JSRT JOURNAL
PAGES: 1-6
6/10/24
JOURNAL OF SCIENTIFIC RESEARCH AND TECHNOLOGY VOLUME-2
ISSUE-6 MAY

Large-Scale Antiquity Sites: Detailed 3D Reconstruction Using Holistic Methods

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ABSTRACT

Tracking an object's current condition is frequently the first and most important step in cultural heritage preservation. It takes a lot of time and effort to complete this operation, especially for large-scale items like buildings. As a result, interest in new, more effective strategies that simplify the process and lessen the financial impact of surveying actions is developing. Before the actual restoration of the façade can begin, professionals must map the damages and determine the necessary remedial actions. Here, the foundation is provided by three-dimensional drawings that show each individual stone. These plans typically come from traditional surveying. To minimise the work on site, a photogrammetric technique is frequently utilised. However, manual, timely processing is used to handle still images, including point measurements and picture registration. Incorporating structure-from-motion, dense image matching, point cloud registration, laser scans, terrestrial imaging, and photos from a UAV platform, created orthographic projections from which the drawings could be created, we presented Taj Mahal here.

Keywords—Photometric, UAV platform, Three-dimensional, Photogrammetric.

I. INTRODUCTION

Cultural heritage preservation has come to more attention in the last years, as there is a growing awareness of the need to maintain monuments and other artefacts for future generations. As an initial step most preservation actions include a documentation of the current state of the object of interest. In case of façade restoration actions, standard surveying methods are usually chosen to observe the façade's geometric appearance. Enough points need to be measured to allow a mapping of each single stone and other details important for the restoration task. From these measurements 2D CAD drawings are derived, which again enable civil or structural engineers and architects to map damages, plan corresponding counter measures and estimate costs. Tachymetry as a classical surveying method provides very accurate but only punctual measurements which need to be triggered manually. Thus laser scanning is often preferred due to its' high measurement density and fast acquisition rate. Photogrammetry also provides fast on-site acquisition. When used in a modern, highly automated manner, incorporating techniques as structure-from-motion and dense image matching, it can provide results comparable to laser scanning to a much lower price of hardware. Certainly, it has the drawback of being a triangulating measurement technique and thus a point in space must be observed from more than one station, but a camera station can be changed without much effort. In fact the camera can be mounted on a moving platform as a crane or a hoisting platform and reach areas of a building which are not accessible from the ground. Due to its' relatively low weight it can also be carried by small UAVs, improving the approach's flexibility even more. Since both, laser scanning and dense image matching, observe arbitrary points in space with a high density, producing orthographic projections (orthophotos) of the data seems an adequate basis for the final CAD drawings. Our institute promotes the introduction of modern image processing strategies into the branch of heritage preservation through practical application of internal and external developments since more than three years. Within the presented project, which aims at the restoration of the facades of the St. Martin dome in Rottenburg am Neckar, Germany, took over the task of status-quo-documentation.

II. RELATED WORK

A Nona Tree Space Partitions (NTSP) algorithm is proposed for dealing with very large data processing and visualisation. A new geometric active contours model is used to automatically segment interesting image areas such as water or flooded regions, forest region and residential region. A primitive shape matching method is proposed to detect the residential objects, such as buildings and houses. The experimental results demonstrate that our approach is a promising one, which is able to deal with large environment reconstruction effectively[1]. The methodology used to acquire the data and construct a computer model of Michelangelo's Florentine Pieta with enough detail and accuracy to make it useful in scientific studies. We describe the project to acquire and build the 3D model[2]. Presented a component approach that combines in a seamless way the strong features of laser range acquisition with the visual quality of purely photographic approaches. The relevant components of the system are: (i) Panoramic images for distant background scenery where parallax is insignificant; (ii) Photogrammetry for background buildings and (iii) High detailed laser based models for the primary environment, structure of exteriors of buildings and interiors of rooms[3]. Presented a novel 3D reconstruction method for large-scale 3D environments. There are three core components of our work: dynamic terrain modelling, river and water region identification and modelling using an active contour model and primitive shape matching method. Real-time environment reconstruction is constructed using real measurement data of GIS, in terms of digital elevation data and satellite image data[4].

III. PROPOSED SYSTEM

In the proposed system, using Image processing Technique to reconstruct the building. The system displays the original building with modified construction of different parts. In this system, discussing about the polluted Yamuna river flowing next to the Taj Mahal had been the cause of algae proliferation and various other insects like mosquitoes(the chironomids).The green droppings of these mosquitoes and the colouration due to algae had contributed to the brown color of the monument. So to avoid this what reconstruction can do is discussed.

IV. METHODOLOGY

Data collection

Using the image-based technique, completely modeled the Taj. Acquired different sets of images,

.

Figure 1:Tajmahal

Data processing our goal is to identify and practically apply given software solutions to heritage preservation. In this case, the tasks which needed to perform range from image registration, dense point measurement and registration of point clouds to the production of orthographic projections and deriving drawings from the latter. To our knowledge, there is no software package available which can handle all these topics in one pipeline, but there is a variety of packages which can provide solutions for single sub-tasks. For structure-from-motion, as well as dense image matching have applied internal own developments. For point cloud processing, mostly used freely available packages (OpenSource:Python).

Structure-from-Motion This step appeared to be the most sensitive part of the process chain. Applied our internal development. The basic work flow of both implementations consists of:

1. Keypoint detection and descriptor extraction (per image) \
2. Keypoint matching and estimation of relative orientation (for each image pair) 3. Point tracking and connectivity computation 4. Iterative triangulation of points contained in oriented images and resection of new images, followed by a (small scaled) bundle adjustment 5. Final (global) bundle adjustment For completeness, it should be mentioned, that in some cases optical flow is used instead of extraction of distinct features. However, optical flow is better suited for video streams, where parallaxes between consecutive images stay small. The selection of images and assigning the initial image pair and the setting of program parameters has a high impact on the results. While both implementations yield comparable results, problems regarding connectivity or orientation accuracy occur at different parts of the dataset. Both implementations use a 2-parameter radial distortion model and allow either assigning one camera model to all images or assigning a separate model to each image. While the latter is especially useful for cases in which images are obtained from internet data bases or with a zoom lens, the first option should be preferred when the images are taken with a single camera with fixed focal length. In our case four cameras have been used, partially with zoom lenses and partially with fixed focal length. Assigning separate models per image was the most practicable solution for us and delivered reasonable results. Nonetheless a more flexible assignment of camera models is a desirable feature for future developments, as it can be expected to make the structure-from-motion process more robust in some cases. The same might hold for embedding more complex distortion models. use a semi-automated approach to identify the structural components and number of repetitions of each geometric component inside a 2D image I(x, y), where x and y are the coordinates of each pixel in the image. The user draws a rectangle over any one component represented by a template T (x, y). The template T (x, y) is shifted into nine different positions. The intensities are multiplied and summed at each position, producing a correlation coefficient matrix. Let I(x, y) be the intensity value of the Mx × My image I at pixel (x, y), x ∈ {0, 1,...,Mx−1}, y ∈ {0, 1,...,My−1}. Similarly, let T (x, y) be the intensity of the Nx × Ny template T at pixel (x, y) where Nx ≤ Mx and Ny ≤ My . NCC is evaluated at every point (u, v) for I and T , which is shifted over from the original image I(x, y) by u steps in the x direction and v steps in the y direction. The formula for the (u, v)th entry of the correlation matrix is as follows:

$$R_{u,v}=\frac{\sum_{x,y}(I(x,y)-\bar{I}_{u,v})(T(x-u,y-v)-\bar{T})}{\sqrt{\sum_{x,y}(I(x,y)-\bar{I}_{u,v})^2\sum_{x,y}(T(x-u,y-v)-\bar{T})^2}},$$

where ¯Iu,v denotes the mean value of I(x, y) within the area of template T shifted by (u, v) steps, and is given by the following formula: ¯

$$\bar{I}_{u,v}=\frac{1}{N_xN_y}\sum_{x=u}^{u+N_x-1}\sum_{y=v}^{v+N_y-1}I(x,y), \qquad (2)$$

and T¯ denotes the mean value of template T , defined in the same way. The NCC has the following advantages which make it well suited for component identification: (1) The NCC is brightness invariant; i.e., in the case of changes in external illumination, the NCC will not change. (2) NCCs are robust to blurring. Even if the NCC changes with the blurring of the template, the position of its maxima will not change. This is important if images are taken at high view angles as they may suffer from serious blurring. (3) The NCC is usually fast to calculate. (4) The calculated NCCs will be evenly distributed across the whole image. However, there are also some clear limitations of using the NCC. The NCC can determine a numerical value only between 0 and 1, where 0 means 'no match' and 1 means 'identical', To obtain sub-pixel accuracy, a second-order polynomial around the position of the NCC maximum is established. The template T (x, y) is shifted into nine different positions to determine the second-order polynomial, applying the least-squares method. Fig. 3b shows the results of the identified components and their repetitions from the input 2D image of the Taj Mahal. Similar components are labeled using a single unique color to distinguish each structural part. The second approach for component identification uses features or cues from the given 2D image.

V. System Architecture

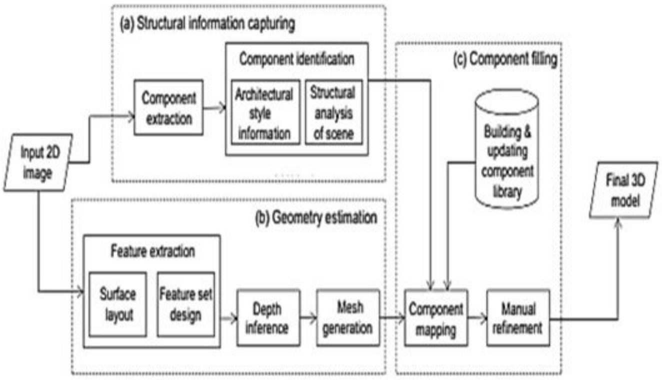

Figure 2: System Architecture

VI. Results And Discussions

In this system reconstruction of the monument tips given here using image processing technique and displays what is the problem and how to solve the problem

Figure 3: Menu

This is the main screen of the program

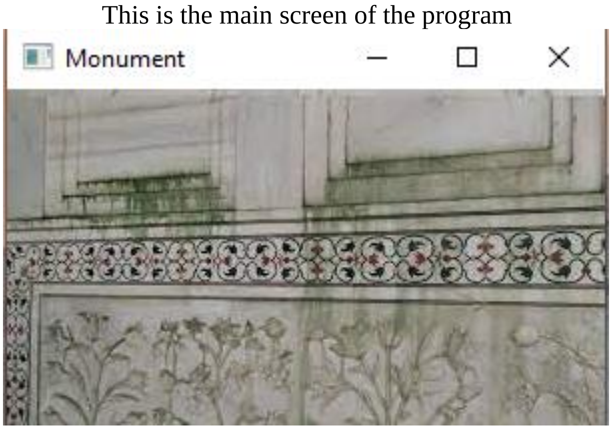

Figure 4: Read Image

This module selects image of the algae affected part of the monument.

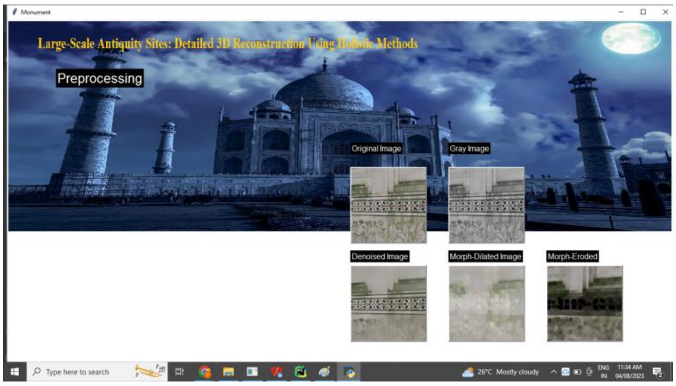

Figure 5:Preprocessing

Perform preprocessing and removes noise and converts to grayscale using morphology technique

VII. CONCLUSION

Although unfavourable circumstances during the data gathering stage made some aspects of data processing challenging, overall, can say that the proposed methodologies can be used for legacy applications. The software solutions must become even more powerful and incorporate a greater range of functions in order to make the procedures suitable to a larger group of users.

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