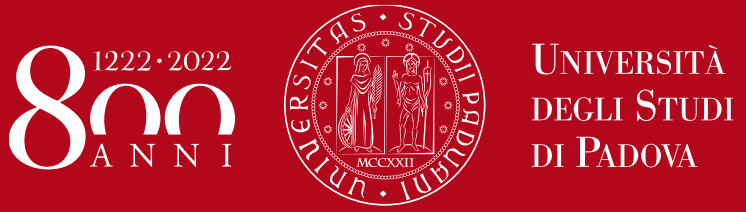


Prevention of Potential Catastrophes Depending on Interferometric Radar Technique and Artificial Intelligence

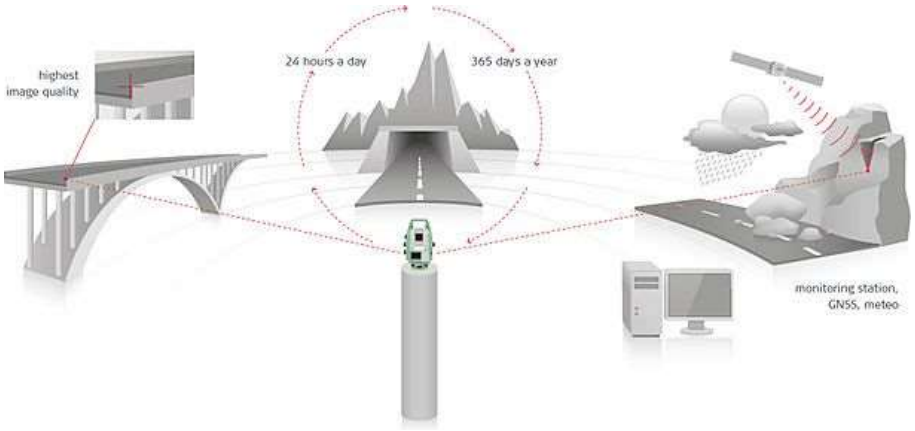
E.Lama Moualla - 36th Cycle

06/11/2020

Table of Contents

Introduction

- The change in the equilibrium state of the earth's crust leads to its deformation and the distortions caused by either natural phenomena or from the construction of huge engineering installations often cause heavy material losses



- There are various equipment for measuring and monitoring distortions

Introduction

How can we extract information from InSAR satellite images quickly, effectively and automatically, achieving the maximum benefit for end-users?

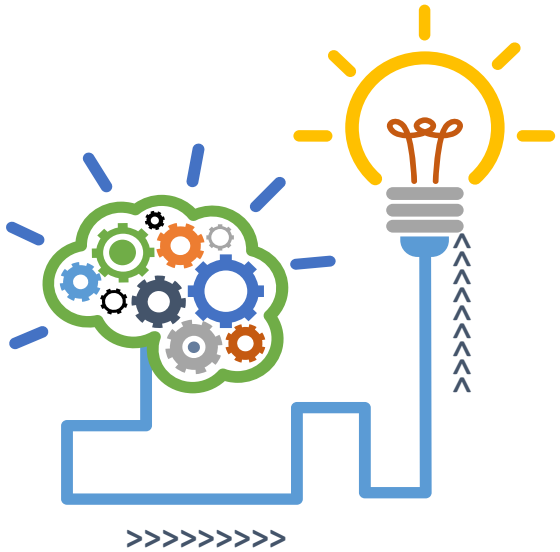


Table of Contents

State of The Art

The first axis: Applications of InSar technology in monitoring infrastructure displacements

The second axis: Integration between artificial intelligence technologies and geographic information systems GIS

The third axis: Artificial intelligence techniques developed in monitoring infrastructure displacements using satellite images

Applications of InSar technology in monitoring infrastructure displacements

Sentinel-1

State of The Art for The First Axis

Applications of InSar technology in monitoring Ground Deformations

Measurement Methods				Study Main Goal	Date
Analysing Displecements Time Series for InSar Images	Differential Synthetic Aperture Radar Interferometry DInSar	Small BAseline Subsets SBAS	Persistent Scatterer Interferometry PSI		
		✓	✓	Create a 3D map of crustal deformations	2010
	✓			Monitoring land subsidence caused by mining operations	2017
			✓	Ground deformation monitoring of a landslide sensitive area surrounded by a stable area	2017
			✓	Monitoring the deformation of an area in which the water extraction processes take place	2018
✓				Dynamic ground deformation monitoring	2018

State of The Art for The First Axis

Applications of InSar technology in monitoring infrastructure displacements

Methodology	The influencing factor	Number of Images ascending or descending	Date	Infrastructure Type	Case Study
MT-InSAR, SARProZ	Ground movements	28	Mar.2015 to Feb.2016	Arenoso dam	province of Cordoba, Spain
Simplified PSI	Temperature	29 Asc.	Apr.2015 to Aug.2016	Nanjing Dashengguan Yangtze River High-speed Railway Bridge	Jiangsu, China
MT-InSAR, SARProZ	Aging	51Asc. & 47Des.	Dec.2014 to Apr.2017	Ajaure dam	Västerbotten, North Sweden
PSI, ENVI SARscape	Seasonal Soil Movement	23 Asc.	Sep.2015 to Dec.2016	Road and rail networks	(Bristol, Bath, Bournemouth) Western UK
		23 Asc.	Jan.2016 to Mar.2017		(Grantham, Peterborough, Kings Lynn) Eastern UK
PSI	Active Movement	51	Nov.2014 to Sep.2016	Vulnerable Structures (buildings, roads, etc…)	(Gran Canaria, La Gomera,Tenerife) Spain Islands
Classical PSInSAR SARProZ	Siesmology	36 Asc. & 38 Des.	Oct.2014 to Apr.2016	Cunovo Dam	Bratislava, Slovakia

State of The Art

The first axis: Applications of InSar technology in monitoring infrastructure displacements

The second axis: The integration between artificial intelligence technologies and geographic information systems GIS

The third axis: Artificial intelligence techniques developed in monitoring infrastructure displacements using satellite images

GEOAI

State of The Art for The Second Axis

Integration between artificial intelligence technologies and GIS

Intelligent Methods Integrate with GIS						Study Main Goal	Date
Genetic Algorithm	Neural Networks	Fuzzy C-Means Clustering	Artificial Neural Networks	Artificial Intelligence	Fuzzy Inference System		
			✓		✓	Create a Landslide Sensitivity Map LSM	2010
✓			✓			Damaged Sewage Pipes	2012
		✓	✓			Developing a Model for Predicting Urban Growth	2012
				✓		Interpretation of Spatial Resource Information	2012
	✓					Monitoring Active Faults and Creating Database for Crustal Movements	2016

State of The Art for The Second Axis

Integration between artificial intelligence technologies and GIS

Intelligent Methods Integrate with GIS				Study Main Goal	Date
Data Envelopment Analysis	Artificial Neural Networks	Support vector Machine	Adaptive neuro-fuzzy Inference System		
	✓	✓		Create a map of potential groundwater productivity	2017
✓	✓			Calculate the level of road hazards and identify high-risk portions	2017
			✓	Determine the optimal areas for planning road networks	2018
			✓	Create sensitive maps for subsidence	2018
	✓			Study the spatial distribution of deforestation and modeling of vegetation change forms	2018

State of The Art

The first axis: Applications of InSar technology in monitoring infrastructure displacements

The second axis: Integration between artificial intelligence technologies and geographic information systems GIS

The third axis: Artificial intelligence techniques developed in monitoring infrastructure displacements using satellite images

Developed artificial intelligence techniques in monitoring and extracting infrastructure displacements using satellite images

State of The Art for The Third Axis

Artificial intelligence techniques developed in monitoring infrastructure displacements using satellite images

Measurement Methods						Case Study	Date
Deep Convolutional Neural Network	Artificial Neural Networks	Genetic Algorithm	Fuzzy Inference System	Decision Support System	Adaptive Neuro-Fuzzy Inference system		
			✓		✓	Building a daily prediction system for the horizontal displacements of a dam	2010
				✓		Evaluation and interpretation of 3D shifts of tunnel walls	2010
	✓	✓				Railroad subsidence monitoring and prediction	2015
	✓					Application of data mining techniques in structural safety monitoring	2017
✓						Prediction of InSAR time-series deformation	2019

State of The Art for The Third Axis

Artificial intelligence techniques developed in monitoring infrastructure displacements using satellite images

2018

AlexNet & Gray Model

Detection of volcanic earth deformation

2019

CNN

Detection of slow sustained deformation in InSAR time series

2019

Back Propagation

Analyzing ground deformation

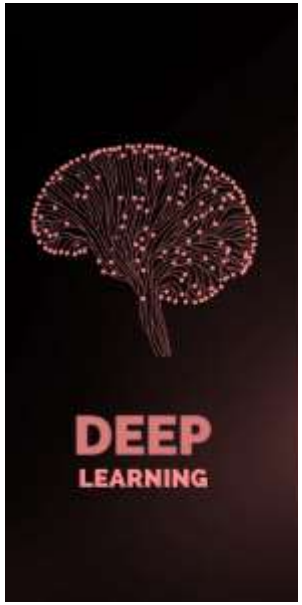
State of The Art

The first axis: Applications of InSar technology in monitoring infrastructure displacements and the nature of the data it provides

The second axis: Integration between artificial intelligence technologies and geographic information systems GIS

The third axis: Artificial intelligence techniques developed in monitoring infrastructure displacements using satellite images

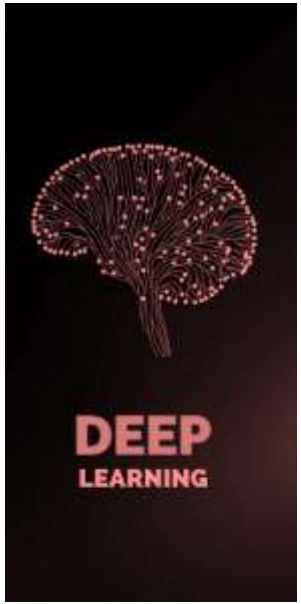
Infrastructure displacements will be detected by using intelligent technologies



NEW Algorithm

State of The Art Summary

Infrastructure displacements will be detected by using intelligent technologies



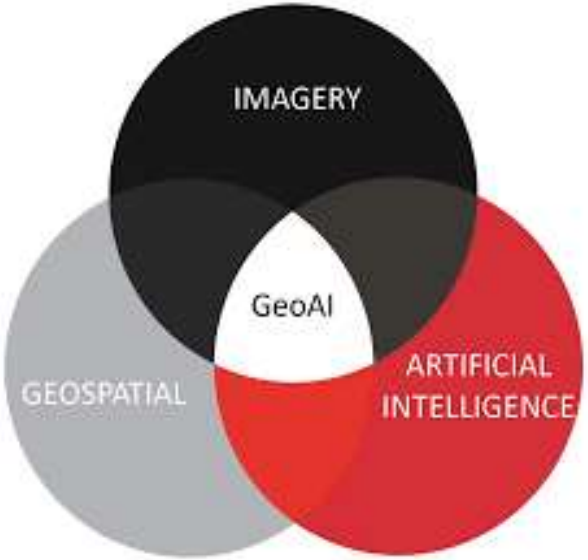
CNN

NEW Algorithm

Predictive Model

ANN

State of The Art Summary



We will develop an intelligent tool that goes beyond talking about what's going on? Where is it happening? And when does it happen?

To show how it happens? And why does it matter? And what will happen?

Table of Contents

Research Problem

What is the best intelligent algorithm that can be used to develop a methodology for detecting infrastructural displacements?

The main problem of the research centers on developing an accurate and intelligent algorithm to create a predictive model in a GIS environment that can be directly applied:

- ✓ To detect displacements
- ✓ To expand the functionality of geographic information systems to include modeling and simulation capabilities
- ✓ To reduce the effort made by experienced interpreters and analysts

Research Problem

How can we use the methodology that we will try to develop in constructing a predictive model of the studied infrastructure displacements?

The main problem of the research centers on developing an accurate and intelligent algorithm to create a predictive model in a GIS environment that can be directly applied:

- ✓ To detect displacements
- ✓ To expand the functionality of geographic information systems to include modeling and simulation capabilities
- ✓ To reduce the effort made by experienced interpreters and analysts

Research Problem

How to invest in the predictive model that we will try to develop within a GIS environment so that ordinary GIS users can benefit from it?

The main problem of the research centers on developing an accurate and intelligent algorithm to create a predictive model in a GIS environment that can be directly applied:

- ✓ To detect displacements
- ✓ To expand the functionality of geographic information systems to include modeling and simulation capabilities
- ✓ To reduce the effort made by experienced interpreters and analysts

Table of Contents

Research Incentives

Until today, GIS doesn't include tools that can detect infrastructural displacements and construct a predictive models for them

Sensitive areas to landslides in Italy represent the study case of the research

The data of GIS is constantly growing

Table of Contents

Research Objectives

First: Using Intelligent algorithms in developing a methodology that can automatically analyze large InSar data packets and identify areas where infrastructures are at risk of displacement due to ground movement

Second: Establishing a predictive model for the displacements of the infrastructure studied in the research, based on the methodology that we will try to develop

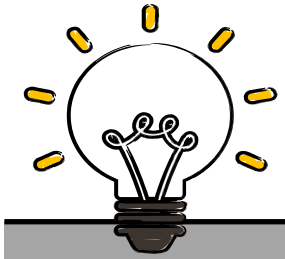
Third: Determine the functions of the GIS tool that will be developed to integrate the final work results within a GIS environment

Table of Contents

Research Significance

The using of radar interference technology and intelligent technologies makes research extremely important in obtaining very important data that will reduce catastrophic risks which will return to the national economy at a high value

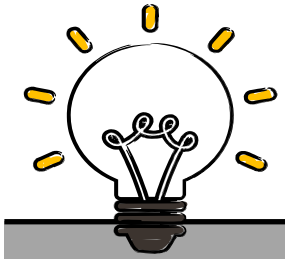
Research Significance



Determine the level of catastrophic risk in potentially unstable locations by following a new standardized method of systematic planning

Axis	Reference Studies
Applications of InSar technology in monitoring infrastructure displacements	1 - 13
Integration between artificial intelligence technologies and geographic information systems GIS	14 - 24
Artificial intelligence techniques developed in monitoring infrastructure displacements using satellite images	25 - 34

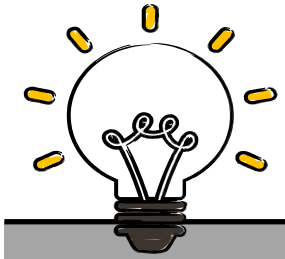
Research Significance



Analyzing huge amounts of images received

Axis	Reference Studies
Applications of InSar technology in monitoring infrastructure displacements	1 - 13
Integration between artificial intelligence technologies and geographic information systems GIS	14 - 24
Artificial intelligence techniques developed in monitoring infrastructure displacements using satellite images	25 - 34

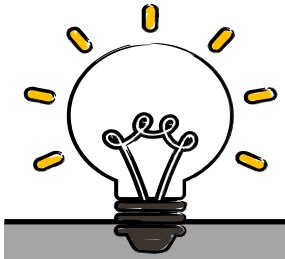
Research Significance



Obtaining periodically updated measurements of displacements over large areas with an accuracy of more than one centimeter per year

Axis	Reference Studies
Applications of InSar technology in monitoring infrastructure displacements	1 - 13
Integration between artificial intelligence technologies and geographic information systems GIS	14 - 24
Artificial intelligence techniques developed in monitoring infrastructure displacements using satellite images	25 - 34

Research Significance



Providing local, regional and national authorities with the final results

Axis	Reference Studies
Applications of InSar technology in monitoring infrastructure displacements	1 - 13
Integration between artificial intelligence technologies and geographic information systems GIS	14 - 24
Artificial intelligence techniques developed in monitoring infrastructure displacements using satellite images	25 - 34

Table of Contents

Research Methodology

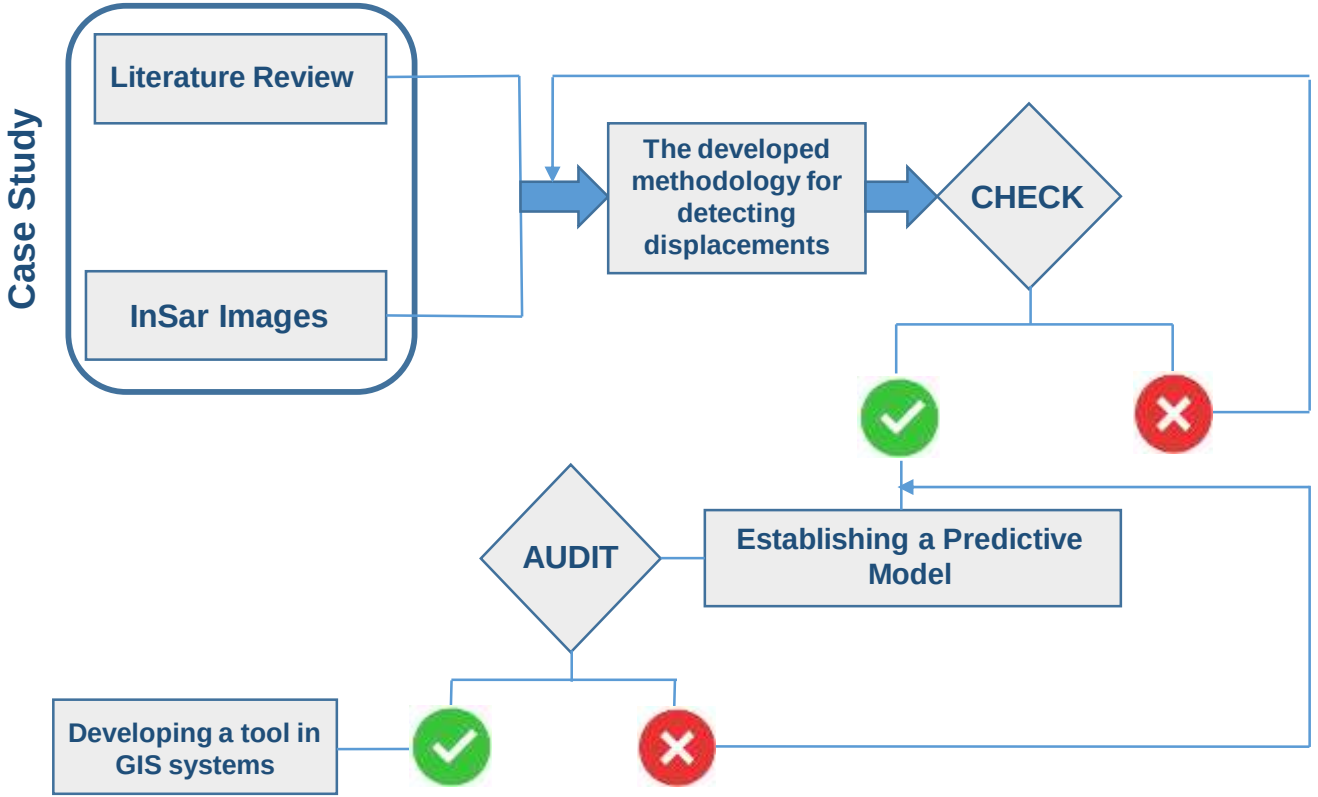
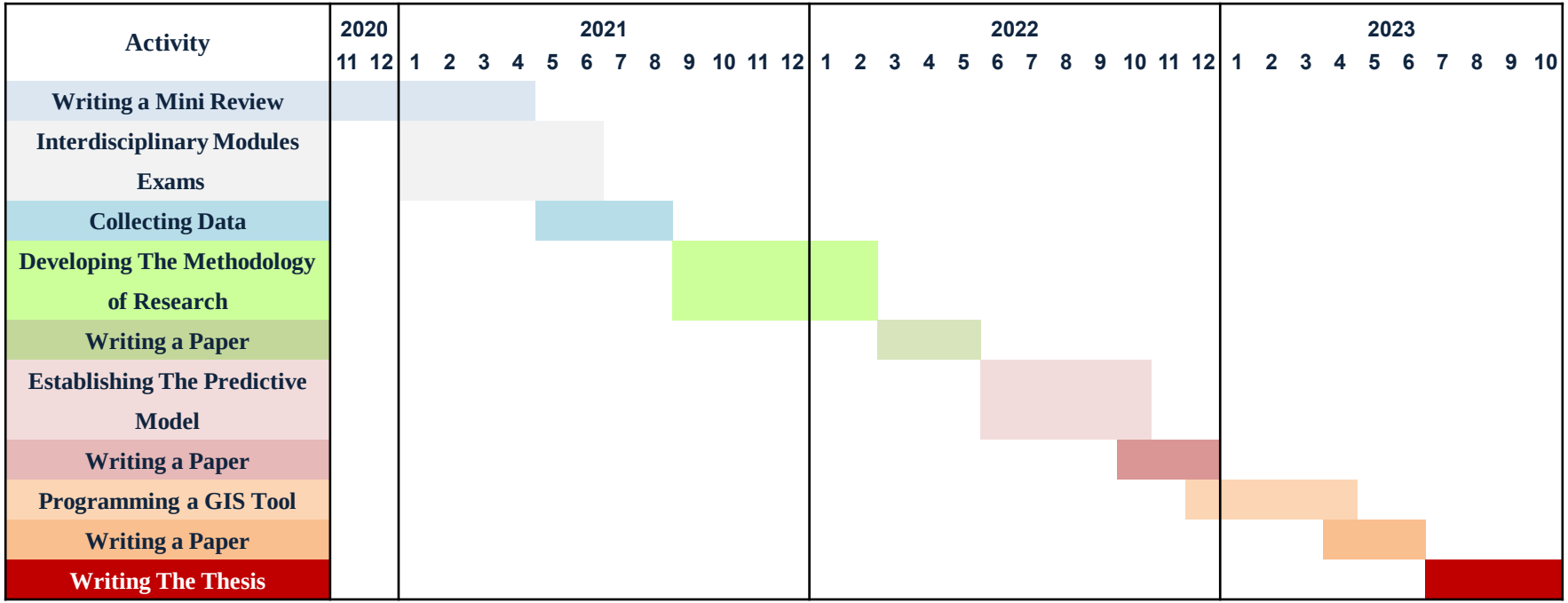


Table of Contents

GANNT-bar Chart of The Research Project



Thanks for the attention