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## VOLUMETRIZATION OF 2D FLIR THERMO-SCANS

Nadya Stamatova<sup>1</sup>, Antoni Angelov<sup>2</sup>

### ABSTRACT:

There are two methods of volumetrization of two-dimensional scans from FLIR thermal cameras, developed by the R&D team of Architectural Spies EOOD. The first is manual, which uses the thermal component of the scans as input data and places them on a 3D model of the object (a building or a facility). The model, on which the scans would be placed on, could be either BIM (if available) or photogrammetrically created. The second method is automated, using the photo and thermal components of the FLIR scans simultaneously.

**Keywords:** volumetrization, 3D model, FLIR, scans, thermal scans, BIM, photogrammetry, AR, Augmented Reality, MR, Mixed Reality, Hololens, hologram

### 1. Introduction

The challenge of visualising volumetrically 2D thermal images (the standard output from FLIR thermal cameras [2]) originates from work conducted by Architectural Spies EOOD [4], producing applications for augmented reality (AR) for a cultural heritage building in Varna (address: 28, Dragoman str.) [5], [6].

The first, as illustrated in *Fig.1*, is for Android devices and the second, which has an almost identical interface, is for iPhones. The third application is for a mixed reality (MR) environment by Microsoft Hololens-2. *Fig. 2* shows a hologram of a scaled BIM model produced by the same team, which can then be used as an input 3D model for volumetrization of the 2D thermal images.

### 2. Similarities and differences between the two methods

Note that the two methods of volumetriazation of the FLIR scans developed are manual and automated.

The types of input and output data of the above methods are presented on *Table 1*. The format of the two types are shown on *Table 2*.

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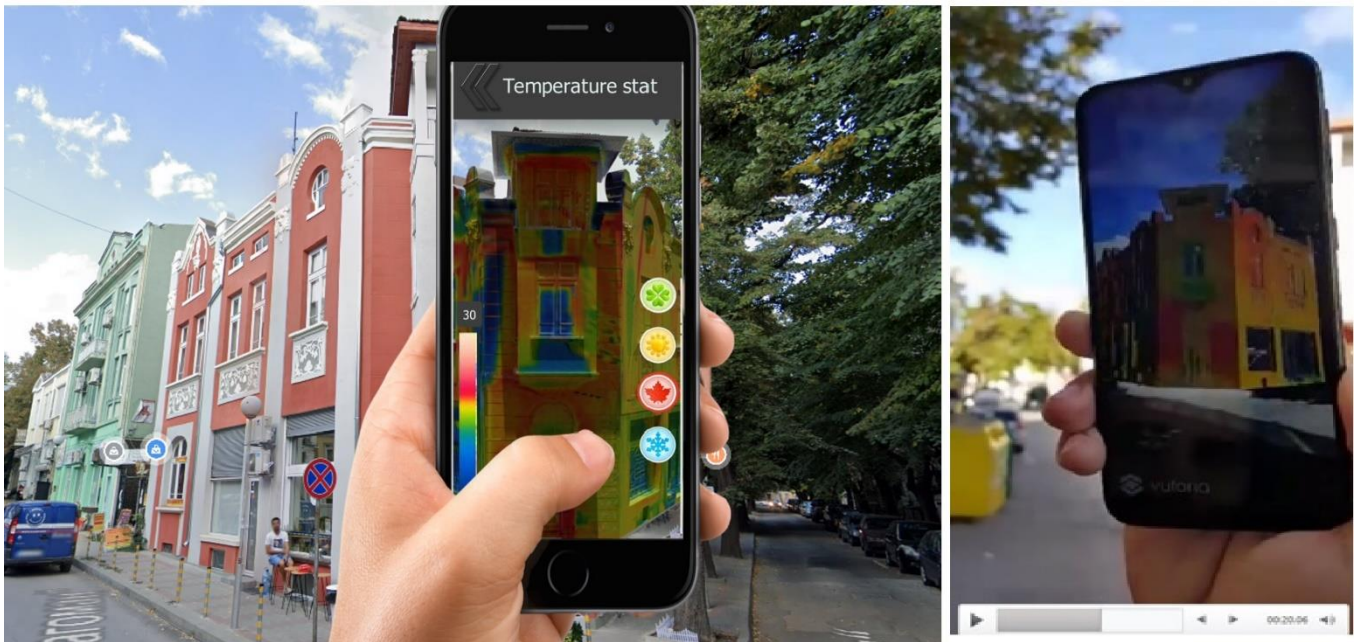


Fig. 1. AR app for smartphones. Left: A collage, part of the Story board and interface view, Right: A videorecording the test for the target recognition



Fig. 2. Videorecording of the view from Microsoft Hololens-2 on the hologram of the BIM

Table 1. Input data and output data of the two methods

METHODS	data		
	input		output
1.Manual	CAD model of the building	FLIR Thermal photos	3D thermal model
2.Automated	FLIR Thermal photos	Higher resolution normal photos matching the thermal ones.	3D thermal model

Table 2. Input and output formats types of the two methods

METHODS	data		
	input		output
1.Manual	.ifc	.jpg	.fbx
2.Automated	.jpg	.jpg	.fbx

### 3. Manual Method

The manual method of volumetrization of the FLIR [1] scans applies the 2D thermal scans as a texture onto a BIM (CAD) model of the building. Alternatively, they can be placed [3], onto a photogrammetrically-created model [1] based on terrestrial and/or aerial photos or videos. However, this method is manual and highly time consuming. The result of this method provides adequate geometric and thermal composition data that can then be used in various ways, including building analysis, its thermal insulation, and so forth. It must be noted that this method has the potential to give errors, as is expected when the temperature texture is applied manually by an operator.

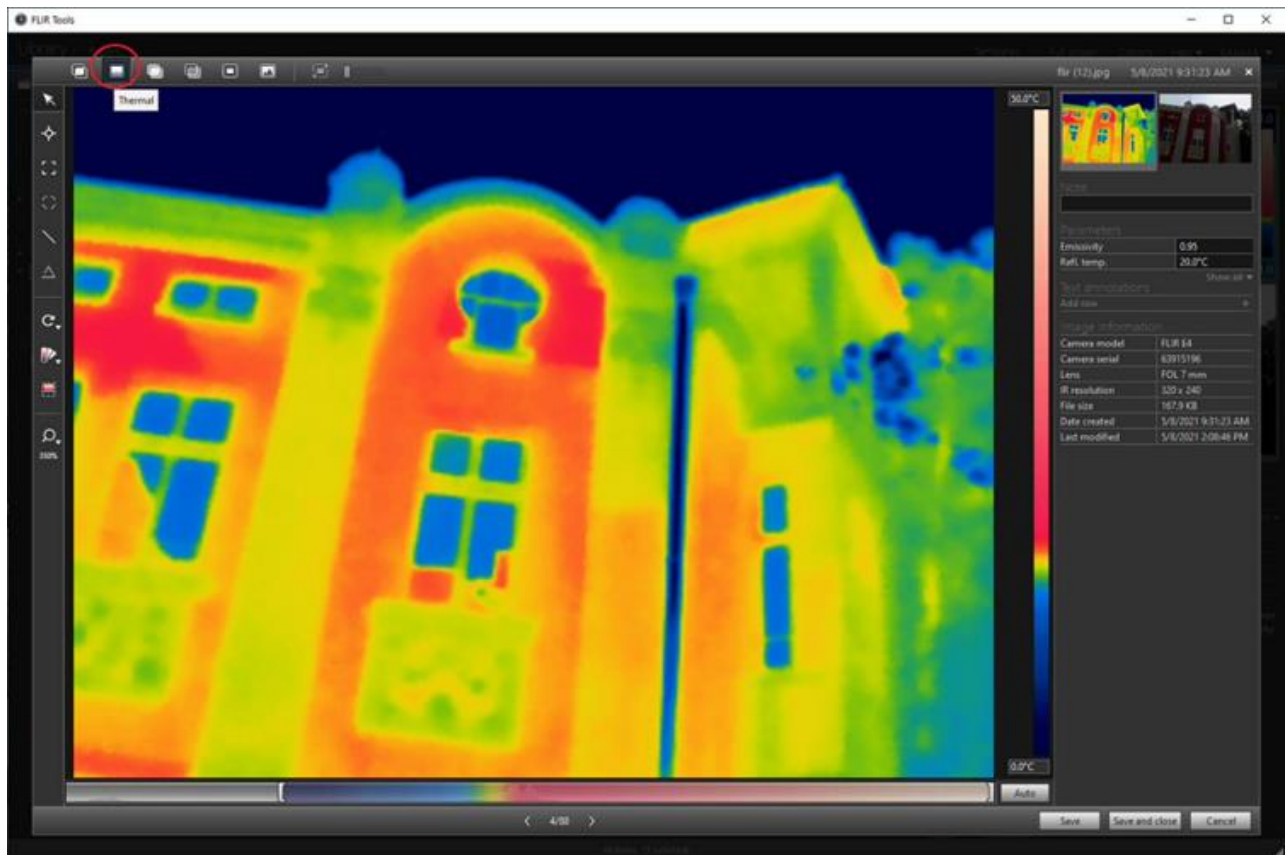


Fig. 3. A result of the manual method

#### 4. Automated Method

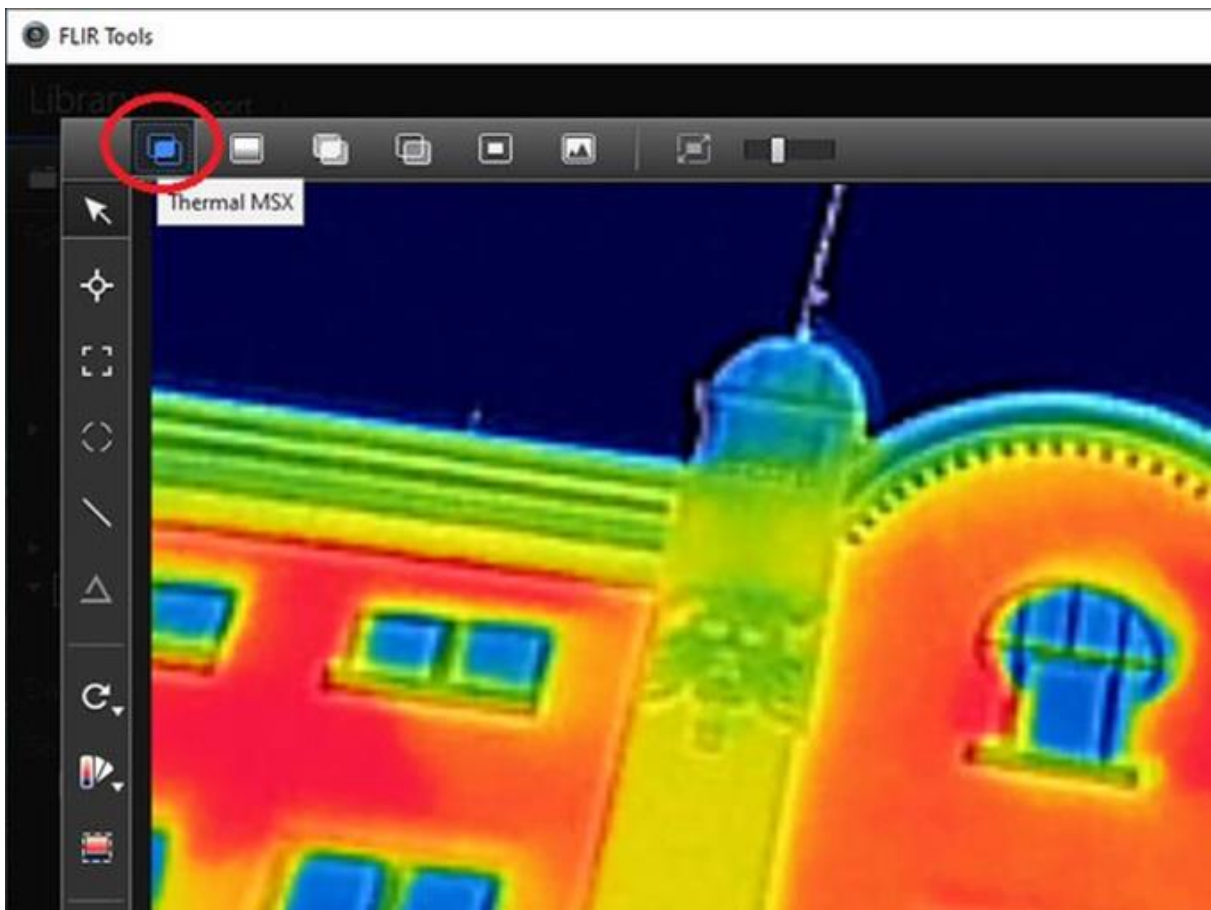
The second method is easier to process in comparison to the first, but it requires a larger amount of thermal scans for it to succeed.

Firstly, one needs to have some understanding of photogrammetry and its relation to the process. Simply put, the process involves the creation of a 3D model from the light invariant contrast lines from 2D images. The contrast lines are a key element to this process. In a normal thermal model, as shown in *Fig. 4*, such contrast lines are not present.



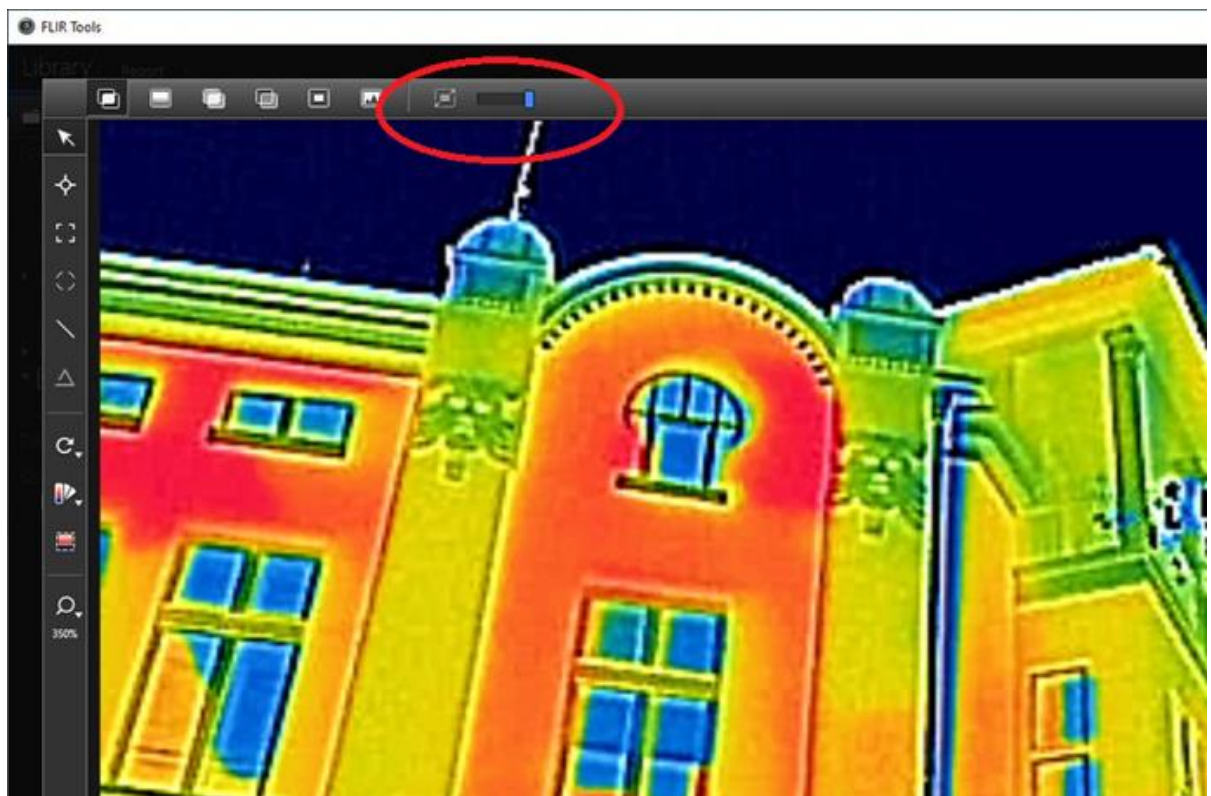
*Fig. 4. A thermal component of a 2D scan by a FLIR thermal camera [2]*

An attempt of photogrammetry from the image shown in *Fig.4* will only result in failure as the edges are not as visible and the thermal photo itself has a relatively a low resolution. However, the FLIR thermal camera is able to create pairs of images, specifically a thermal scan with a regular photo in much higher resolution. This combination provides what is needed to produce a complete 3D thermal model by photogrammetry in an automated way. The process is done in the program FLIR Tools [2] , whereby the two components of the FLIR scans are processed using the Thermal MSX option (*Fig.5*).



*Fig. 5. Compiled image by the option Thermal MSX [2]*

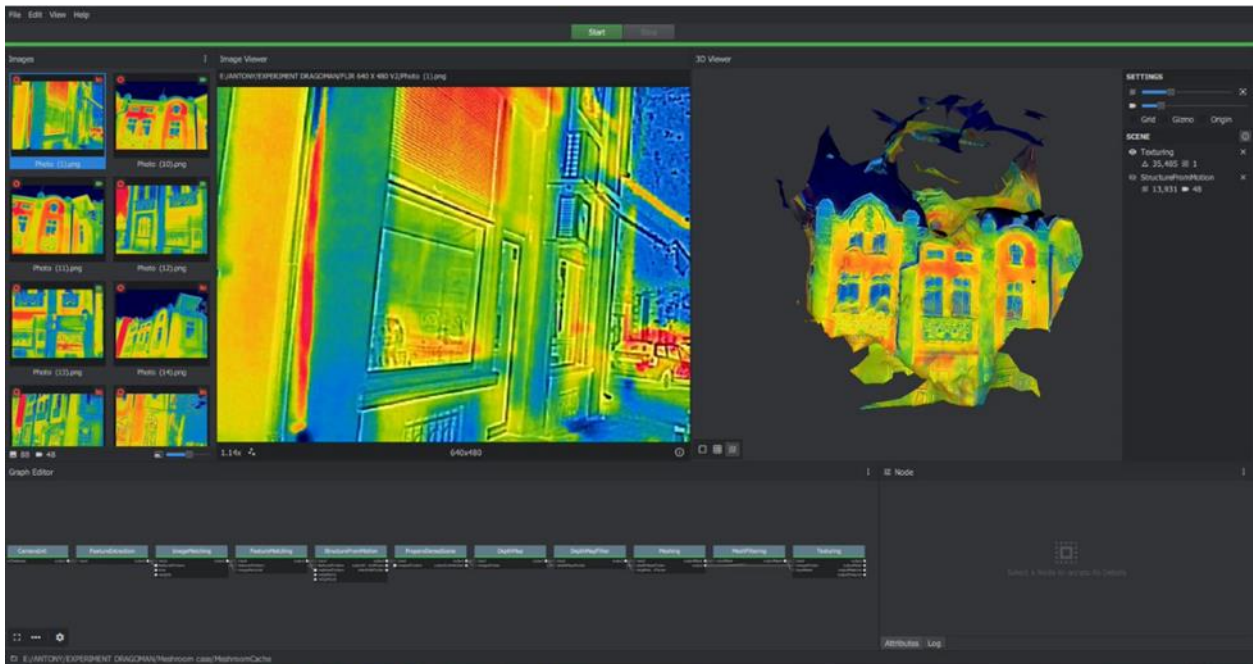
At Fig.5 the lines of the edges are already visible, the sharpness of the graphic can be increased further using the scale, shown at Fig.6:



*Fig. 6. A scale for regulation the sharpness of the graphic lines [2]*

The lines of the edges shown in *Fig.6* is what is needed to create the 3D mesh of the model.

The above process was applied to the remaining photos (around 100). This method did not sound convincing at first, but it produced good results upon completion.



*Fig. 7. An aucthomatic volumetrization of the 2D FLIR thermal scans by photogrammetry [1]*

## 5. Conclusion

Both manual and automated methods could be used independently of each other. It is also possible to use the manual method to correct limited areas with partial defects identified from automatic production. Not all the FLIR thermal scans could produce a three-dimensional model, as for example, scans made at night cannot serve as input data for automatic volumetrization. Also, when working with a limited number of scans, the volumetrization will have to be done manually.

## LITERATURE

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