

Rapid, Automated Post-Event Image Classification and Documentation

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Motivation of the Research

Building and Building Components



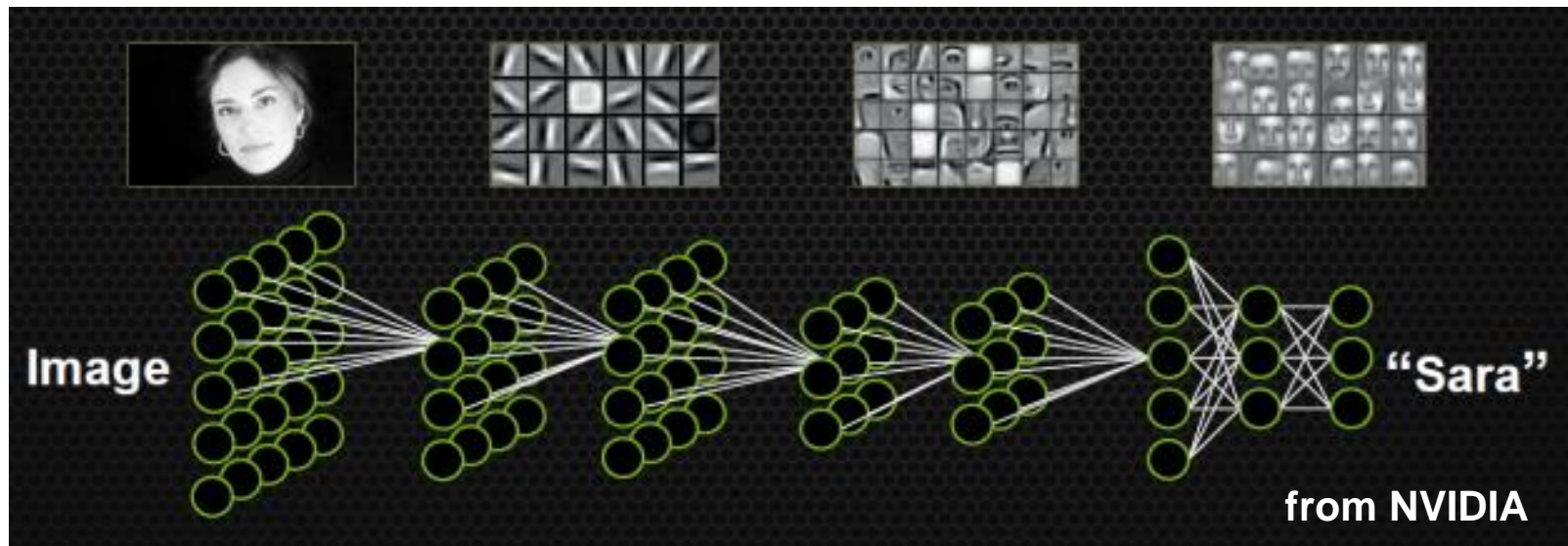
Metadata



Reconnaissance mission

Field engineers collect not only damaged building and its components but also metadata as a form a images

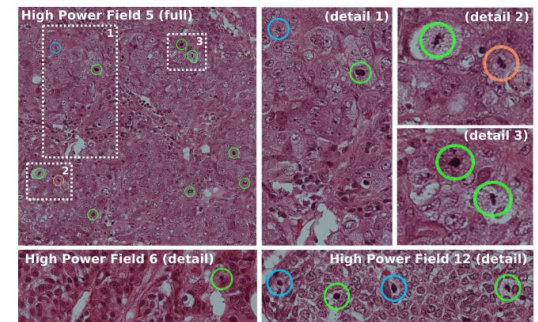
Deep Convolutional Neural Networks (CNN)



Object segmentation

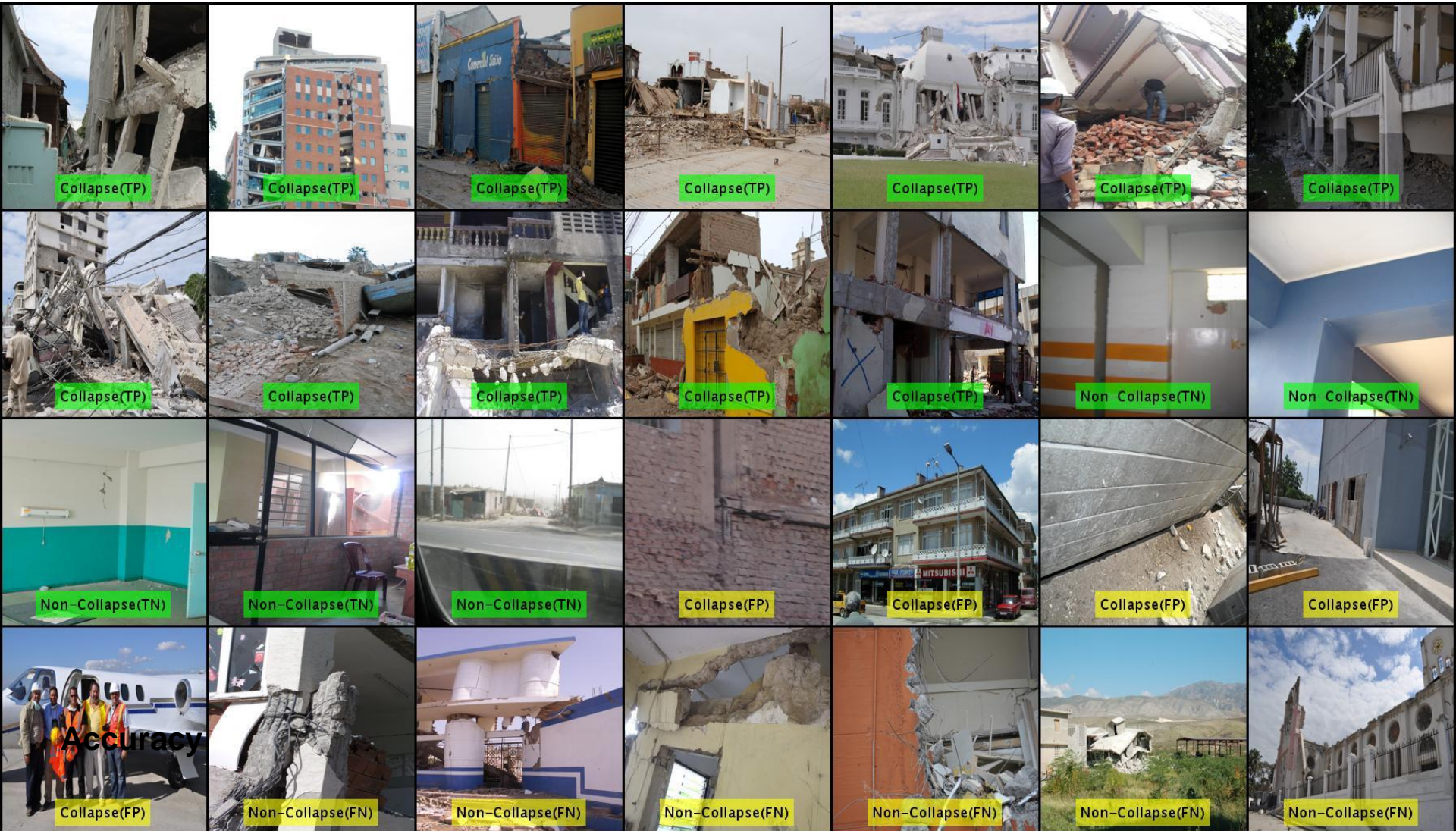


Drone navigation

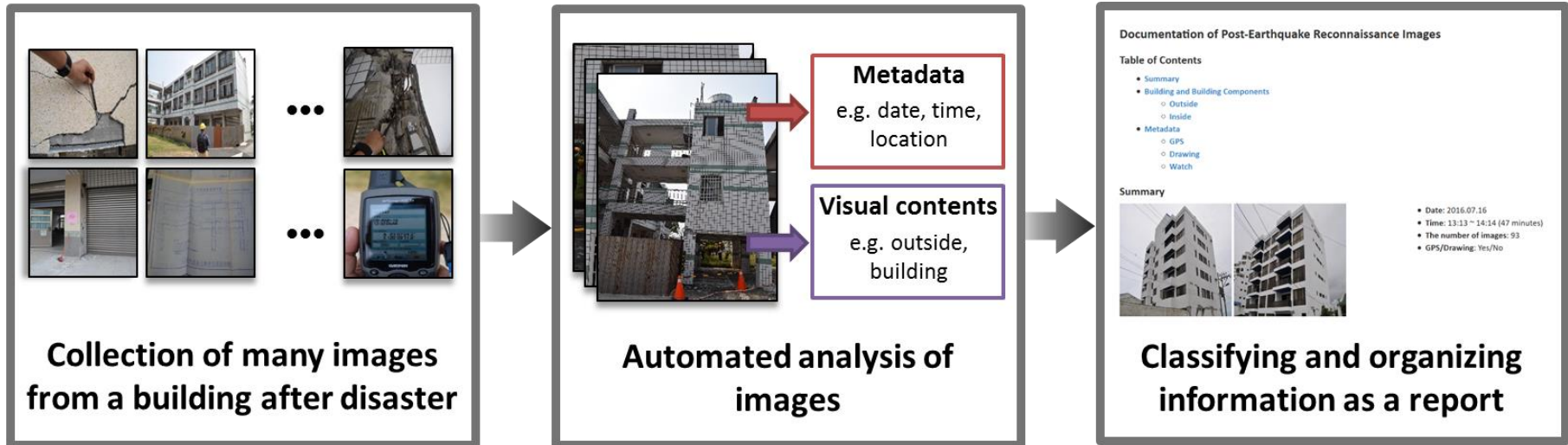


Mitosis detection

Past Results: Classification of Collapse Images



Overview of the Developed Technique



How to support field engineers to readily find and analyze images

Develop an enabling technique to automatically extract and analyze visual contents of the collected images and integrate them as a report so that engineers can easily access and document these images in the field.

A Real-World Example (Images were collected from a single building after 2016 Taiwan Earthquake)



Event: Taiwan Earthquake

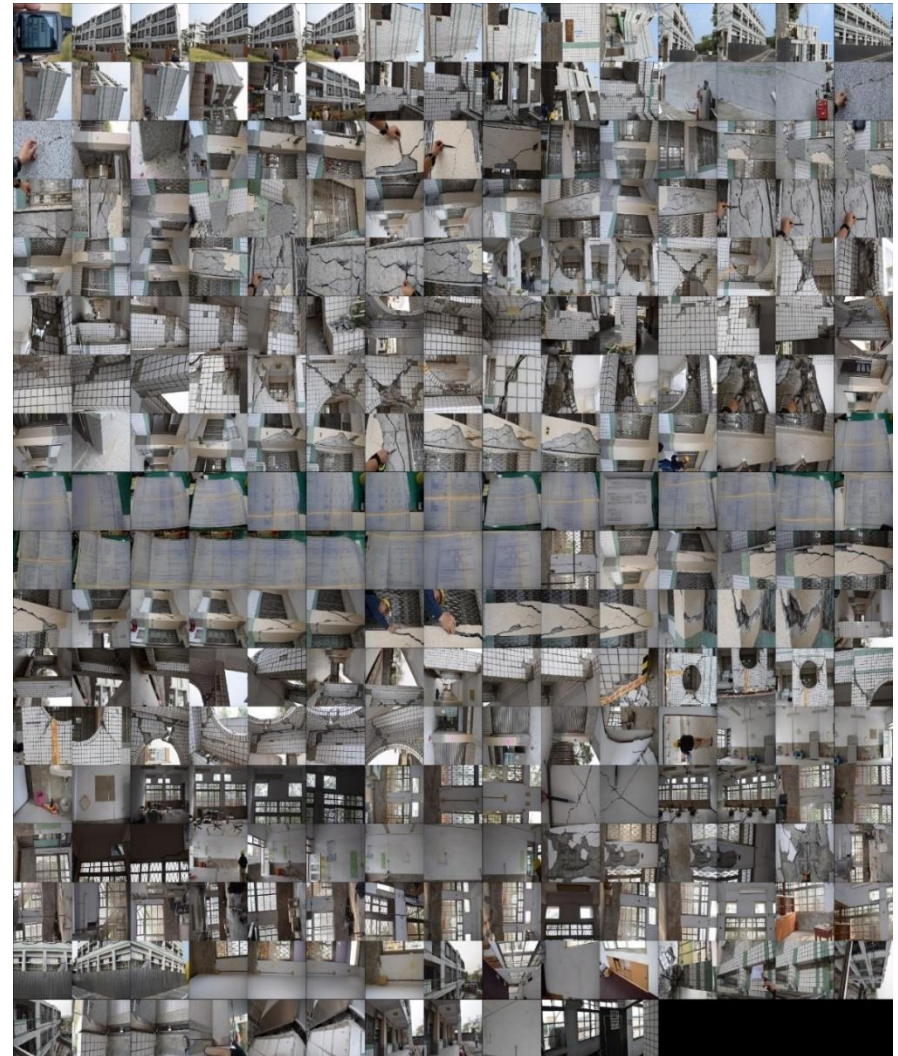
Data: February 6, 2016

Location: Yujing Junior High School

of images: 266

Damage: Structural damage (S) and Masonry wall damage (M)

[L= Light, M=Moderate, S=Severe]



All images collected from a single building

Final Outcome of the Developed Technique



Documentation of Post-Earthquake Reconnaissance Images

Table of Contents

- Summary
- Building and Building Components
 - Outside
 - Inside
- Metadata
 - GPS
 - Drawing
 - Watch
- All Images

Overall view



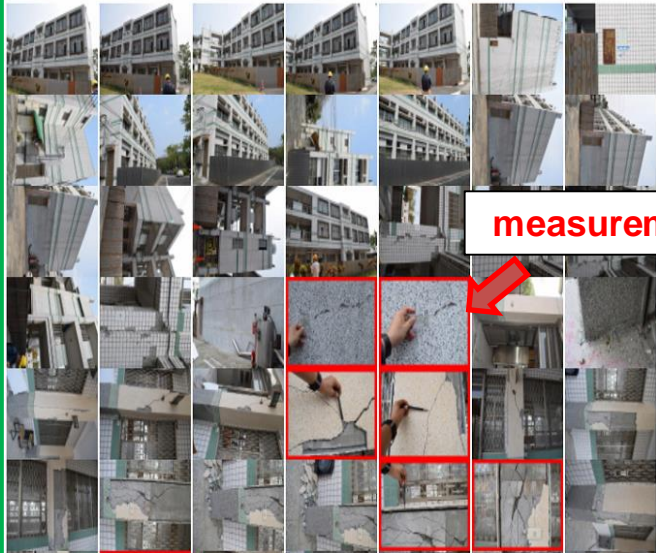
Summary



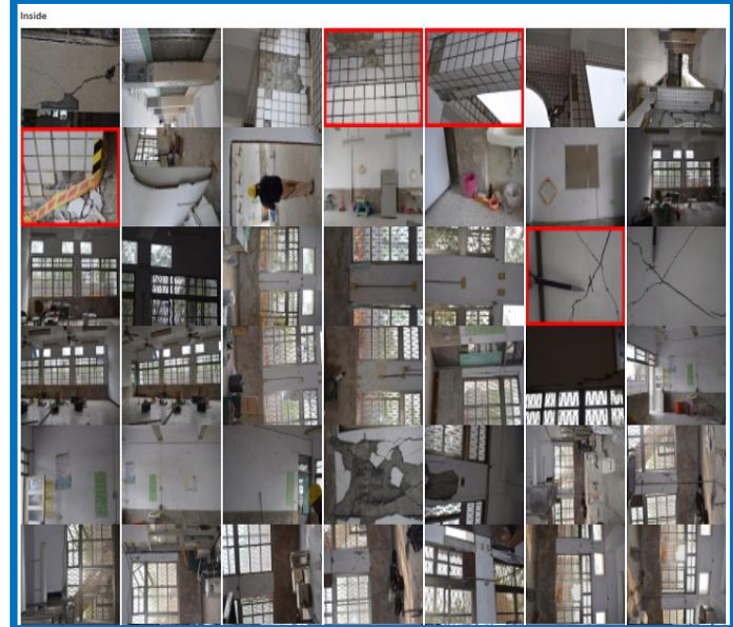
- Date: 2016.03.08
- Time: 00:00 ~ 02:02 (133 minutes)
- The number of images: 263
- GPS/Drawing: Yes/Yes

Building and Building Component

Outside



measurement



Metadata

GPS

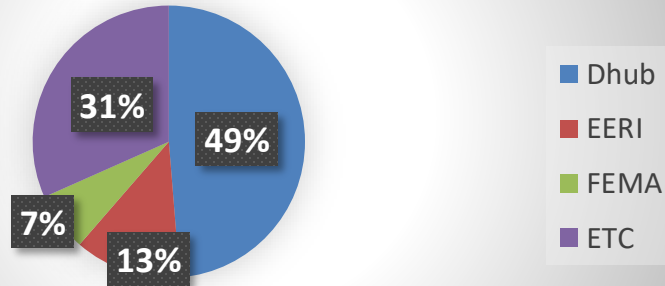


Drawing

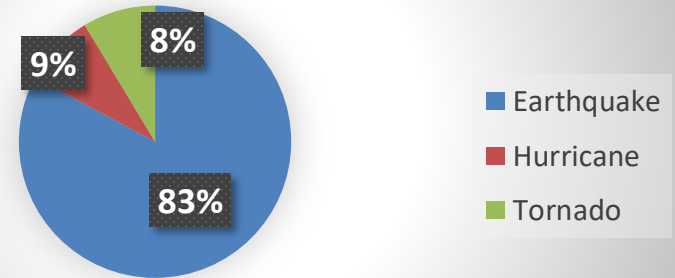


Post-Event Reconnaissance Image Database

Image Resource (83,983)



Types of Disaster (83,983)



Haiti earthquake in 2010 (3,439 images)

L'Aquila (Italy) earthquake in 2009 (414 images)

Florida hurricanes in 2004 (1,178 images)

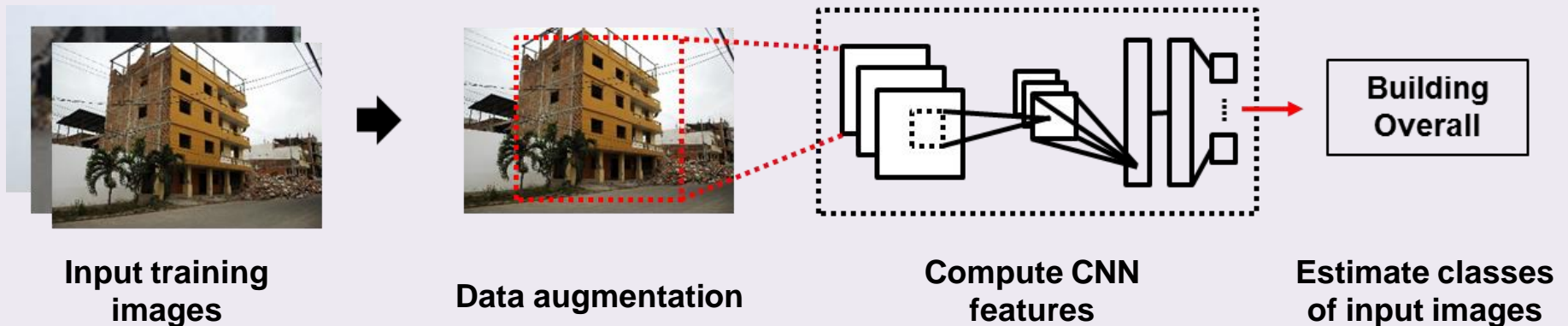
Greensburg tornado in 2017 (412 images)

Deep Convolutional Neural Network for Image Classification

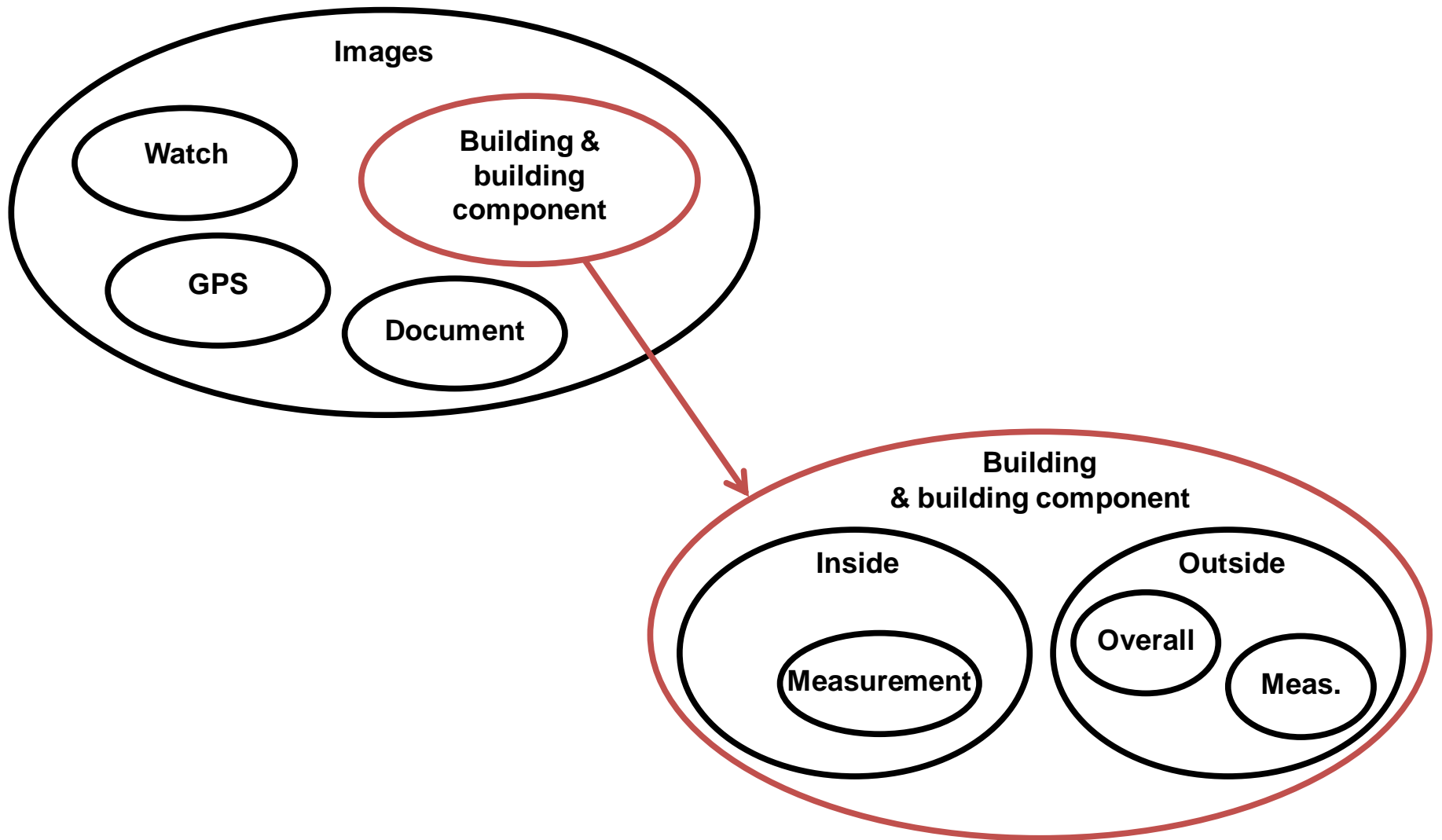
Preparation of training data



Training of classifiers



Structure of the Image Category



Sample Images of Each Category (Ground-truth Labeling)



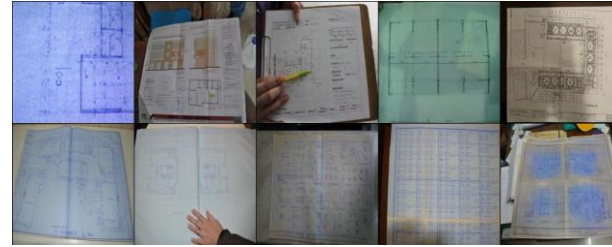
Outside
(OUT)



Inside (IN)



Overall View
(OV)



Drawing (DWG)



Watch (WAT)

from google



Measurement
(MEAS)



GPS (GPS)

Building and Building Components (BBC)

Recording Metadata

Configuration of Training and Testing

CNN architecture : Alexnet for multiclass/binary classification
CNN framework (library) : MatCovnet (CNN implementation in Matlab)
Ratio of training, validation and testing : 0.5, 0.25, and 0.25
of images in a batch size : 256

Classification	Multiclass				Binary		Binary	Binary
Category	BBC	GPS	WATCH	DWG	IN	OUT	OV	MEAS
# of labelled images	16,747	835	320	3,283	6,407	9,650	1,531	690

Legend: **BBC:** building and building components;
GPS: GPS; **WATCH:** watch; **DWG:** drawing;
IN: inside; **OUT:** outside;
OV: Overall view; **MEAS:** Measurement

Sample Report Generated using the Developed (Original Collection)



Sample Report Generated using the Developed Technique (Continue)



Quantification of Classification Results

Classification	Multiclass				Binary		Binary	Binary
Category	BBC	GPS	WATCH	DOC	BIN	BEX	OV	MEAS
# of labelled images	16,747	835	320	3,283	6,407	9,650	1,531	690
# of testing images	4,126	187	80	827	1,609	2,337	360	172
Precision	99.7%	93.8%	86.4%	97.6%	82.2%	90.8%	50.9%	37.4%
Recall	99.1%	97.3%	95.0%	98.7%	87.2%	87.0%	90.0%	79.8%

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- Instituto de Ingenieria, National Autonomous University of Mexico
- FEMA and EERI

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**WE WOULD LIKE TO
TEST YOUR
IMAGES !!**



FEMA

