DESIGN AND RESEARCH ON THE FAST STATISTICAL AND ANALYTICAL SYSTEM FOR EARTHQUAKE DISASTER

Yang Delin,Professor   Wang Menghe,Assistant

Tsinghua University

Beijing, P.R. China

ABSTRAST:

It is very important and significant that the earthquake disaster is timely investigated and counted up after occurrence of earthquake. In this paper, a new idea for the rapid statistic and investigation of seismic damage with the pickup camera photography combining with digital image processing is supposed,and a design plan of fast statistical and analytical system for earthquake disaster is primarily presented.

KEY WORDS: Earthquake disaster. Pickup Camera Photography. Aerophotogrammetry.
Digital Image Processing

1. INTRODUCTION

It is invariably insisted that the earthquake is one of the most destructive natural calamity. The statistic information of stricken scope, destroyed level and disaster situation of seismic area (especially the serious affected area)must be quick obtained after event, and soon provided for the leading departments to overall understand the situation of seismic area, fast make the salvage policy and rationally arrange the post disaster reconstruction. This is a very important and significant job. Therefore, a fast and effectively statistic and analytical system of earthquake disaster is set up necessarily.

The system should meet following requirements for information acquirement and result submission:

(1) Promptitude: The disaster imformation must be supplied in time and by stage after earthquake.

(2)Comprehensiveness:The imformation should overall reflect the situation of stricken area,the relevant data and diagram of disaster grade are offered according to the different damage degree.

(3) Audio-visual speciality: Becauce the damage caused by earthquake and its influence on the social and economic life are a fuzzy value, the visual photographs and images are supplied as far as possible besides the data and diagrams obtained by processing.

(4) Accuracy: Owing to the direct effect on the judgement of the extent of a disaster , the information must be with a reliable precision index to estimate exactly the disaster level.

Based on above requirements,it is the only way that the information is acquired from air. Considering the practical condition,a comprehensive plan of the pickup camera aerophotograph combining with the digital image processing is presented although the information is also achieved with the satellite remote sensing or the aerophotogrammetry which are the nature methods at present.This plan is selected after comparison among remote sensing, aerophoto -grammetry and pickup camera photography. The comparing results are listed in table 1.

According to the comparison, the pickup camera photography combining with the digital image processing is a feasible plan for the seismic damage investigation.

2. DESIGN OF THE OVERALL PLAN FOR INVESTIGATION SYSTEM

The fast statistical and analytical system for earthquake disaster consists of the pickup camera photography in site, the duplication and preprocessing of video tapes, the image processing and recognition,the statistic and analysis of disaster situation and the management of data bank information, its basic technological approach is given as follows:
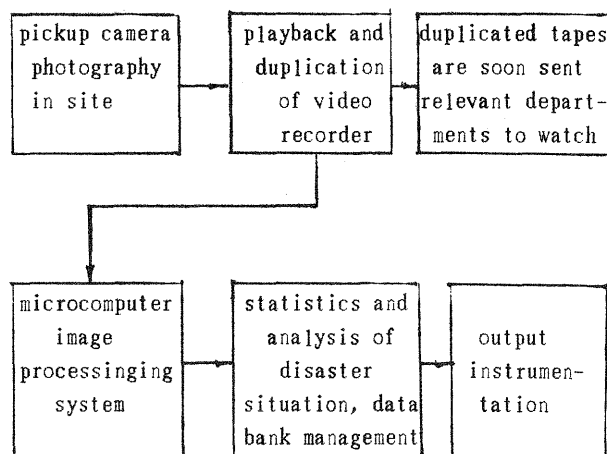
Table 1

metheds compared items	satellite remote sensing (SPOT)	Aerophotogrammetry	Pickup camera photography
information source	remote sensing images or digital tapes (purchase)	air photographs (flight)	air video tapes (flight)
acquiring period	about half month	a week	1 to 3 days
resolution (pixel)	20~30 M	0.5~1 M	1~2 M
scale	1:100000~1:3500000	1:5000~1:50000	1:5000--1:20000
audio-visual speciality	unsuitablee for observation of disaster situation	black and white photograph,experience without reality	colour video tape convenient for playback, experience with reality
flexibility	lack of the flexibility and convenience	necessary for special airplane and camera	unuecessarary for special device,flexible flight plan
processing system	remote sensing image processing system (expensive)	stereo comparator, analytical plotter (expensive)	microcomputer image processing system (developed by oneself)
results	summary statistics	diagram, table and data	duplicated video tapes, diagram, table and data
cost	high	higher	low
conclution	low resolution, long period, high cost and single result,unsuitable for seismic investigation	high resolution, complex intrumentation and long period,difficult to meet survey requirements	fitting resolution, cheeper devices and short period, suitable for seismic investigation

2.1 The Technological Plan of Pickup Camera Photography

2.1.1 Recorder and Camera

Comparing with the general television recorders,the digital video tape recorder (DVTR) has many advantages,for example:

a) overcome the non-linear distortion of magnetic record;

b) eliminate the ripple interference of low carrier frequency moderated record;

c) surmount the effect of time base error;

d) have not the noise accumulation and can be duplicated multify without the deterioration of image quality;

e) be easy to connect with computer.

Thus the DVTR is used for playback and duplication of air video tapes.

With regard to the pickup camera, it should be with the high resolution and sensibility and without the coicidence error, geometric distortion, magnetic field interference, blurred image and cometary tail etc., like the DXC-M7P colour pickup camera made in SONY,Japan.

2.1.2 Pickup Camera Photographic Way

For the sake of conveience of the post treatment and the analytical space location of images, the near vertical photography is applied to gain the near vertical images, which can be processed with the principle and method of aerophotogrammetry. The corresponding control apparatus is used for measuring the attitude parameters of airplane in photography. If possible, the GPS receiver is used to determine the space position of plane.

2.1.3 Flight Programme

The next principles are surely followed in the development of flight programme:

a) Determination of photographic scope. The photographic scope of disaster area is determined on 1:10000~1:50000 map in light of the ralated seismic information.

b) Dividing of stricken area into different photographic regions. Considering that the photography of the earthquake area could not be completed at ones,and that the flight length is limited to the navigation, the photogaphic area should be divided into different regions, for example about 10 square kilometers according to the scope of disaster area and its topographic condition.

c) Estimation of the Photographic Scale. The photographic scale is selected on the basis of the saving and velocity in photograghy and the image resolution. Generally, it is between 1:10000 to 1:20000. With the formula $1/M = f/H$, the flight height is let $H = 1000$ m, then $f = 100$mm when scale 1:10000, and f= 50mm when scale 1:20000. The focal distances of pickup camera are between 8.5 to 140mm, which meet the needs of photography.

d) Computation of the photographic strip and the exposure.The computation methods are similar to the aerophotogrammetry.

2.2 Processing Method of Image Data

The image data processing is composed of the digitization of video tape image (A/D transform), the preprocessing of image data, the image dividing and recognition, the acquisition and analysis of damage information and the management of data bank for disaster situation,which are discussed respectively.

2.2.1 Digitization of the Video Tape Image

The analogue of the video tape photographed from pickup camera are transformed into the digital images through the image input and collection system. With the DVTR playback tape, the video signal is entered into the input terminal of image collective card in order to digitize the picture. The TARGA+ true colour-picture collective card from Truevision Inc.of America is used,which is suitable

for IBM-PC/AT (286,386 and its compatible computer) and can be directed enter in the extented slot in the mainframe box. It can be formed into a real time image processing system while the pickup camera (video recoder),picture display and proper software are provided. the sketch is given below.
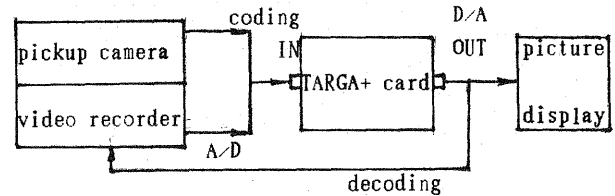
2.2.2 Preprocessing of the Image Data

The preprocessingg contains the noise cancellation, the image enhancement and restoration and the geometric correction. The aim is to correct the image distortion, cancel the blurred component, restore the original picture (restoration),transfer the picture into the observable and suitable image for computer processing (enhancement), and do the geometric transformation,including the minification, amplification and rotation based on the processsing requirements. In addition, in order to ensure the geometric accuracy, the images are corrected with the flight parameter (roll,pitch and yaw), height and velocity or the ground control points for the coordinate conversion.

2.2.3 Dividing and Recognition of Image

The preprocessed images are used for post-treatments, concerning:

a) Feature abstract: The interesting components of damaged objects are separated from image, i.e., the necessary information for object recognition are abstracted from image.

b) Image-dividing. The image space is divided into the significant blocks,for instance,the road,bridge, building and others, destroyed by earthquake,in the ground scene image photographed by pickup camera, are recognized by means of the image-dividing. The analysis and recognition are made by the man-machine interaction, their process is given as follows:
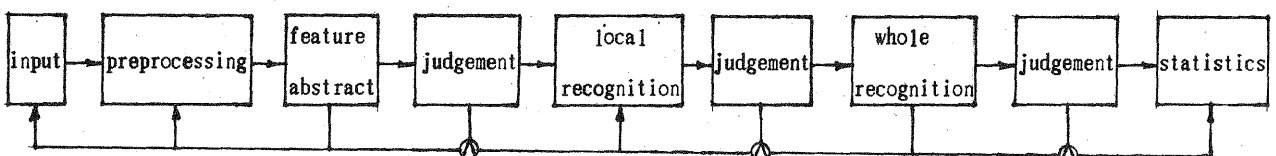
2.2.4 Statistics and Analysis of Damage Information

The damaged and undamaged objects (buildings and roads etc.) are distinguished after image recognition with man-machine interaction, and divided from other scenes, and their boundaries are checked further forming the boundary outlines of objects. Then the damaged objects can be counted and their areas can be calculated.

So far as information of disaster situation, the damage level and disaster grade of objects can be estimated by certain discriminant rules.

2.2.5 Data Bank Management of Disaster information

The disaster information can be used for rational evaluation and classification of seismic hazard, therefore the index system for judging the disaster situation should be firstly set up, which includes:

a) earthquake magnitude and stricken level (intensity);

b) disaster scale (stricken scope and population);

c) casualty degree of personnel;

d) damage degree of living condition (damaged house number and rate);

e) damage degree of production condition (number and rate damaged industrial buildings);

f) damage degree of social function (interrupting ratio and time of lifeline engineering);

g) economic loss (total of direct economic losses);

h) disaster relief scale and post earthquake reconstruction time (mobilization scope and personnel for relief).

Above four indexes (b,d,e and f) can be supllied by this processing system, other indexes are gathered from the related departments. Then a data bank of disaster situation can be established and used to analyse and evaluate the seismic losses. It also can be connected with GIS, which is very important significance for organizing the disaster relief and resuming the production after earthquake.

2.3 Output Results

The output results contain the colour images of earthquake stricken area, the statistic data, diagrams and tables of damage information and the related files and materials, which are displayed by monitor or exported by plotter or printer.

3. BASIC COMPOSITION OF THE INVESTIGATION SYSTEM

The basic composition of system consists of both parts of hardware and software. The former is introduced above. Now the software is discussed.

3.1 Main environment of the Software Development

The software development uses the Microsoft Quick C (2.5) and assembly language, and the program is performed in MS-DOS 3.30 operating system.

3.2 Principal Structure of the Software

The software system uses the modular structure. Each functional module not only is independent, but also can be utilized each other, and affected under the management of the united menu. The sketch is given in table 2.

3.3 Illustration of the Software Function

3.3.1 Initialized module: It initializes the picture board, pickup camera, display and mouse target to make their operation to accord with the parameter and model stipulated by system.
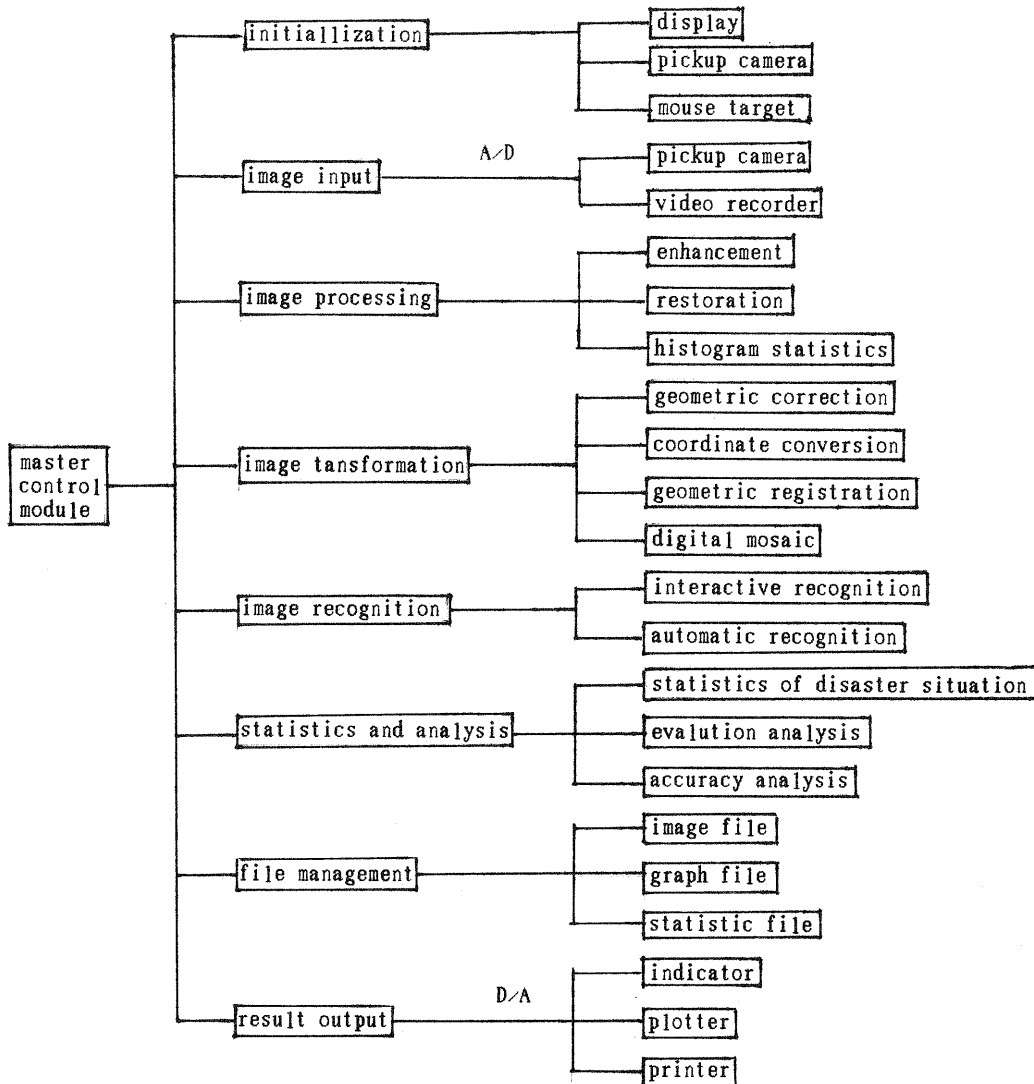
3.3.2 Image input module: It completes the image input and A/D conversion. The images can be inported in real time by pickup camera or use the images recorded by playback tapes of video recorded.

3.3.3 Image processing module: It accomplishes a set of the basic function for image processing such as image enhancement, image restoration and histogram statistics, and access each frame image, and storage in image file, the compression and anti-compression of image data.

3.3.4 Image transformation module: It fulfils the geometric correction of image (with the feature points),the coordinate transformation (translation, amplification, minification and rotation), the geometric registration (connection between two adjacent images) and the digital mosiac (connection of images in all regions).

3.3.5 Image recognition module: It includes the interactive and automatic recognition. In the interactive recognition, some feature information are provided with the man-machine conversation,then processed with computer recognizing the need feature objects.The automatic recognition is a more difficult method that the standard images interpreted in the past stricken area are in advance stored in the image bank of computer, then the images in present stricken area are compared with the standard ones, by which the damage information are obtained.

table 2.


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                    ┌initiallization┐────────┌display┐
                                            ├pickup camera┐
                                            └mouse target┘

                    ┌image input┐    A/D     ┌pickup camera┐
                                            └video recorder┘

                    ┌image processing┐──────┌enhancement┐
                                            ├restoration┐
                                            └histogram statistics┘

                                            ┌geometric correction┐
                    ┌image tansformation┐   ├coordinate conversion┐
┌master   ┐                                 ├geometric registration┐
│control  │──                               └digital mosaic┘
│module   │
                    ┌image recognition┐─────┌interactive recognition┐
                                            └automatic recognition┘

                                            ┌statistics of disaster situation┐
                    ┌statistics and analysis┐├evalution analysis┐
                                            └accuracy analysis┘

                                            ┌image file┐
                    ┌file management┐────────├graph file┐
                                            └statistic file┘

                                            ┌indicator┐
                    ┌result output┐  D/A     ├plotter┐
                                            └printer┘
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3.3.6   Statistic and Analysis module: It counts and analyses the recognized damaged objects and writes various information indexes of disaster situation in the data bank of disaster information.

3.3.7   File management module: It manages the image and graph files obtained in processing and the statistic data file of disaster situation, including the inquiry, addition, deletion and modification of the operation, and display or print the output.

3.3.8   Result output module: It exports all kinds of results in the output device.

4. PREDICTION AND PROSPECT

The successful development of the system is beneficial to the fast investigation of the damaged objects caused by seismic disaster,and also useful to other fields,for instance the dynamic monitoring of flood, the route selection of road and railway and the reconnaissance of land resources in certain limits. It is belived that the system will be developed more extensively with the progress of computer, electronics and image processing techniques, and becomes more accurate and feasible for the investigation and analysis of seismic disaster situation.