linearly permitting parallel searching, what can be said fast and suitable for demining operations.

Chapter1: Introduction （緒論）. Presents the structure of the thesis, very basic concepts and information related to demining operations, such as landmines types and working principle, humanitarian demining and some existing solutions (using animals, metal detector, machines and robots). The limitations of these solutions are presented and the importance of Gryphon is highlighted, followed by the motivations for this thesis of enhancing landmine detection, marking and discrimination.

Chapter2: Description of the Robotic Demining System Gryphon. This chapter describes the demining robot Gryphon and its main parts: mobile platform (for carrying Gryphon along hard conditions of minefields), manipulator (for moving landmine sensors and tools near the ground), stereo vision camera (for detecting terrain information), metal detector (the main sensor used with Gryphon), marking system (for clearly pointing the location of detected landmines), GPS (for localizing itself along the field) and control architecture.

Chapter3: Targets Detection Method Enhancements. Introduces the main difficulties for landmine

detection and the proposed solution in the project. The solution consists of implementing and evaluating different filters for processing the metal detector signal and permitting easier visualization by a human operator. Several filters based on different approaches such as median, moving window, half-peaks, etc were implemented and evaluated by some subjects, who marked potential targets after the signals being submitted to the filters.

Chapter4: Targets Marking Method Enhancements. Once targets can be detected more efficiently, new methods for marking with higher efficiency are proposed. First, an algorithm for searching the perimeter of the signals of detected targets is proposed, followed by a targets center searching algorithm. For increasing time efficiency, improvements in the sequence and trajectory of the robot's manipulator during the marking task were also done. Besides pointing more accurately the correct targets and their centers, human operator's workload and operation time duration were greatly reduced, eliminating possible human factors.

Chapter5: Proposed Curve Characterization Method. This chapter presents the main landmine/metal fragment discrimination method developed in this project. Basic definitions as Spatially Represented Metal Mine Detector Signals and its Main Axis are introduced. All necessary steps for the method are detailed, such as the searching criterion, database, depth interpolation method, metal detector signal conditioning and database integrity experiment. Experiments in laboratory, soil, using data from test fields and inputting noisy data were also conducted, showing the robustness and potential of the method.

Chapter6: Further Enhancements in the System. Besides the main goals, some further enhancements were achieved in the system. First, the scan line step for a reliable detection is investigated, showing that the scan can be done in two steps, fast and reliably. Second, a new artificial vision technique for extreme sunlight conditions is presented. This enhancement permits the camera to correctly detect features in light contrast areas, increasing the reliability of demining operations. Finally an interface for integrating GPS signals with databases was developed and tested.

Chapter7: Conclusions (結論と今後の課題). A summary of all achievements is done followed by the main results obtained. According to the experiments, the proposed landmine detection and marking methods reduce greatly workload and time of demining operations. Moreover, the method permits quick landmines and metal fragments discrimination with lower FAR, as well as accurate depth and material estimation. No false negatives can happen by setting correct safety margins, increasing the potential of the robot in real operations.