Dissertation for the Faculty of Computer Science (FIN), Otto von Guericke University (OVGU), Magdeburg

# Data Confidentiality for Distributed Sensor Fusion

Marko Ristic

July 29, 2022

#### Reviewers:

Prof. Dr.-Ing. Benjamin Noack (OVGU, Magdeburg, Germany)

. . .

## Contents

Acknowledgements  Abstract  Zusammenfassung							
				Notation			/iii
				1.		luction Γhesis Structure	<b>1</b>
2.	Stat	-of-the-Art and Research Questions	2				
3.	<b>Prel</b> 3.1.	ninaries Estimation Preliminaries	<b>3</b>				
		3.1.1. Kalman Filter	3				
		3.1.3. Extended Kalman Filter	3				
	3.2.	3.1.5. Extended Information Filter	3				
		3.2.1. Meeting Cryptographic Notions	3				
		3.2.3. Joye-Libert Aggregation Scheme	3				
4.		ate Fusion on an Untrusted Cloud	4				
	4.1. 4.2.	Problem Formulation	4				
	4.3.	Confidential Cloud Fusion Leaking Fusion Weights	4				
		Confidential Cloud Fusion Without Leakage	4				
5.		buted Non-Linear Measurement Fusion with Untrusted Participants  Problem Formulation	<b>5</b>				
	5.2.	Related Literature	5				
	5.3.	Confidential Range-Only Localisation	5				
		5.3.1. Unidirectional Alternative	5				
		5.3.2 Solvable Sub-Class of Non-Linear Measurement Models	5				

#### Contents

6.	Provable Estimation Performances	6	
	6.1. Problem Formulation	6	
	6.2. Related Literature	6	
	6.3. Covariance Privilege	6	
	6.4. Privileged Estimation for Linear Systems	6	
	6.4.1. Extension to Non-Linear Systems	6	
7.	Conclusion		
Α.	Linear-Combination Aggregator Obliviousness		
В.	B. Cryptographic Proof of LCAO Scheme Security		

## List of Figures

## **List of Tables**

## Acknowledgements

Acks go here.

### **Abstract**

Abs goes here.

## Zusammenfassung

German abs goes here.

## **Notation**

Complete notation here.

## 1. Introduction

#### 1.1. Thesis Structure

2. State-of-the-Art and Research Questions

### 3. Preliminaries

#### 3.1. Estimation Preliminaries

- 3.1.1. Kalman Filter
- 3.1.2. Kalman Filter Optimality
- 3.1.3. Extended Kalman Filter
- 3.1.4. Information Filter
- 3.1.5. Extended Information Filter

#### 3.2. Encryption Preliminaries

- 3.2.1. Meeting Cryptographic Notions
- 3.2.2. Paillier Homomorphic Encryption Scheme
- 3.2.3. Joye-Libert Aggregation Scheme
- 3.2.4. Lewi Order-Revealing Encryption Scheme

### 4. Estimate Fusion on an Untrusted Cloud

- 4.1. Problem Formulation
- 4.2. Related Literature
- 4.3. Confidential Cloud Fusion Leaking Fusion Weights
- 4.4. Confidential Cloud Fusion Without Leakage

# 5. Distributed Non-Linear Measurement Fusion with Untrusted Participants

- 5.1. Problem Formulation
- 5.2. Related Literature
- 5.3. Confidential Range-Only Localisation
- 5.3.1. Unidirectional Alternative
- 5.3.2. Solvable Sub-Class of Non-Linear Measurement Models

### 6. Provable Estimation Performances

- 6.1. Problem Formulation
- 6.2. Related Literature
- 6.3. Covariance Privilege
- 6.4. Privileged Estimation for Linear Systems
- 6.4.1. Extension to Non-Linear Systems

## 7. Conclusion

# A. Linear-Combination Aggregator Obliviousness

# B. Cryptographic Proof of LCAO Scheme Security