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FOTOGRAMETRIČNI ANALITIČNI SISTEM ZA IZVREDNOTENJE ENEGA POSNETKA

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Izvleček

V prispevku je opisan analitični sistem za monoizvrednotenje (AMS), namenjen topografskim aplikacijam. Dandanes z enoslikovnimi postopki že uspešno zamenjujemo dvoslikovne postopke povsod tam, kjer je dopustna manjša natančnost.
Ključne besede: *analitični enoslikovni sistem, digitalni model terena (DMR), projekt ORTO, stereoizvrednotenje,*

1. UVOD

V letu 1990 je dala Republiška geodetska uprava (RGU) pobudo za izdelavo metodologije za operativno izvedbo geodetskih del in nalog pri projektu z naslovom Vrednotenje proizvodne sposobnosti kmetijskih zemljišč (Biotehniška fakulteta – agronomija). V okviru te naloge je nastal razvojni projekt ORTO, ki naj bi dal odgovor na zastavljeno nalogo. Nosilca projekta sta bila Inštitut GZ RS in FAGG – Oddelek za geodezijo. Osnovni namen projekta ORTO je bila izdelava ustreznega sistema za zajemanje prostorskih informacij, ki bi zadovoljil predpisano natančnost izvrednotenja. Poleg tega bi moral biti sistem povezljiv tudi z drugimi sistemi (npr. GIS-i). Glede na dane zahteve smo izdelali programski paket AMS, katerega zasnova in izdelava sta bili predmet moje diplomske naloge (mentor prof.dr. P. Šivic, somentor Z. Fras).

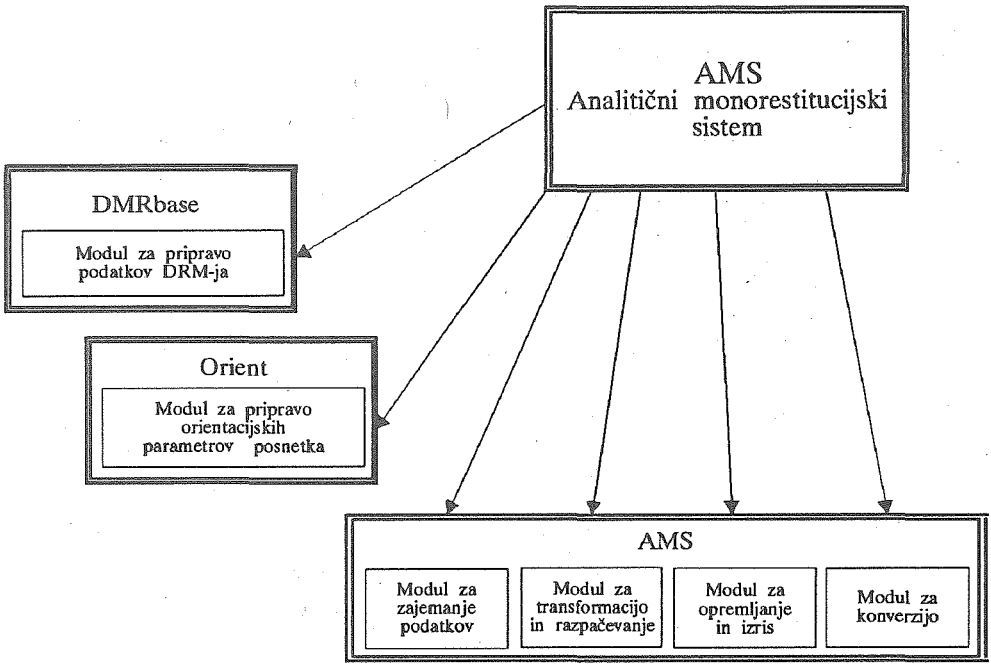
AMS spada med analitične enoslikovne sisteme, kjer predstavlja osnovno delovno enoto en sam posnetek. Z enoslikovnimi postopki ne dosegamo natančnosti, ki jih nudijo postopki stereoizvrednotenja, kar pa za mnoge negeodetske stroke, ki se ukvarjajo s prostorom, niti ni tako pomembno, saj se le-te mnogokrat zadovoljijo že z decimetrsko ali celo metrsko položajno natančnostjo prostorskih informacij. Tovrstni postopki so zanimivi predvsem za stroke, kot so kmetijstvo, gozdarstvo, urbanizem in krajinarstvo, arheologija, ipd. Pri stereoizvrednotenju določimo poljubno prostorsko točko s presekom ustreznega para prostorskih žarkov (homologni žarki), medtem pa pri enoslikovnem izvrednotenju to ni mogoče, saj posamezno prostorsko točko opredeljuje le po en prostorski žarek. Zato potrebujemo še dodatno informacijo o terenu in sicer višinski prikaz terena (DMR). Za delovanje AMS-ja smo uporabili obstoječo republiško bazo podatkov o digitalnem modelu reliefa s 100-metrskimi gridnimi celicami.

Osnovni nalogi, ki ju rešujemo s programskim paketom AMS-ja, sta:

- orientacija posnetka v prostoru
- transformacija vsebine posnetka v odgovarjajočo obliko za kartiranje ali za vzdrževanje položajnih in opisnih baz podatkov.

2. ZGRADBA AMS-JA

Ena od lastnosti AMS-ja je modularna zgradba. Programski paket je sestavljen iz treh samostojnih programskih delov (DMRbase, Orient, AMS), ki vsebujejo enega ali več sistemskih modulov (Slika 1).



Slika 1

3. DELOVANJE AMS-JA

Operativno delo z AMS-jem zahteva naslednje kadre:

- geodetskega strokovnjaka
- strokovnjaka iz negeodetske stroke (uporabnika AMS-ja) in
- operaterja.

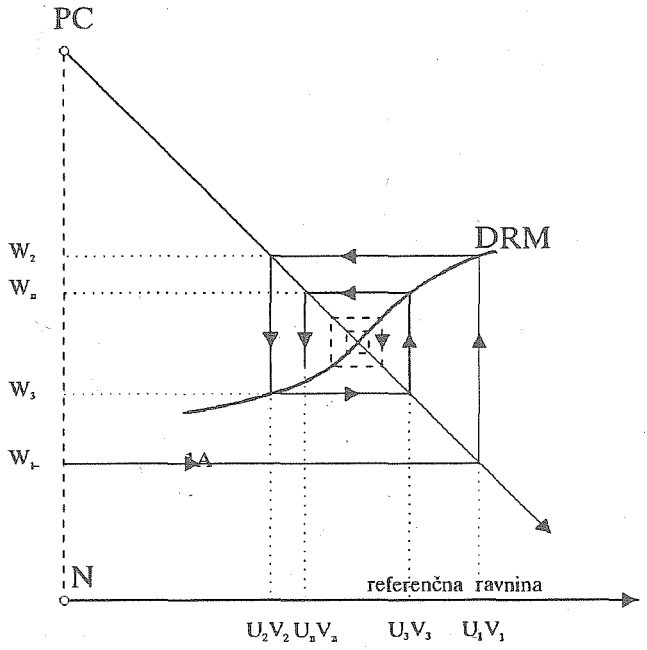
Kadar orientiramo posnetek, na katerem nimamo signaliziranih oslonilnih točk, moramo podatke za orientacijo določiti s pomočjo karte ali načrta (npr. TTN 5) območja, ki je prikazan na posnetku. To pa je velikokrat zelo negotovo, saj smo neposredno odvisni od natančnosti, s katero je bila karta oz. načrt izdelan. Glavni vir kasnejših netočnosti v rezultatih izvrednotenja je treba iskati ravno v fazi orientacije posnetka. Zaradi zahtevnosti faze orientacije posnetka to delo opravlja geodetski strokovnjak. Tu je treba omeniti hitro razvijajočo se tehnologijo GPS-ja (Global Positioning System), ki nam bo v bližnji prihodnosti omogočil enostavno in dovolj

natančno določitev orientacijskih elementov snemalne aerokamere v trenutku ekspozicije posnetka. Eden takšnih sistemov je NAVSTAR GPS (Navigation System with Time and Ranging Global Positioning System), ki so ga razvili na Inštitutu za fotogrametrijo v Stuttgartu (Friess 1987). Tako bo odpravljena tudi potreba po določevanju oslonilnih točk na terenu.

Po opravljeni fazi orientacije posnetka preidemo na drugo glavno nalogo AMS-ja, to je transformacijo prostorskih informacij iz koordinatnega sistema posnetka v referenčni koordinatni sistem (npr. Gauss-Kruegerjev). Za izvedbo prostorske transformacije moramo imeti zbrane podatke:

- o orientaciji posnetka
- o višinski predstavi terena (DMR)
- slikovne koordinate točk vsebine posnetka.

Za prostorsko transformacijo iz slikovnih v terenske koordinate smo uporabili metodo, ki so jo razvili na ITC-ju, Nizozemska (Makarovič 1986) (Slika 2), ter jo dopolnili s postopkom za iskanje preseka prostorskega žarka z DMR-jem.



Slika 2

4. TESTIRANJE AMS-JA

Testiranje sistema smo razdelili v dva dela. V prvem delu testiranja smo preverjali natančnost in zanesljivost numeričnih algoritmov za orientacijo posnetkov in razpačevanje vsebine posnetkov; v drugem delu pa uporabnost sistema (operativnost).

Testirali smo:

- vpliv načina izbora, števila in razporeditve oslonilnih točk na posnetku
- vpliv ločljivosti digitalnika (komparatorja)

- vpliv sprememb v orientacijskih elementih posnetka na rezultat izvrednotenja
- vpliv natančnosti obstoječe baze DMR-ja in
- vpliv velikosti gridne celice DMR-ja.

5. ZAKLJUČEK

AMS se je izkazal primeren predvsem za negeodetske stroke, ki upravljajo s prostorom, same pa ne razvijajo postopkov, kako bi svoje informacije vezale na prostor oz. prostorski koordinatni sistem. S testiranjem smo pokazali, da je natančnost in zanesljivost sistema odvisna predvsem od podatkov DMR-ja in natančnosti izdelave temeljnih topografskih načrtov v merilu 1:5 000 (TTN 5). Oba izvora podatkov sta obremenjena s slučajnimi napakami, ki so ponekod tudi večmetrske, kar močno zmanjšuje možnost uporabe AMS-ja za geodetske namene. Z izdelavo AMS-ja nismo imeli namena, da bi nadomestili dvoslikovne fotogrametrične postopke. Uporabniku smo ponudili operativno, enostavno in cenovno sprejemljivo programsko orodje. Posredna namena, ki smo ju želeli doseči z uveljavitvijo AMS-ja, sta bila popularizacija uporabe DMR-ja in povečanje zanimanja za uporabo aeroposnetkov.

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PHOTOGRAMMETRIC ANALYTICAL MONORESTITUTION SYSTEM

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Abstract

The paper describes analitical monorestitution system (AMS) to be used for topographic applications. Nowadays, stereorestitution procedures are efficiently replaced by monorestitution ones in all cases with allowed minor accuracy.
Keywords: *analitical monorestitution system, digital terrain model (DMR), project ORTO, stereorestitution*

1. INTRODUCTION

In 1990, the Republican Surveying and Mapping Administration (RGU) suggested an elaboration of a methodology for operative realization of surveying tasks within the project entitled Production capability evaluation of agricultural land (Biotechnical Faculty – Agriculture). Within the frame of this project the ORTO research project was to supply the required answers. The project holders were the Inštitut GZ RS and the FAGG – Department for Geodesy. The basic aim of the ORTO project was to elaborate an appropriate system for spatial collection on condition that the regulation restitution accuracy be satisfied. In addition, this system had to be connectable with other systems (e.g. GIS). According to given requirements the AMS software package was made; its conception and elaboration were the subject of my graduation thesis (mentor prof.dr. P. Šivic, co-mentor Z. Fras).

AMS belongs to analytical monorestitution systems, where the basic working unit is represented by only one aereal photograph. Monorestitution systems fail to achieve the accuracy of stereorestitution procedures. Yet for many nonsurveying branches dealing with space this minor accuracy is of no great importance. A decimetre or even metre position accuracy of spatial information is quite satisfactory. So procedures of this kind are interesting above all for branches like agriculture, forestry, urban planning and landscape-gardening, archeology, etc. In a stereorestitution procedure any spatial point can be defined with a resection of an adequate pair of spatial rays (homolog rays), but this is impossible in a monorestitution procedure, where an individual spatial point is defined by only one spatial ray. So additional information about the terrain is needed – DMR. For the AMS application the already established republic database about DMR with 100 m grid cells was used.

Basic tasks the AMS software package is to solve are as follows:

- aerial photograph space orientation
- aerial photograph content's transformation into corresponding shape for plotting or for position and descriptive database maintenance.

2. AMS STRUCTURE

Modular structure is one of the AMS's characteristics. The software package consists of three independent software segments (DMRbase, Orient, AMS), which contain one or more system modules (FIG. 1).

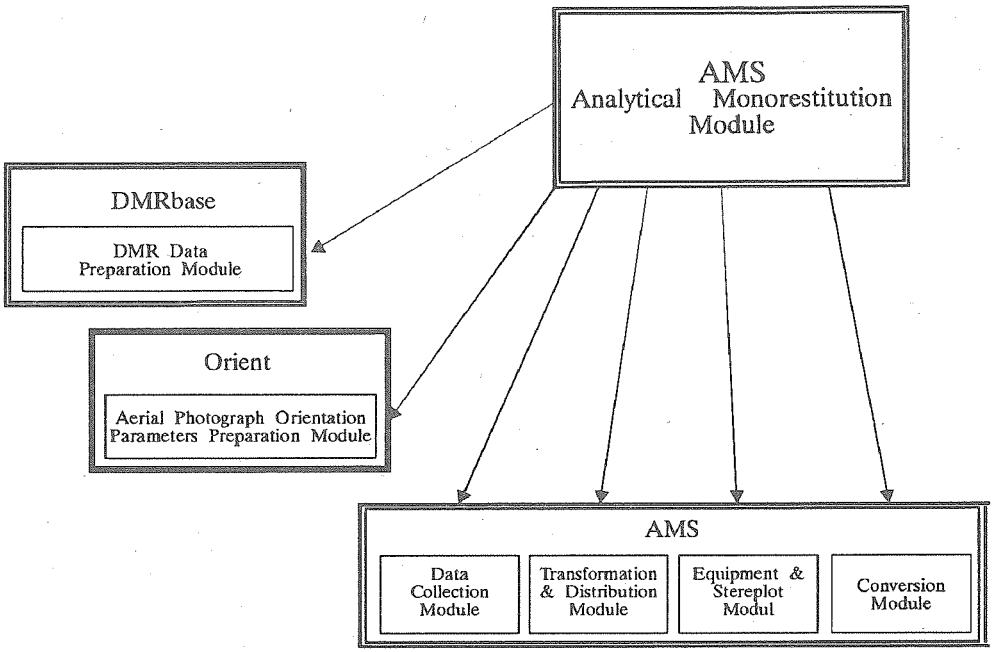

FIG. 1

3. AMS IN OPERATION

The following personnel is needed for AMS to operate:

- a surveying expert
- an expert from a nonsurveying branch (AMS user), and
- an operator.

When orienting an aerial photograph on which there are no control points, data for orientation have to be defined by a map or a plan (e.g. TTN 5) of the area, shown on the aerial photograph. In many cases this turns out to be very uncertain as one directly depends on accuracy with which the map or plan was made. The main source of later restitution results inaccuracy originates in the phase of aerial photograph orientation. Due to the importance of aerial photograph orientation this work is done by a surveying expert. Here I would like to say a word about a rapidly

developing GPS (Global Positioning System) technology, which will enable, in near future, simple and accurate enough definition of oriented elements of air survey camera in the moment of air photograph exposition. One of such systems is the NAVSTAR GPS (Navigation System with Time Ranging Global Positioning System), developed by the Institute of Photogrammetry in Stuttgart, Germany (Friess 1987). In this way the need to define control points on terrain becomes redundant.

The phase of aerial photograph orientation accomplished, the second main task of the AMS follows, e.g. the transformation of spatial information from aerial photograph coordinate system into reference coordinate system (e.g. Gauss-Krueger). For the realization of the spatial transformation following data have to be collected:

- aerial photograph orientation data
- DMR
- picture points' coordinates of aerial photograph contents.

For spatial transformation from picture to ground coordinates a method developed by ITC, the Netherlands has been used (Makarovič 1986) (FIG. 2). We contributed a procedure for spatial ray resection retrieval from DMR.

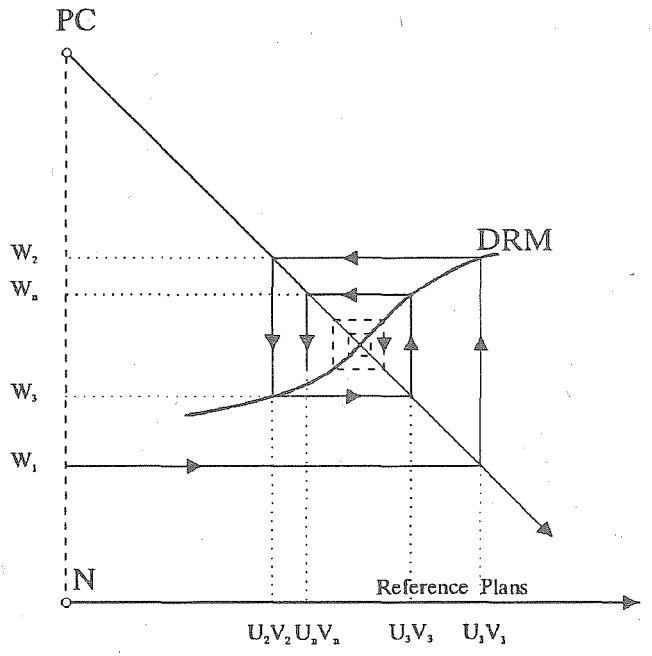

FIG. 2

4. TESTING AMS

The system testing was divided into two parts. The first part of testing was to check accuracy and reliability of numerical algorithms for aerial photograph orientation and aerial photograph contents' dispatch; in the second part the applicability of the system was tested.

Tested items:

- effect of the method of choice, number and reclassification of control points on aerial photographs
- effect of digitizer (comparator) resolving power
- effect of changes in aerial photograph orienting elements on restitution result
- effect of accuracy of the existing DMR database
- effect of size of DMR grid cell.

5. SUMMARY

The AMS system proved appropriate especially for nonsurveying branches dealing with space management but not developing their own procedures with which to connect their information to space e.g. to space coordinate system. Tests proved that system accuracy and reliability mostly depend on DMR data and on the accuracy of map elaboration 1:5 000 (TTN 5). Both data sources are accidental errors burdened, errors reaching in some cases a few metres, thus highly reducing AMS application possibilities for surveying purposes. The intent of the AMS elaboration was by no means the replacement of stereorestitution photogrammetric procedures. The offer to users was an operative, simple and pricely acceptable software tool. Indirect aims to be achieved by AMS were to popularize the use of DMR and to spur interest in aerial photographs.

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