FIG WORKING WEEK 2023
28 May - 1 June 2023 Orlando Florida USA
Protecting Our World, Conquering New Frontiers

Presented at the FIG Working Week 2023,
28 May - 1 June 2023 in Orlando, Florida, USA

AUGMENTED REALITY APPLICATION USING 3D MODEL OF TLS (TERRESTRIAL LASER SCANNER)

(CASE STUDY: PLAOSAN LOR TEMPLE, KLATEN REGENCY)

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Research Background

MAINTENANCE OF PLAOSAN TEMPLE

TOURISM

INDUSTRY 4.0

AUGMENTED REALITY WITH GEODETIC MEASUREMENT

PROBLEMS FORMULATION

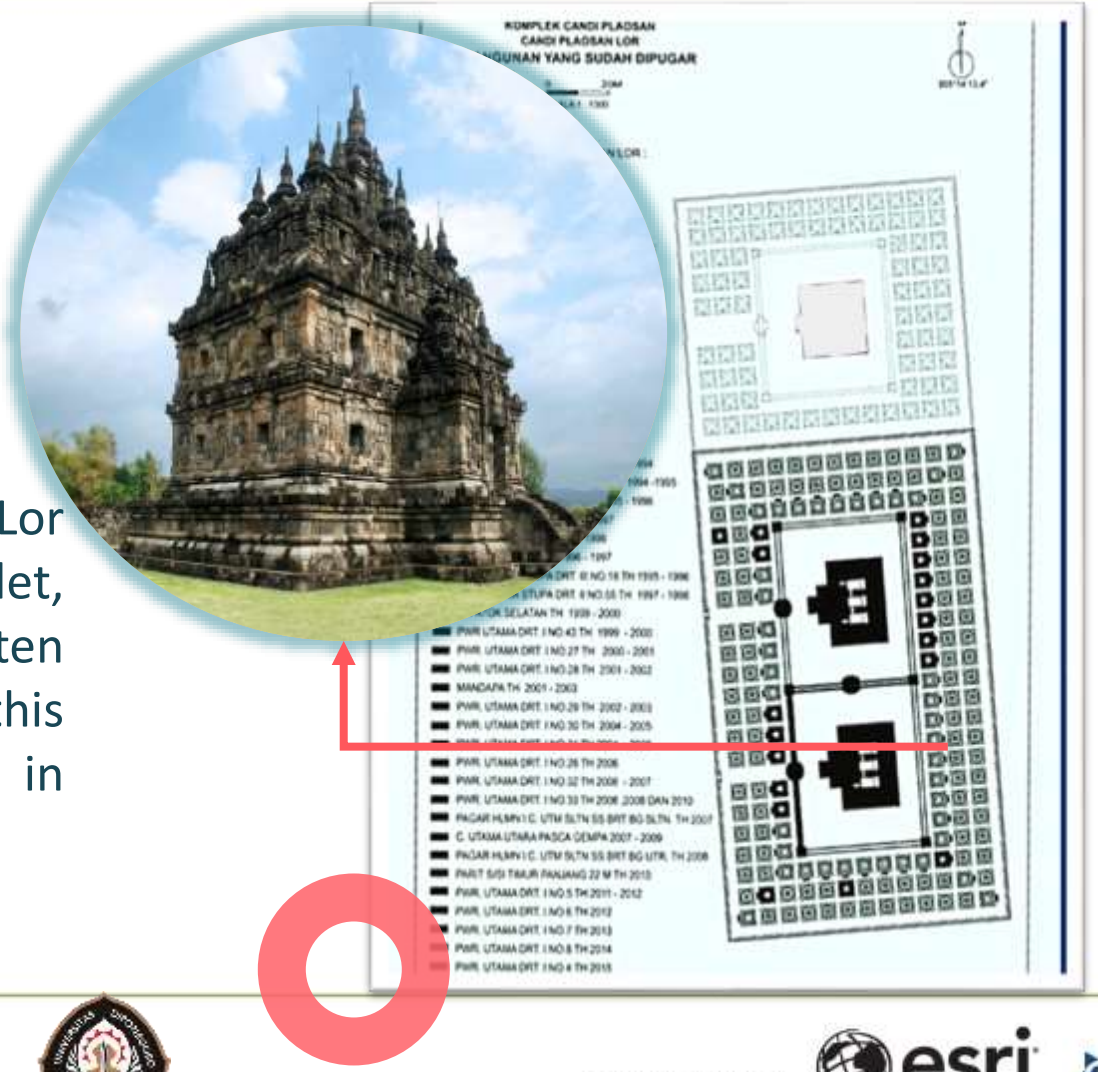
How is the point cloud registration analysis resulting from combining data from TLS and UAV?

How is the qualitative analysis of the results of the visualization of the 3D model of Candi Plaosan Lor in Augmented Reality?

RESEARCH OBJECT

NORTH OF PLAOSAN TEMPLE

The location of this research is Plaosan Lor Temple which located in Plaosan Hamlet, Bugisan Village, Prambanan District, Klaten Regency, Central Java. The object of this research is one of the main temples in Plaosan Lor Temple.



RESEARCH TOOLS AND MATERIALS

Laptop Asus VivoBook A442U

TLS BLK360

UAV Mavic 2 Pro

Smartphone Samsung 50S

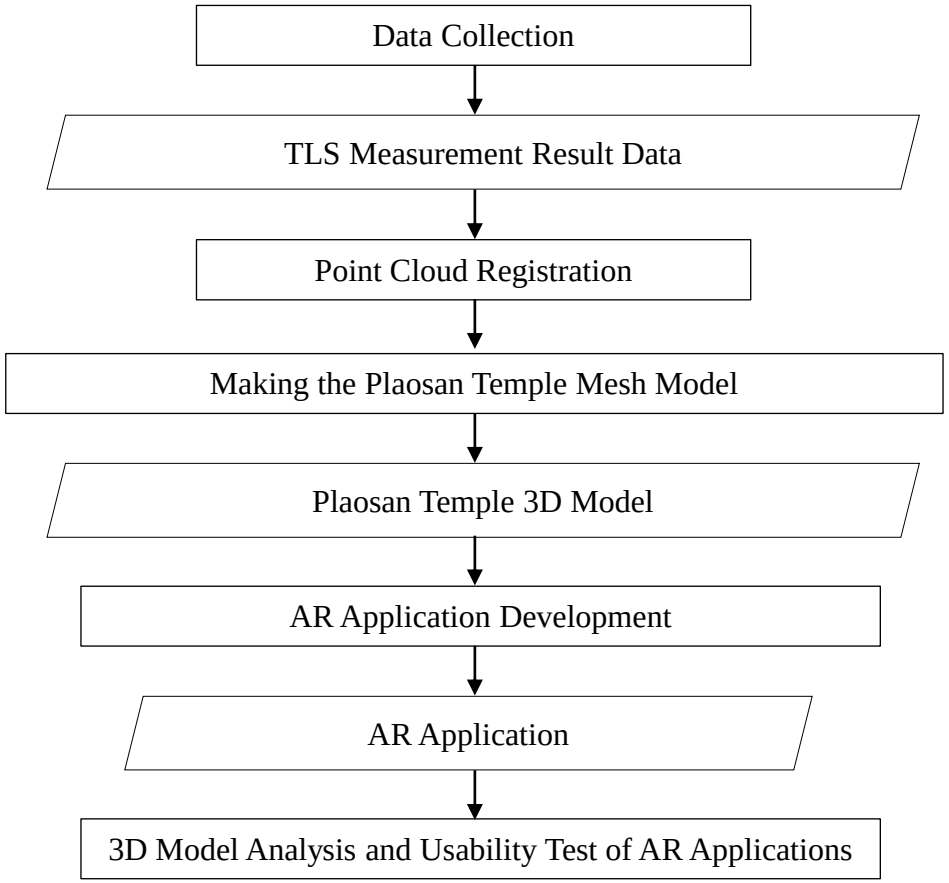
RecapPro
(License Type : Education Stand-alone)

Microsoft Office 2010
(License Type : Office 365 A1 for faculty)

Agisoft Photoscan
(Open Access)

CloudCompare
(Open Access)

Unity
(License Type : Personal License)



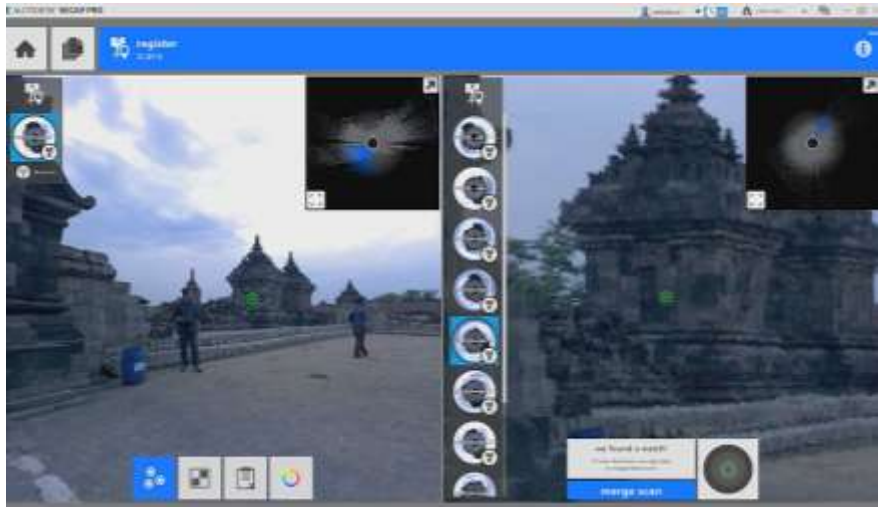
RESEARCH METHODOLOGY

Preparation Phase

Implementation Phase

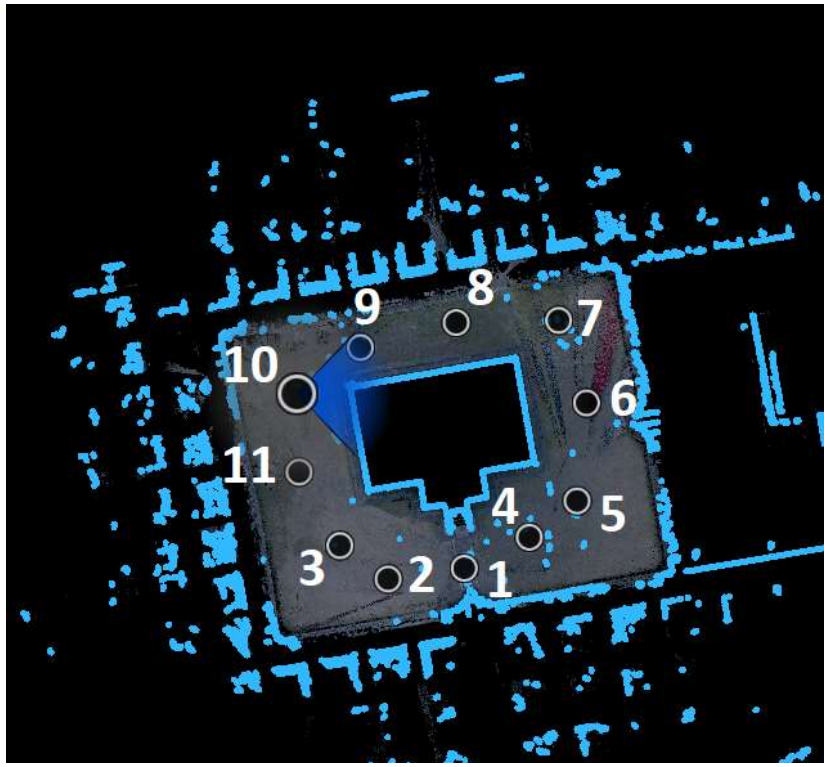
Analysis Phase

TLS DATA

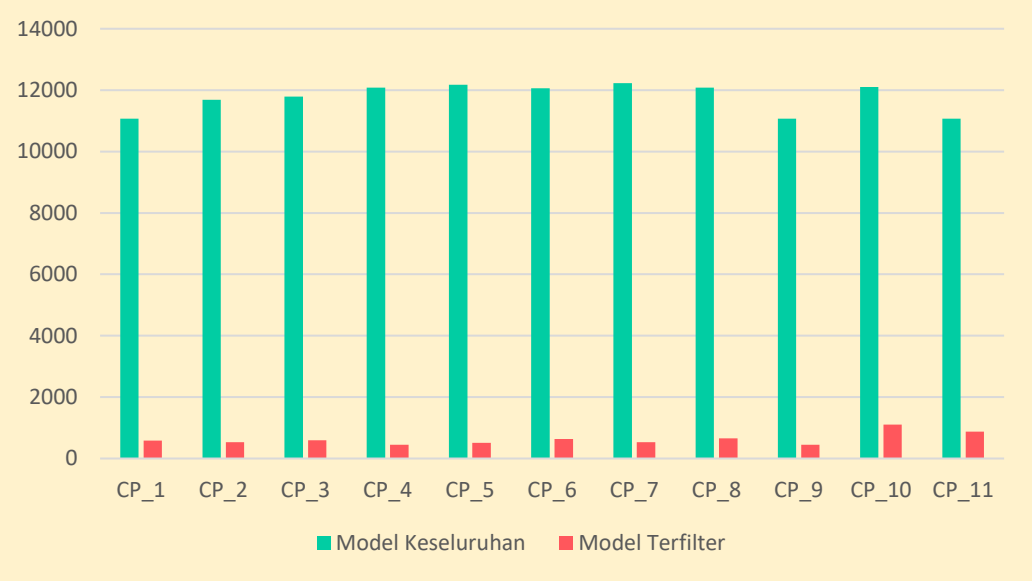


CLOUD TO CLOUD

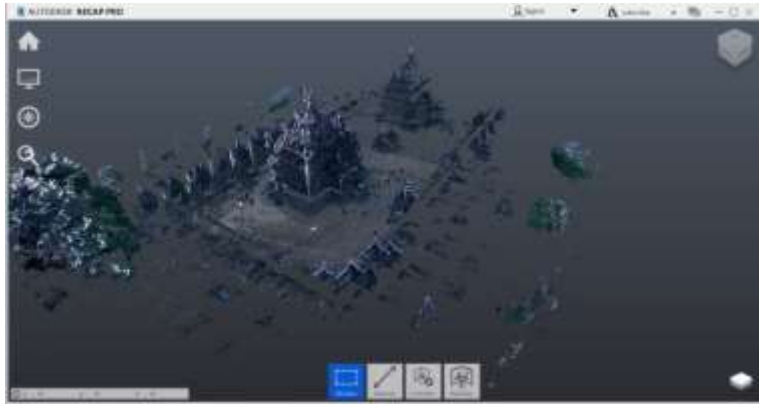
This registration uses a minimum of 3 points that are owned from the two scans. The purpose of this concept is to find the offset or the closest distance repeatedly from the two closest points between the two cloud point sets.



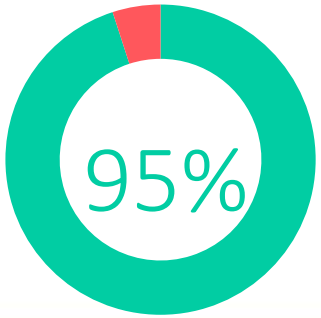
11 tool stands with a maximum distance of 2m between points



FROM THIS



TO THIS

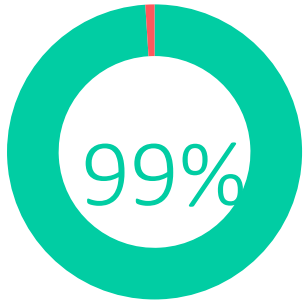


CLOUD POINT REDUCTION

from 129,429,314 points to only 7,198,274 points

UAV DATA

The data is generated from the Mavic 2 Pro hardware with a flying height of 100m with 80% overlap and 40% sidelap. There are 430 numbers of aerial photographs produced.



CLOUD POINT REDUCTION

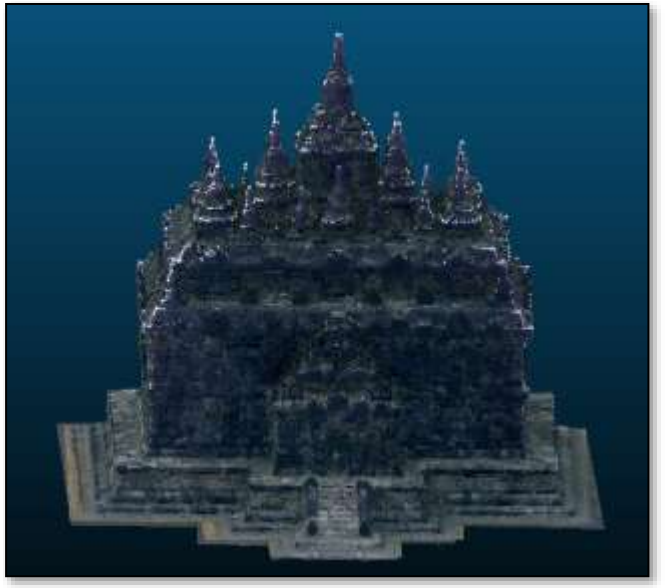
from 24,180,212 points to only 440,684 points

FROM THIS

TO THIS

ALIGNMENT DATA

POIN CLOUD UAV				
NO.	X	Y	Z	ERROR
A0	445386.103	9144338.708	178.414001	0.0386984
A1	445384.703	9144361.427	178.954002	0.0281836
A2	445371.036	9144337.379	117.628998	0.051886
A3	445367.381	9144343.866	177.692001	0.0256872
A4	445369.804	9144353.809	178.057999	0.0119344
A5	445366.849	9144353.588	177.940002	0.015897
A6	445369.632	9144360.081	178.268997	0.0339328
POIN CLOUD TLS				
NO.	X	Y	Z	ERROR
R0	27.741484	5.637982	-0.627863	0.0386984
R1	5.278656	1.909068	-0.615434	0.0281836
R2	30.584045	-9.260016	-0.624868	0.051886
R3	24.539886	-13.479595	-0.616552	0.0256872
R4	14.402279	-12.150108	-0.653858	0.0119344
R5	14.919536	-15.083216	-0.635958	0.015897
R6	8.203098	-12.962484	-0.616918	0.0339328
Total RMS *error*				0.0320501



This RMS value is taken from the alignment error value remaining between each pair after registration. So that the combined RMS value of the two is 0.0320501 m or about 3 cm. The RMS value has a good index. The combined point cloud has a total of 7,636,895 points.

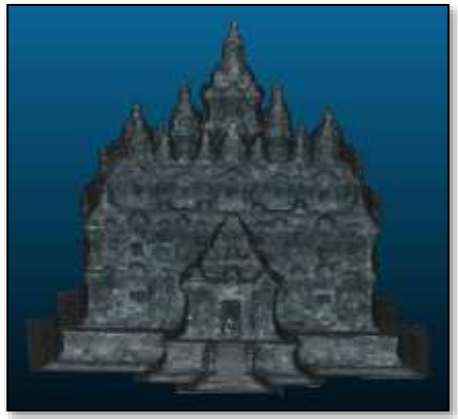
SURFACE RECONSTRUCTION

Poisson surface reconstruction is a plugin that generates a mesh piling algorithm created by Misha Kazhdan of Johns Hopkins University.

The process of building a model using this plug-in must enter a normal value which is sure to be clean from noise.

Apart from being a 3D form, the output can also include density information to get a more valid mesh.

MODEL 3D
From UAV data



Model 3D from UAV data has 1.664.083 faces

MODEL 3D
From TLS data

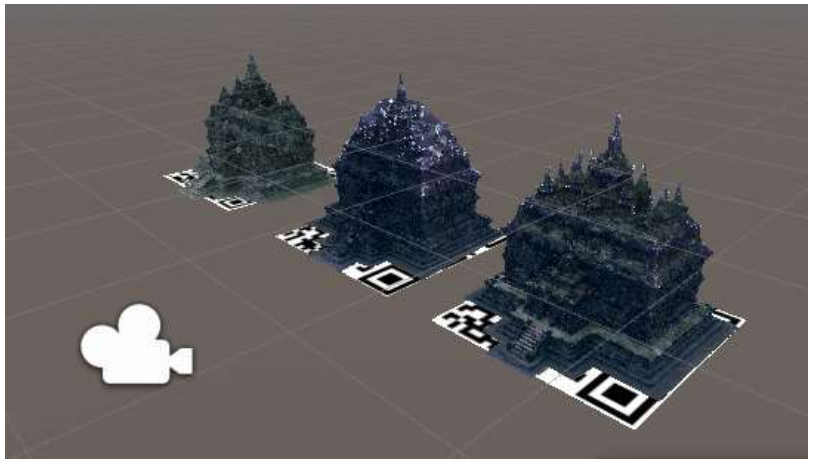
Model 3D from TLS data has 12.959.39 faces

MODEL 3D
From COMB data

Model 3D from Combination of both data has 14.206.094 faces

AR BUILDING

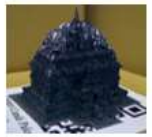
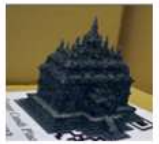
Design of application



- Unity implements global coordinates based on its software. That is, Unity has its own coordinates in its world.
- The target is set with a scale of 1: 1: 1.
- The model scale adjusts according to the target with a scale of 4: 4: 4.

Download the apps in link below :

http://bit.ly/ARCANDIPLAOSAN

Candi Keseluruhan	Detail Candi
1. Photo Smartphone	
(1.a)	(1.b) (1.c) (1.d) (1.e)
2. *Scan* AR Model 3D UAV	
(2.a)	(2.b) (2.c) (2.d) (2.e)
3. *Scan* AR Model 3D TLS	
 (3.a)	(3.b) (3.c) (3.d) (3.e)
4. *Scan* AR Model 3D Gabungan	
 (4.a)	(4.b) (4.c) (4.d) (4.e)

AR BUILDING

Qualitative Test

Qualitative test on the 3D model in AR using 5 samples from each model

CONCLUSION

01. TLS has a point cloud of 7,198,274 larger points than UAV with 440,684 points. Registration of combined point cloud data TLS and UAV refers to data that has more points. TLS data becomes a reference for UAV data. The registration resulting from combining the two data uses 7 tie points with an average error of 0.0320501 m.

02. This research produces 3 different 3D models of Plaosan Lor temple based on the data source. The 3d model created from TLS data generates 12,959.39 faces, UAV data generates 1,664,083 faces, while combining the two data results in 14,206,094 faces. The three of them are displayed through virtual media with an AR design. The results of the qualitative test of the three models used 5 samples of the part of the model in AR and their appearance in the field. As a result, the combined model has better quality among other models, because the TLS and UAV data fill each other's gaps. However, with an efficient process in terms of time, cost and energy, the UAV model can roughly represent the temple. Meanwhile, TLS is not recommended to analyze the temple as a whole, but if the need is only for the analysis of the temple side of the temple, this vehicle is suitable for use.

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Thanks !

TERIMA KASIH

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