Near Real-time Change/Anomaly Detection on Airborne and Spaceborne SAR Images

ENS 492 GRADUATION PROJECT

FACULTY: FACULTY OF ENGINEERING AND NATURAL SCIENCES (FENS)
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SPONSORING INSTITUTION BACKGROUND

- TÜBİTAK BİLGEM has been established in 1968
- TÜBİTAK BİLGEM is an Infomatics and Information Security Research Center
- TÜBİTAK BİLGEM is one of the most competent research and development centers in Turkey
- Human resources that is more than 1600 ,experience over 40 years. Its operations includes R&D, Test and assessment, prototype production and training
- BİLGEM has gone beyond the country's border, whose work has been used by many European and Asian countries and NATO as well.

INTRODUCTION

Project Description:

- Turkey is frequently affected by the common occurances of natural disasters(i.e. eartquakes, floods, landslides, and fire).
- Turkish civil and govermental bodies attach importance to enhance the institutional capacity for disaster preparedness as well as response and recovery capacity which are the most important aspects of adaptation to disasters.
- Therefore rapid damage assessment after a disaster within the context of disaster management is crucial for emergency planning, human recovery and subsequent reconstruction efforts.

Project Objective: The objective of the project is to determine the extent of flooded areas using SAR imageries.

Aim: The aim of the project is providing near real-time flooding information.

- To relief agencies for damage assessment.
- To minimize the loss of lives and properties.
- To achieve that, creating a comparison based monitoring system is required to see the differences between the initial state and the damaged state.
- Our goal is to be as efficient as possible while detecting the damage
- Main consideration is to code the fastest working algorithm.

Case Study and Context: Edirne Meriç (Maritsa) River Flood, Turkey (Figure 1), was chosen as a case study area to perform a flood damage assessment.

- 66 percent of the river has the slope of %12.5 which is the reason of rapid accumulation of rain water.
- Also climate changes cause rapid melting of snow masses.
- 4 months every year low lands around Maritsa are flooded.
- Since February-May 2014, heavy rain on region cause overflows resulted with significant economic damage.
- Sentinel-1 SAR Images and 5m resolution DEM used for the flood analysis of the project (Figure 3).

Figure 1 – Satellite image of Edirne Meriç Basin

ADVANTAGES OF SAR IMAGERY

The images of Meriç basin are acquired using synthetic aperture radar(SAR) systems due to its advantages over optical data analyzing systems.

- Floods generally occurs on cloudy days. SAR imagery does not affected by cloud, haze, or seasonal changes.
- SAR images can be acquired any time of a day. (i.e. morning or night)
- Water/Flood/Overflow containing regions can be detected robustly.
- Digital elevation model(DEM) acquired from SAR is effective for detection on the extent of flood.

MAIN STEPS OF THE PROJECT

1.) Literature review
2.) Current state analysis
3.) Methodology selection and conducting decision analysis process.
4.) Determination of a system architecture
5.) Conducting Conceptual Modelling process
6.) Implementation

- The project was conducted in a compatible manner with the principles of SCRUM. JIRA is used as a communication system with TÜBİTAK and made collaborative work easier, transparent, inspected, and adapted between groups.

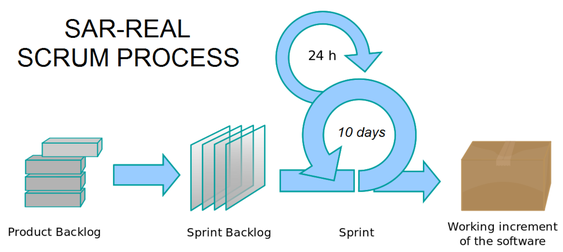

Figure 2 – SCRUM Process

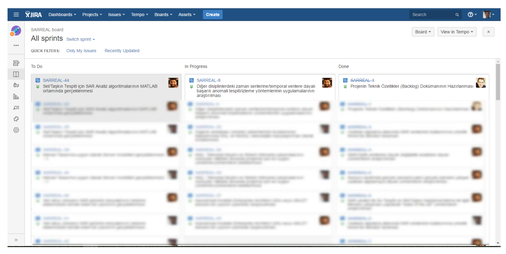

Figure 3 – JIRA Interface

DATA SET

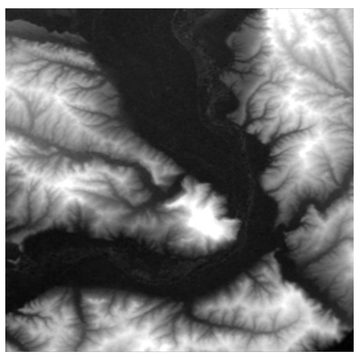

Figure 4 – DEM values with 5m resolution

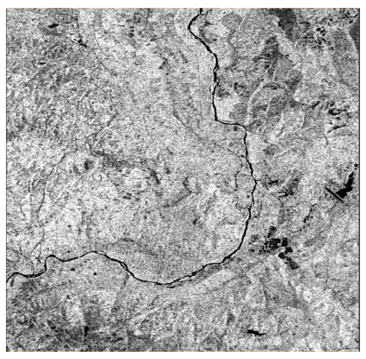

Figure 5 – Backscatter values 24 October 2014 Before Flood

Figure 6 – Backscatter values 10 February 2015 After Flood

SELECTED METHODOLOGY

Backscatter(Sigma0) change analysis is chosen as change detection algorithm because of, time efficiency, data efficiency, and accuracy.

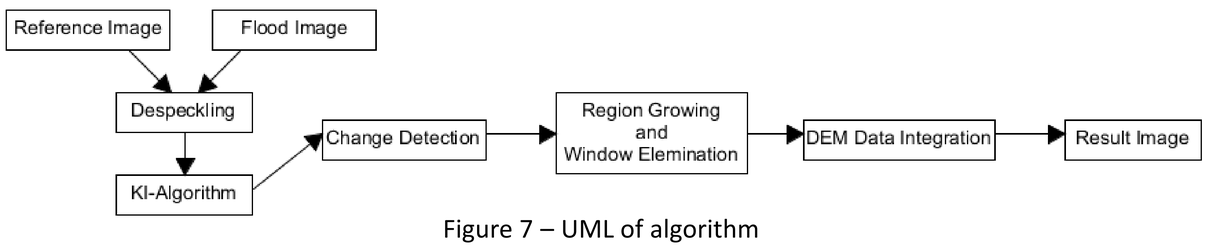

Figure 7 – UML of algorithm

PROBLEMS AND PROPOSED SOLUTIONS

There were three main problems encountered in this project.

1.) Elimination of Speckle noise (Despeckling)
Solution: Using a 3x3 Gamma-MAP filter

2.) Automatic threshold determination for change detection
Solution: Kittler and Illingworth's Algorithm(KI)

3.) Elimination of shadows in the SAR images
Solution: Using DEM (Digital Elevation Model).

INITIAL RESULTS (SAR-DERIVED FLOOD MAPS)

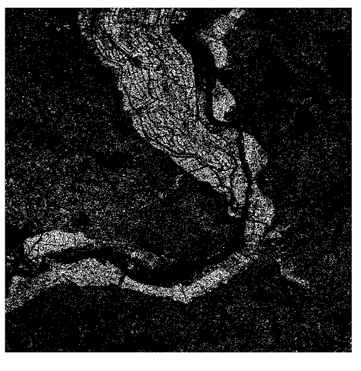

Figure 8 – SAR-derived Flood Map without DEM integration

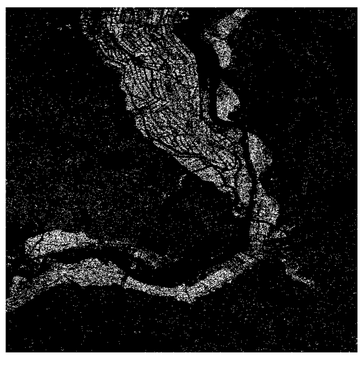

Figure 9 – SAR-derived Flood Map with integrated DEM

Initial results are promising but needs clarification on the content of flood with post improvement, plan in the next few weeks;

- To use region growing method to extend water areas
- To use window size elimination method to eliminate small flood alerts

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