A Deformation Analysis Method for the Metrological ATLAS Cavern Network at CERN

Angelika Lippitsch

Dissertation

Graz University of Technology

Graz, May 2007

Series Editor

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Engineering Geodesy and Measurement Systems
Graz University of Technology
Steyrergasse 30, A-8010 Graz, Austria
http://www.igms.tugraz.at

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A Deformation Analysis Method for the Metrological ATLAS Cavern Network at CERN

Shaker Verlag
Aachen 2007

Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at http://dnb.d-nb.de.

Zugl.: Graz, Techn. Univ., Diss., 2006

The dissertation was submitted to the Faculty of Mathematical and Physical Sciences at the Graz University of Technology for achieving the academic degree of Doctorate of Technical Sciences.

Examination Committee:

Examiner: Univ.-Prof. Dr. Fritz K. Brunner
Second examiner: Univ.-Prof. Dr.-Ing. Otto Heunecke

Day of oral examination: December 20, 2006

Printed in Germany.

ISBN 978-3-8322-6289-1
ISSN 1864-2462

Shaker Verlag GmbH • P.O. BOX 101818 • D-52018 Aachen
Phone: 0049/2407/9596-0 • Telefax: 0049/2407/9596-9
Internet: www.shaker.de • e-mail: info@shaker.de

Abstract

The Large Hadron Collider (LHC) project at CERN includes the construction of four large physics experiments, which will study particle collisions. Each particle detector needs to be precisely aligned with respect to the accelerator beam line by survey measurements. One of these particle detecting experiments is called ATLAS.

Configurations of the geodetic underground cavern network are constrained due to access and space limitations. Sighting restrictions increase as the installation of detector parts in the cavern progresses. Consequently, the reliability of the network reduces. Additionally, deformations of the cavern as well as access structures affect the geodetic network and need to be considered. Dedicated network measurements can only be carried out on an irregular and sparse basis. For processing the inhomogenous and hybrid measurements an adaptive Kalman Filter (KF) is developed interpreting the cavern network as a kinematic system. This enables to handle changing network configurations easily, as well as maintaining a higher level of reliability in the network compared to individually adjusted network measurements. With such an algorithm it is possible to evaluate survey measurements more efficiently, giving accurate estimations for the point positions and corresponding

error information at times of measurements but also to predict future positions and error estimates.

The application of the developed method to the processing of simulated and real survey data sets for the ATLAS cavern network demonstrates the algorithm's superior performance and advantageous capabilities compared to conventional processing methods.

Zusammenfassung

Im Rahmen des Large Hadron Collider (LHC) Projektes am CERN werden vier große Teilchendetektoren Kollisionen untersuchen. Jeder dieser Detektoren muss mit Hilfe von geodätischen Messungen in Bezug auf den Teilchenstrahl ausgerichtet werden. Eine dieser Detektoranlagen ist ATLAS.

Zahlreiche Einschränkungen für die Konfiguration von geodätischen Netzen ergeben sich aus dem Umfeld einer Kaverne. Behinderungen durch bauliche Einrichtungen und Detektorbauteile, die mit zunehmendem Baufortschritt in der Kaverne Platz finden, nehmen mit der Zeit zu. Die Möglichkeiten für geodätische Messungen werden immer mehr eingeschränkt und die Zuverlässigkeit im geodätischen Netz wird dadurch reduziert. Das geodätische Netz wird zusätzlich von Deformationen der Kavernenstruktur und Plattformen beeinflusst. Spezielle Netzwerkmessungen können nur selten und in unregelmässigen Abständen durchgeführt werden.

Ein adaptiver Kalman Filter (KF) wird entwickelt, der die kinematische Interpretation eines Netzwerkes erlaubt. Veränderliche Netzwerkkonfigurationen können im KF Formulismus einfach behandelt werden. Die Zuverlässigkeit des Netzwerkes kann auf einem hohen Niveau ge-

halten werden. Messdaten werden im KF Algorithmus effizienter analysiert, als im Ausgleich von einzelnen Messepochen und ergeben präzisere und zuverlässigere Koordinatenergebnisse und Genauigkeitsinformationen. Für Epochen ohne Messdaten können Koordinaten und entsprechende Genauigkeitsinformationen prädiziert werden.

Die Anwendung der entwickelten Methode auf simulierte und reale Vermessungsdaten für das ATLAS Kavernennetzwerk zeigt die hohe Leistungsfähigkeit des Algorithmus.

Acknowledgments

I would like to thank Prof. Fritz K. Brunner, head of the Institute of Engineering Geodesy and Measurement Systems at Graz University of Technology for supervising this thesis.

Many thanks go to Christian Lasseur, head of the Experimental Metrology Section at CERN, who proposed the topic of this thesis and who gave me as much time as possible to work on and finish this thesis even though the experiment installation schedules were pressing on the survey team. A big 'Merci!' to all members of CERN's survey group who supported me in my thesis work and in the practical surveying work during my time at CERN.

I would like to thank especially Dirk Mergelkuhl and Antje Behrens for proof reading this thesis and Vasco Correia Carmona Pires and Andreas Herty for their help in taking the photographs of CERN survey equipment.

The support and encouragement of Werner Riegler, coordinator of the Austrian Doctoral Student Program, and of Christian Joram and Lucie Linssen of CERN's Physics department have been very important enabling me to finish this thesis.

I am very grateful to have Alexander Koschik as my partner at my side. His help and support for me to work on and write this thesis and his dedication to understand surveying analysis techniques, often strange to a physicist's understanding, has been unrivalled.

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