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Application of GIS Technique for Fire Drill in Hillside Area

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ABSTRACT

The purpose of this study is to describe 3-Dimensional technique to obtain spatial information automatically using PhotoModeler Pro. PhotoModeler Pro is excellent software with the three-dimensional measurement function used by a personal computer using Windows operating system. However, it is not sufficient to carry out the automatic matching work with two stereo images. This is very large neck as a 3-D measurement software. In this study, the automatic stereo matching work using the self-making program and DDE interface within PhotoModeler Pro was tried. The experiment field is the hillside and stair zone of Tateyama region, Nagasaki City. The results of automatic stereo matching work were very good with 100% hitting ratio of target.

Keywords : Hillside area, fire drill, Application of GIS

요 약

본 연구는 PhotoModeler Pro를 이용하여 공간 정보를 자동적으로 추출하기 위한 기법에 관한 것이다. PhotoModeler Pro는 Windows시스템에서 개인용 컴퓨터 상에서 3차원 공간 정보를 취득할 수 있는 우수한 도구이나 스테레오 이미지를 자동적으로 병행하여 처리하는 데는 충분하지 않은 단점이 있다. 따라서 본 연구는 PhotoModeler Pro 상에서 자동생성 프로그램과 DDE인터페이스를 이용한 스테레오 매칭 연구에 관한 것으로, 적용 지역은 사면과 계단이 많은 타테야마 지역(일본 나가사키 시)을 대상으로 하였다. 연구 대상 지역에 대한 자동 스테레오 매칭 결과 100%의 적중률을 보였다.

주요어 : 사면지역, 소방 훈련, GIS적용

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1. Introduction

There are many steps and slope way in the Nagasaki City. It is said that about 70% of the Nagasaki municipal area is the hillside district. The population on this hillside region decreases and the aging advances. For the reason of the superscription, Nagasaki City is planning for the activation in this hillside region as a regional development policy. The study area of this paper, Tateyama district of Nagasaki City, is the hillside district that is almost hillside zone with steep steps and slope way[1].

The Nagasaki City has been holding meetings of community planning to discuss how to improve their living circumstances in local area (Tateyama region) since 1998. The investigation
of stair zone is included in this community planning. The GIS technology has been utilized for this community planning of Tateyama district. Because, the GIS database becomes basic material of the activation countermeasure of hillside zone[2][3]. Especially, GIS database of steps and hillside way offer the information to local residents, it is very important for the welfare policy or disaster countermeasures. But details are at an early stage due to insufficient GIS database and technique.

The purpose of this study is the 3-dimensional information extraction for Database of the GIS on hillside district with steps.

2. The GIS Conditions in Research Area

The Tateyama district in the Nagasaki City, Japan is chosen for the study, which is a typical hillside town as shown as Figure 1. The town is characterized by small flat land

Figure 1. Tateyama district of Nagasaki City

and many steep stairs. The hillside area of the Nagasaki City was formed in the high growth period after 1960's. But the district was weeded out not only in industrial development, but also the movement of motorization in 1980's. This resulted in a decrease of the young generation, hollowing of the population, and aging advanced on the hillside area. In the Nagasaki city virtual reality simulation using GIS technology was adopted to activate regional economy revival, and to social welfare system.

3. 3-D Software Photomodeler Pro

3.1 Summary of Photomodeler Pro

PhotoModeler Pro is the award-winning professional software package for the creation of accurate 3D models, coordinates and measurements from photographs[4]. It is widely used by professionals in the fields of accident reconstruction, architecture, archaeology, engineering, 3D graphics and so on.

PhotoModeler Pro offers powerful tools that generate high quality 3D data of real-world objects and scenes. A few of the advanced features include automatic camera orientation, surface drawing, enhanced file export, enhanced photo-texturing, cylinder and curve modeling, and multimedia tutorials. As started mentioned above in abstract, PhotoModeler Pro is not possible to carry out the automatic matching work used stereo images (photograph). The stereo matching would be done manually. The manual stereo matching is a good method for accuracy improvement. However, this method takes time and manpower. The efficiency for the manual technique is bad. In this study, the work of automatic image matching was attempted using the self-making program and DDE function.

3.2 DDE Interface Function

PhotoModeler can be controlled and have data fed to it by other Windows applications. PhotoModeler provides a DDE (Dynamic Data Exchange) interface and a set of simple DDE commands for this purpose. PhotoModeler acts as a DDE server (a server accepts DDE commands and responds to them). To talk to PhotoModeler the user will need to use a DDE client (a client initiates a DDE connection to a DDE server and sends commands to it).

DDE clients can be written in many Windows programming languages but one of the easiest is Visual Basic by Microsoft. Other programs like Microsoft Word, Microsoft Excel and AutoDesk AutoCAD can act as DDE clients and sometimes DDE servers. Not every aspect of PhotoModeler can be accessed through DDE. PhotoModeler's DDE interface provides for loading and saving PMR (PhotoModeR) files, marking points, getting 3D point locations and getting cylinder information.

3.3 Macro Language

PhotoModeler's DDE commands take a

very simple form. Most of the complexity of DDE has been left off so we can concentrate on getting real work done. All PhotoModeler DDE commands are ASCII text strings and are of the format: "commandName commandParam1 commandParm2...". All commands return values and a return code indicating success or failure. Each programming or macro language has different syntax and methods for using DDE. In this study, the Microsoft Word Visual Basic language was used[5].

The typical set of DDE commands used with PhotoModeler are:

1. "OpenProject" to open a PMR file.
2. "GetNextPointID" to determine what Point ID to start at.
3. "GetPhotoList" to determine which photographs this project has.
4. "MP" to mark points on the photographs and do implicit referencing.
5. "ResetLists" to reset the sequence of returned data points.
6. "GetNextPoint" to return the 3D coordinates of processed or approximated 3D points.
7. "GetNextCylinder" to return the information of cylinders.

4. Used Stereo Matching Method and Field Work

4.1 Field Work

The fieldwork area was Tateyama district, and the object of this study was a stair. The photographs of fieldwork area had taken by dividing the same place into right and left, Procedures are as follows;

(a) The marker was placed in the field.
(b) The photographing was carried out from right and left direction.
(c) The self-making program was executed, and macro program was made.
(d) The DDI function program of PhotoModeler Pro was executed, and the result by PhotoModeler Pro was extracted.

4.2 Marker Detection

The detection of the stair within hillside area is a very complicated model. So many steps of various forms and colors are scattered complicatedly at there. For that reason, the automatic extraction of target is very difficult. In this study, we used target marker in order to extract target exactly. The aspect of the marker is shown in Figure 2. The marker added the color information in order to raise the extraction accuracy. The center of the cross wire of the marker has been set as a target.

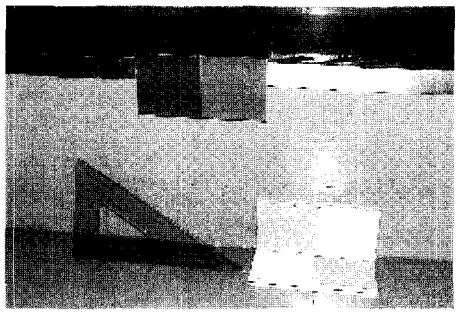


Figure 2. Target marker

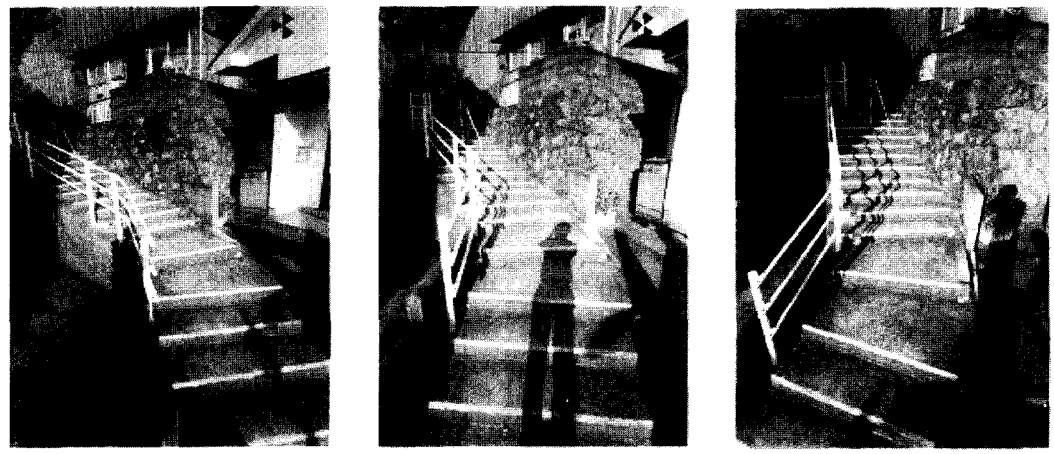
(a) Matching Work-1

Firstly, The correlation coefficient was calculated by using the combination of marker fellow (stereo marker set) on the two photographs. Secondly, it was chosen the markers of seem to be the surest in the correlation coefficient (see figure 3).

(b) Matching Work -2

Using the combination of the above-mentioned marker, the affined transformation matrix was calculated. At that time, the combination of the marker including the error over some thresholds was deleted. As these results, only the combination of the surest marker remains.

(a) photo-1(left) (b) photo-1(center) (c) photo-1(right)



(d) photo-2(left) (e) photo-2(center) (f) photo-2(right)

Figure 3. Experimental field of stereo marching work

(a) photo-1(left) (b) photo-1(center) (c) photo-1(right)

(d) photo-2(left) (e) photo-2(center) (f) photo-2(right)

Figure 4. Results of experimental field of stereo marching work

(c) Matching Work -3

The coordinate of the marker of first photograph was converted into the coordinate of second photographs using the above-mentioned transformation matrix. From this result, the matching work of the target is confirmed.

As a result, the Rate of hit of the target was 100%. The result was similar, even if the direction of the photograph (see Figure 4) changed.

4.3 Execution of Macro Language

After the work of the superscription, the self-making program forms the macro language list automatically as shown as Table 1. According to formed macro language, the manual matching process of PhotoModeler Pro needs to be automated to be more efficient.

Table1. Macro language list made by self-making program

```
sub test_all()
' command        : makeMacroFile.c(V00E02/MTCH)
'                : Oct 27 2004 20:07:23
' create time  : Thu Oct 28 15:52:11 2004
' project name : d:\test_all.pmr
'
' file #001     : 301C.gif, 301C.shiftResource
' file #002     : 301L.gif, 301L.shiftResource
' file #003     : 301R.gif, 301R.shiftResource
' file #004     : 302C.gif, 302C.shiftResource
' file #005     : 302L.gif, 302L.shiftResource
' file #006     : 302R.gif, 302R.shiftResource
'
    On Error Resume Next
    c = DDEInitiate(App:="PhotoModeler", Topic:="Data")
    MsgBox DDERequest(Channel:=c, Item:="OpenProject d:\test_all.pmr")
    'MsgBox DDERequest(Channel:=c, Item:="GetPhotoList")

    ' file #001 : 301C.gif, 301C.shiftResource
    MsgBox DDERequest(Channel:=c, Item:="MP 1 150 238.586 381.3")
       --- (omission) ---
    MsgBox DDERequest(Channel:=c, Item:="MP 1 171 400.981 609.352")
    ' file #002 : 301L.gif, 301L.shiftResource
    MsgBox DDERequest(Channel:=c, Item:="MP 2 151 413.669 444.216")
       --- (omission) ---
    MsgBox DDERequest(Channel:=c, Item:="MP 2 164 373.418 425.191")
    ' file #003 : 301R.gif, 301R.shiftResource
    MsgBox DDERequest(Channel:=c, Item:="MP 3 150 245.419 352.172")
       --- (omission) ---
    MsgBox DDERequest(Channel:=c, Item:="MP 3 171 404.666 584.508")
    ' file #004 : 302C.gif, 302C.shiftResource
    MsgBox DDERequest(Channel:=c, Item:="MP 4 200 279.02 341.686")
       --- (omission) ---
    MsgBox DDERequest(Channel:=c, Item:="MP 4 235 395.444 471.009")
    ' file #005 : 302L.gif, 302L.shiftResource
    MsgBox DDERequest(Channel:=c, Item:="MP 5 202 88.5476 403.301")
       --- (omission) ---
    MsgBox DDERequest(Channel:=c, Item:="MP 5 231 543.664 641.158")
    ' file #006 : 302R.gif, 302R.shiftResource
    MsgBox DDERequest(Channel:=c, Item:="MP 6 200 367.923 314.863")
       --- (omission) ---
    MsgBox DDERequest(Channel:=c, Item:="MP 6 238 452.242 845.566")

    MsgBox DDERequest(Channel:=c, Item:="SaveProject d:\test_all.pmr")
    DDETerminate c
End Sub
```

5. Results and Discussion

Figure 5 presents real stairs in Tateyama district made by Macro language program. According to the experience, the matching work time of PhotoModeler Pro occupies 80%. If the program of this study will be utilized, the workload can be reduced by about 80% with good accuracy.

Future problem is to keep 100% hitting ratio without the target. Contrivance of the photographing is necessary in order to raise the hitting ratio. The contrivance of the target arrangement is also one of the future problems. GIS technique has been applied in broad field to obtain spatial information. Therefore, it has been neglected to extract information in limited area. Our experiments supported GIS have a characteristics to reappear real world in narrow area, our efforts would help the drill of fire activities and many kinds of welfare having many hillside areas.

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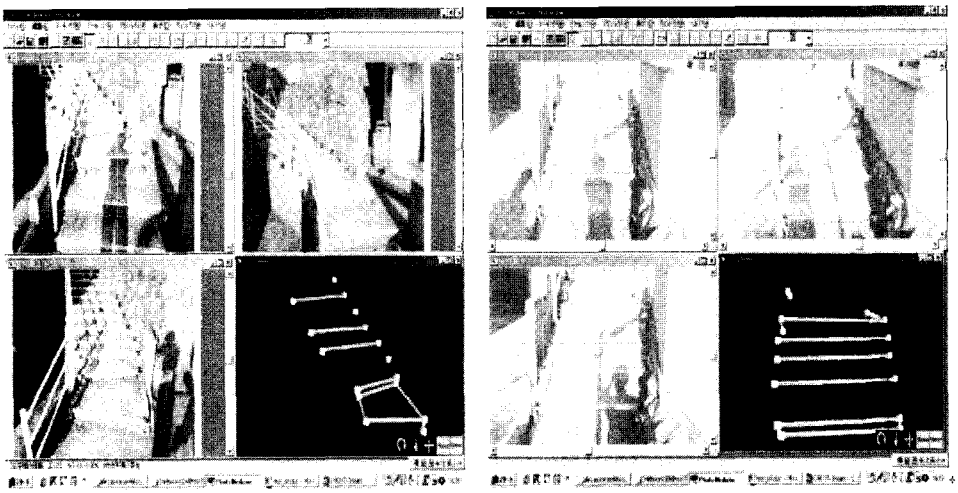

Figure 5. Results of fieldwork for Tateyama district