

# A Brief History of Photogrammetry in Croatia

## The Beginnings of Photogrammetry

A. Laussedat is considered to be the father of photogrammetry. In 1851, using the method of the Swiss mathematician J. H. Lambert (Freye Perspective, Zürich, 1759), he reconstructed a recorded object from two photographs. He called the method "Métrophotographie", and the result was years of research into constructions based on a topographic table and a camera obscura. According to the available literature, the term photogrammetry was first used in science by W. Jordan in 1876 for the professional field of "indirect measurement of spatial objects using photography". From 1883, mathematician G. Hauck published a series of articles in which he researched and analysed two projections/perspectives on the basis of descriptive geometry. Already in the title of the first and in the text, the term "Photogrammetrie" appears as a generally accepted term. Today, in the Croatian scientific classification, Photogrammetry is a branch in the field of Geodesy, a scientific field of Technical Sciences.

The first book/textbook on photogrammetry was printed in Weimar in 1889 by C. Koppe, the second in Vienna in 1891 (authored by F. Steiner, professor at the Technical University in Prague), and already in 1897 in Križevci the book "Fotogrametrija i praktični dio tahimetrije" (Photogrammetry and the Practical Part of Tachymetry) was printed, written in Croatian by the nobleman Franjo Kružić, professor at the Royal College of Economics and Forestry, civil engineer. In 1901, C. Pulfrich constructed the first stereo comparator, a device for measuring image coordinates. Analytical stereo instruments and systems (Leica SD3000, Zeiss P-Series Planicomp...), developed before the advent of digital photogrammetric workstations, are based on the same principles in terms of construction.

## Teaching Photogrammetry in Croatia

As elsewhere in the world, photogrammetry was first developed at universities in Croatia. According to the above-mentioned book by F. Kružić, photogrammetry was apparently taught before 1897 at the School of Economics and Forestry in Križevci. In 1898, the school of forestry was transferred to Zagreb, where the Forestry

Academy was opened. In 1908 a special Geodetic course was established there, which was transferred to the newly founded Technical High School in 1919. In 1920, in the Scientific Fundamentals of the Geodetic and Engineering Department of the Technical High School, Photogrammetry was a subject in the second year, and it was recorded that it was taught by Prof. A. Fasching (1923-1927). In 1926, the Technical High School became part of the University of Zagreb as the Technical Faculty. From 1927 to 1942, photogrammetry was taught by Prof. N. Abakumov at the Department of Applied Geodesy. From 1943 to 1946, with an interruption in the 1944/1945 academic year, photogrammetry was taught part-time by F. Braum. In 1947, with the establishment of the Department of Photogrammetry and the appointment of F. Braum as its head (in the same year he was also appointed head of the Institute of Photogrammetry), intensive development of photogrammetry in Croatia began. In 1956, the Technical Faculty was divided into the Faculty of Architecture, Civil Engineering and Geodesy, and in 1962, through further division, the independent Faculty of Geodesy was established. By the 1975 statute, the chairs were abolished, and the Institute of Photogrammetry became one of the basic scientific and educational organizational units of the Faculty, and the lecturers were F. Braum, V. Donassy, K. Šmit and J. Pleško. After 65 years of successful independent work, the realisation of numerous photogrammetric tasks and projects, the education of generations of photogrammetric experts and the training of photogrammetric facilities for work, the Institute of Photogrammetry was abolished in 2006. Today (2025) photogrammetry is taught in a series of subjects (Photogrammetry, Remote Sensing, Image Surveying, Close Range Photogrammetry) at the new Chair of Photogrammetry and Remote Sensing, while professional and scientific projects are carried out at the Institute of Cartography and Photogrammetry.

## The Position of Croatian Geodesy between the Two Wars

After the 'unification' of 1918, the administration of the entire cadastre was centralized at the Ministry of Finance (Department of Cadastre and State Property). Belgrade devoted all its attention and work to the new

# Kratka povijest fotogrametrije u Hrvatskoj

## Počeci fotogrametrije

Ocem fotogrametrije smatra se A. Laussedat koji je 1851. godine koristeći metodu švicarskog matematičara J. H. Lamberta (Freye Perspective, Zürich, 1759), iz dvije fotografije rekonstruirao snimljeni objekt. Metodu je nazvao "Metrophotographie", a rezultat su godine istraživanja konstrukcija baziranih na topografskom stolu i cameri obscuri. Pojam fotogrametrija, prema dostupnoj literaturi, prvi je u znanosti upotrebio W. Jordan 1876. godine za stručno područje "indirektnog mjerenja prostornih objekata pomoću fotografije". Od 1883. godine matematičar G. Hauck objavljuje niz članaka u kojima istražuje i analizira dvije projekcije/perspektive na temeljima deskriptivne geometrije. Već u naslovu prvoga, a i u tekstu pojavljuje se pojam "Photogrammetrie" kao opće prihvaćena odrednica. Danas, u hrvatskoj znanstvenoj klasifikaciji Fotogrametrija je grana polja Geodezije, znanstvenog područja Tehničkih znanosti.

Prva knjiga/udžbenik fotogrametrije tiskana je u Weimaru 1889. godine, autor je C. Koppe, druga u Beču 1891. godine (autor je F. Steiner profesor na Tehničkoj visokoj školi u Pragu), a već 1897. godine u Križevcima tiskana je knjiga "Fotogrametrija i praktični dio tahimetrije" koju je napisao na hrvatskom jeziku Franjo pl. Kružić "profesor u kr. gosp. i šumarskom učilištu, civ. Ingenieur". Godine 1901. C. Pulfrich konstruira prvi "Stereokomparator", uređaj za mjerenje slikovnih koordinata. Analitički stereoinstrumenti i sustavi (SD3000 Leica, P-Series Planicomp Zeiss...), razvijani sve do pojave digitalnih fotogrametrijskih radnih stanica, temelje se konstrukcijski na istim principima.

## Nastava fotogrametrije u Hrvatskoj

Kao i u svijetu, fotogrametrija se u Hrvatskoj prvo razvijala na učilištima. Prema gore navedenoj knjizi F. Kružića fotogrametrija se očito predavala prije 1897. godine na Gospodarskom i šumarskom učilištu u Križevcima. Godine 1898. šumarska nastava je prenesena u Zagreb gdje je otvorena Šumarska akademija i na njoj je 1908. godine ustrojen poseban Geodetski tečaj koji je 1919. priključen novoosnovanoj Tehničkoj visokoj školi. Godine 1920. u "Naučnim osnovama geodetsko-inženjerskog

odjela" Tehničke visoke škole Fotogrametrija je predmet u drugoj godini, a zabilježeno je da ju je predavao prof. A. Fasching (1923-1927). Tehnička visoka škola 1926. godine ulazi u sastav zagrebačkog Sveučilišta kao Tehnički fakultet. Od 1927. do 1942. godine Fotogrametriju predaje prof. N. Abakumov na Katedri za primjenu geodeziju. Od 1943. do 1946. godine, s prekidom ak. god. 1944/1945, fotogrametriju predaje honorarno F. Braum. Godine 1947. osnivanjem Katedre za fotogrametriju i postavljenjem F. Brauma za njezina šefa (iste godine postavljen je i za predstojnika Zavoda za fotogrametriju) započinje intenzivan razvoj fotogrametrije u Hrvatskoj. Godine 1956. Tehnički fakultet se dijeli pa nastaje Arhitektonsko-građevinsko-geodetski fakultet i daljnjom podjelom 1962. godine samostalni Geodetski fakultet. Statutom iz 1975. godine ukinute su katedre i Zavod za fotogrametriju postaje jednom od osnovnih znanstveno-nastavnih organizacijskih jedinica Fakulteta, a nastavnici su uz F. Brauma, V. Donassy, K. Šmit i J. Pleško. Nakon 65 godina uspješnog samostalnog rada, izradi mnogobrojnih fotogrametrijskih zadataka i projekata, odgoja generacija fotogrametrijskih stručnjaka i osposobljavanja fotogrametrijskih pogona za rad, 2006. godine ukinut je Zavod za fotogrametriju. Danas (2025) fotogrametrija se predaje u nizu predmeta (Fotogrametrija, Daljinska istraživanja, Izmjera snimki, Blizupredmetna fotogrametrija) na novoj Katedri za fotogrametriju i daljinska istraživanja, a stručni i znanstveni projekti izvode se u Zavodu za kartografiju i fotogrametriju.

## Položaj hrvatske geodezije između dva rata

Nakon 'ujedinjenja' 1918. godine centralizirana je uprava cijelog katastra kod Ministarstva financija (Odeljenje katastra i državnih dobara). Beograd je svu pažnju i rad posvetio novoj izmjeri Srbije, sa stavom da u prvom redu treba izvršiti izmjeru u krajevima Jugoslavije gdje je nema. Na novoj izmjeri Srbije radio je nemali broj geodetskih stručnjaka iz Hrvatske pa je tako posebno zaslužan za djelomični uspjeh trećeg (prvo snimanje izvedeno je 1930) probnog aerofotogrametrijskog snimanja općine Mlado Nagoričano (1937) ing. Branko Borčić (kasnije profesor na Geodetskom fakultetu u Zagrebu). Kartiranje



**Fig. 1** WILD A7 Autograph.  
**Slika 1.** Autograf WILD A7.



**Fig. 2** WILD A8 Autograph with an automatic register and a plotter table.  
**Slika 2.** Autograf WILD A8 sa automatskim registratorom i stolom za iscrtavanje (ploterom).

survey of Serbia, with the position that the survey should first be carried out in the areas of Yugoslavia where it does not exist. A large number of geodetic experts from Croatia worked on the new survey of Serbia, and thus, engineer Branko Borčić (later a professor at the Faculty of Geodesy in Zagreb) is particularly responsible for the partial success of the third (the first survey was carried out in 1930) trial aerial photogrammetric survey of the municipality of Mlado Nagoričano (1937). The mapping was carried out on the newly acquired Stereoplanigraph (made by Zeiss-Aerotopograph) of the Military Geographical Institute in Belgrade. Although problematic, the results of this trial work opened the door to a new surveying method. The implementation of the Decision of the Department of Cadastre and State Property on the acquisition of a certain number of automatic stereophotogrammetric instruments prevented the war.

In the period up to 1939, when the Banovina of Croatia was founded, the cadastre in Croatia was completely neglected (only in 1929 were 15 cadastral administrations established with too few professional staff, primarily responsible for land tax and managing state property). From the foundation of the Banovina, Croatian surveyors (organized in professional surveying associations) strived to have the cadastral competences transferred in full from the Ministry of Finance to the Ban's authority in Zagreb. With the transfer of documentation/registers to Croatia and the division of property, staff and financial resources of the Cadastre Department in Belgrade, the prerequisites were created for the development of the geodetic profession, and thus photogrammetry in Croatia. The process of decentralization, which was

under way, was interrupted by the collapse of the common state and World War II.

### The beginnings of photogrammetry in Croatia

There are few written documents about photogrammetry in Croatia before the World War II, but its application existed, so we will cite the information we know:

- In 1929 and 1930, aerial imaging of the wider area of the city of Zagreb was carried out, and it was carried out 'with its own planes and cameras' by the 1st Airborne Regiment from Novi Sad, commissioned by the 'Government of the Free and Royal Capital of Zagreb for the purposes of creating a general regulatory plan'. It was taken from a height of 3,000 meters and photomosaics were made at an approximate scale of 1:10,000 (10 of them were made, laminated on cardboard in three parts). The enlarged images are not uniform in contrast, the sharpness is poor and the editing is poor even in the lowland area (with jumps of up to 70 m in the inner city and up to 250 meters outside the city area).
- In 1936, according to the records of W. Mecking (Wild's repairman), a Wild A5 autograph was installed in Split (probably in the Hydrographic Office, which has been the navy Hydrographic Institute since 1937).
- In 1939, probably the Military Geographical Institute from Belgrade recorded the Sava River from Podsused to Ivanja Reka from a height of 2100 meters. A photomosaic was made at an approximate scale of 1:10,000, laminated onto cardboard in 20 parts, approximately A4 format. The photomosaic is photographically flawlessly made, with even tones and minimal fading, and shows the state of the Sava River flow after regulation.



izvedeno je na, tek nabavljenom, Stereoplanigraphu (tvrtke Zeiss-Aerotopograph) Vojnogeografskog instituta u Beogradu. Iako problematični, rezultati toga probnog rada otvorili su vrata novoj metodi snimanja. Provođenje Odluke Odeljenja katastra i državnih dobara o nabavci izvjesnog broja automatskih stereofotogrametrijskih instrumenata, spriječio je rat.

U razdoblju do 1939. godine, kad je osnovana Banovina Hrvatska, katastar u Hrvatskoj je potpuno zanemaren (tek 1929. godine osnovano je 15 katastarskih uprava s premalo stručnog osoblja i s prvenstvenim zaduženjima oko zemljarine i rukovanju državnim dobrima). Od osnivanja Banovine hrvatski geodeti (organizirani u stručnim geodetskim društvima) nastojali su da se kompetencije katastra u cijelosti prenesu iz Ministarstva financija na Bansku vlast u Zagrebu. S prijenosom dokumentacije/operata u Hrvatsku i podjelom imovine, osoblja i financijskih sredstava Odeljenja katastra u Beogradu stvorili bi se preduvjeti za razvoj geodetske struke, a time i fotogrametrije u Hrvatskoj. Proces decentralizacije, koji je bio u toku prekinut je raspadom zajedničke države i II. svjetskim ratom.

## Počeci fotogrametrije u Hrvatskoj

O fotogrametriji u Hrvatskoj prije II. svjetskog rata malo je pisanih dokumenata, ali je primjena postojala pa navodimo poznate podatke:

- Godine 1929. i 1930. izvedeno je aerosnimanje šireg područja grada Zagreba, a izveo ga je 'svojim avionima i kamerama' 1. vazduhoplovni puk iz Novog Sada po narudžbi 'Poglarstva slobodnog i kr. glavnog grada Zagreba za potrebe izradbe generalnog regulacionog plana'. Snimano je s visine od 3000 metara i izrađeni su fotomozaici u približnom mjerilu 1:10 000 (napravljeno ih je 10, kaširani su na kartonu u tri dijela). Uvećane snimke nisu kontrastno ujednačene, slabe su oštine i montaža je loša čak i u nizinskom području (sa skokovima do 70 m u intravilanu i do 250 metara u ekstravilanu).
- Godine 1936., prema zapisu W. Meckinga (servisera Wilda), u Splitu je instaliran autograf A5 tvrtke Wild (vjerojatno u Hidrografskom uredu koji je od 1937. godine Hidrografski institut mornarice).
- Godine 1939., vjerojatno Vojno-geografski institut iz Beograda, snima rijeku Savu od Podsuseda do Ivanje Reke s visine 2100 metara. Izrađen je fotomozaik u približnom mjerilu 1:10 000, kaširan na karton u 20 dijelova, približnog formata A4. Fotomozaik je fotografski besprijekorno izrađen s izjednačenim tonovima i minimalno izbljedio, a pokazuje stanje toka rijeke Save nakon regulacije.
- Poslije II. svjetskog rata u Vodnoj zajednici u Donjem Miholjcu pronađen je fotogrametar (stari naziv za fotogrametrijsku kameru) O. Neya iz Berlina (vjerojatno iz 1910. godine). Očito se netko u Hrvatskoj u praksi dosta rano bavio fotogrametrijom.

O stanju fotogrametrije u Hrvatskoj piše F. Braum u Geodetskom listu (1941) "od svih naroda, s kojima se uobičajemo upoređivati, mi smo Hrvati u tom pogledu upravo zadnji".

Pitanje uvođenja fotogrametrije u civilnu geodeziju u Hrvatskoj pokrenuo je prof. S. Horvat, a početci su osmišljeni i započeti na Geodetsko-kulturnotehničkom odjelu Tehničkog fakulteta Sveučilišta u Zagrebu pa je 1941. godine na Katedri za primijenjenu geodeziju osnovan i Zavod za fotogrametriju, sa zadatkom razvijanja i uvođenja fotogrametrije u praksu. Nakon rata inicijativa na Fakultetu se nastavlja, osniva se Katedra za fotogrametriju (1947) i za njezina šefa postavlja docent F. Braum koji sa skromnom fotogrametrijskom opremom izvodi praktičnu nastavu iz fotogrametrije (Geodetska uprava NR Hrvatske ustupila je Zavodu Aeroprojektor Multiplex i ogledalni stereoskop s mikrometrom, a Rudarski odjel fototeodolit TAN i stereokomparator Pulfricha, sve od tvrtke Zeiss-Aerotopograph).

## Uvođenje fotogrametrije kao nove metode izmjere

Godine nakon završetka II. svjetskog rata s oskudicom deviznih sredstava nisu pogodovale nabavci skupe fotogrametrijske opreme (automatskih stereoinstrumenata), nužne za praktično uvođenje fotogrametrije u geodetsku praksu, pa je prof. F. Braum (predstojnik Zavoda za fotogrametriju), tražio podršku Elektroprivrede, Uprave za šumarstvo, Uprave za ceste, Vodoprivrede i IPZ-a. Uz zagovor političara B. Bakrača, tek 1955. godine nabavlja prve automatske stereoinstrumente autografe A7 (sl.1) i A8 (sl.2) švicarske tvrtke Wild. Oba su instalirana u suterenu zgrade Tehničkog fakulteta u posebno adaptiranoj prostoriji (duboko temeljena postolja, dvostruka vrata).

Odmah nakon montaže/instalacije oba instrumenta koriste se intenzivno za već ranije pripremljene zadatke kartiranja (prvi zadatak je topografska karta u mjerilu 1:10 000 i plan u mjerilu 1:2500 za projektiranje ceste kroz Plitvička jezera) i obuku stručnjaka geodetske operative za buduće restitute. Dobra pripremljenost stručnjaka Zavoda omogućila je odmah komercijalno korištenje kapaciteta oba instrumenta pa je višak kapaciteta (radilo se u dvije smjene), koji je preostao nakon nastavne i znanstvene djelatnosti, iskorišten za kartiranje velikih zadataka (izrada topografskih karata u mjerilima 1:5000 i 1:10 000 slivova Kupe-Korane, Cetine, Lonjskog polja, Zapadne pustinje u Egiptu). Iz ekonomske analize izvedenih radova za vremensko razdoblje od 1956. do 1961. godine proizlazi da se autograf A7 amortizirao na razlici troškova između fotogrametrijske i restričke topografske izmjere što i bez velike uštede na vremenu opravdava investiranje u skupu fotogrametrijsku opremu. Neusporedivo veći doprinos napretku tehnike je u primjeni fotogrametrije u drugim tehničkim i

- After World War II, a photogrammeter (the old name for a photogrammetric camera) by O. Ney from Berlin (probably from 1910) was found in the water-works company (Vodna zajednica) in Donji Miholjac. Apparently, someone in Croatia was engaged in photogrammetry in practice quite early on.

F. Braum writes about the state of photogrammetry in Croatia in Geodetski list (1941) that "of all the nations with which we are accustomed to compare ourselves, we Croats are precisely the last in this respect".

The issue of introducing photogrammetry into civil geodesy in Croatia was raised by Prof. S. Horvat, while its beginnings were conceived and started at the Geodetic and Cultural Engineering Department of the Technical Faculty of the University of Zagreb. In 1941, the Institute of Photogrammetry was founded at the Department of Applied Geodesy, with the task of developing and introducing photogrammetry into practice. After the war, the initiative at the Faculty continued, the Chair of Photogrammetry was established (1947) and Assist. Prof. F. Braum was appointed as its head. He conducted practical classes in photogrammetry with modest photogrammetry equipment (the Geodetic Administration of the People's Republic of Croatia gave the Institute a Multiplex Aeroprojector and a mirror stereoscope with a micrometre, and the Mining Department a TAN phototheodolite and a Pulfrich stereocomparator, all from the Zeiss-Aerotopograph company).

### Introduction of Photogrammetry as a New Surveying Method

The years after the end of the World War II, with a shortage of foreign currency, were not conducive to the acquisition of expensive photogrammetric equipment (automatic stereo instruments), necessary for the practical introduction of photogrammetry into geodetic practice, so Prof. F. Braum (head of the Institute of Photogrammetry) sought support from Elektroprivreda (electric power company), the Forestry Administration, the Road Administration, Vodoprivreda (water management company) and the Engineering Project Institute – IPZ. With the intercession of politician B. Bakrač, it was not until 1955 that he acquired the first automatic stereo instruments, the A7 (Fig. 1) and A8 (Fig. 2) Autographs from the Swiss company Wild. Both were installed in the basement of the Technical Faculty building in a specially adapted room (deep base pedestals, double doors).

Immediately after assembly/installation, both instruments were used intensively for previously prepared mapping tasks (the first task was a topographic map at a scale of 1:10,000 and a plan at a scale of 1:2,500 for designing a road through the Plitvice Lakes) and training of geodetic operational experts as future restitutors. The good preparation of the Institute's experts enabled

the immediate commercial use of the capacities of both instruments, so the excess capacity (work was done in two shifts), which remained after teaching and scientific activities, was used for mapping large tasks (production of topographic maps at scales of 1:5,000 and 1:10,000 of the Kupa-Korana and Cetina drainage basins, Lonjsko Polje and the Western Desert in Egypt). The economic analysis of the work carried out for the period from 1956 to 1961 shows that the A7 autograph was depreciated on the difference in costs between photogrammetric and terrestrial topographic surveys, which, even without a significant saving in time, justifies investing in expensive photogrammetric equipment. An incomparably greater contribution to the advancement of technology is the application of photogrammetry in other technical and related areas (protection of monumental heritage, archaeology, urban planning, road design, medicine, forestry, etc.), in which the Institute has been a leader in this part of Europe for years.

Prof. F. Braum continued the campaign to procure photogrammetric instruments. With the arguments of an economic cost-effectiveness analysis, and with the support of the political leadership of Croatia (V. Bakarić), he secured financial resources, and despite the obstruction of the Main Geodetic Administration in Belgrade (D. Milačić), the Croatian geodetic operations received three more A8 autographs (1961). It is interesting to mention the involvement of Prof. F. Braum regarding these purchases in Switzerland, where he arranged for the compensatory export of Dalmatian wine (photogrammetric instruments for wine).

### Photogrammetric Plants and Companies

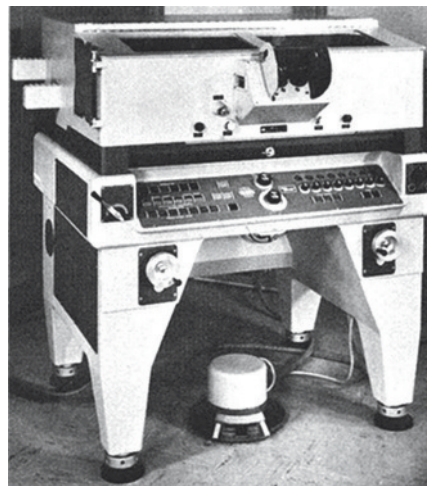
Until the completion of the reform of the geodetic service, the stereo instruments were located at the Faculty of Architecture (Kačićeva 26), and the staff of the Land Survey Office of the Geodetic Administration of the People's Republic of Croatia worked, under the supervision of the Institute's experts, on a new topographic and cadastral survey.

With the reform of the geodetic service (1961), an enterprise of special social interest was established, the Institute of Photogrammetry in Zagreb, and four Land Survey Institutes in Zagreb, Osijek, Rijeka and Split. The Land Survey Institute in Zagreb has since closed down, while the other, former land survey institutes continued their successful business activities as Geodetic Institutes in Osijek, Rijeka and Split, introducing photogrammetric surveying methods into their operations, as follows:

- The Geodetic Institute in Rijeka by acquiring the first analytical stereo instrument AP-C/2 from the OMI company (1971). The instrument was particularly interesting because its design was far ahead of its time; its high measurement accuracy was ensured by a stereo



**Slika 3.** WILD A10 autograph.  
**Fig. 3** Autograf WILD A10.



**Slika 4.** Analitički stereoinstrument OMI AP-C/2.  
**Fig. 4** OMI AP-C/2.

srodnim područjima (zaštiti spomeničke baštine, arheologiji, urbanizmu, projektiranju prometnica, medicini, šumarstvu i dr.) u čemu je Zavod godinama prednjačio u ovom dijelu Europe.

Prof. F. Braum nastavio je akciju nabavke fotogrametrijskih instrumenata. S argumentima ekonomske analize isplativosti, uz podršku političkog vrha Hrvatske (V. Bakarić), osigurao je financijska sredstva, i unatoč opstrukcije Glavne geodetske uprave u Beogradu (D. Milačić), geodetska operativa Hrvatske dobila je još tri autografa A8 (1961). Zanimljivo je spomenuti angažiranost prof. F. Brauma oko tih nabavki i u Švicarskoj, gdje je dogovorio kompenzacijski izvoz dalmatinskog vina (fotogrametrijski instrumenti za vino).

### Fotogrametrijski pogoni i tvrtke

Do završetka reforme geodetske službe stereoinstrumenti su se nalazili na AGG fakultetu (Kačićeva 26), a osoblje Ureda za izmjeru zemljišta Geodetske uprave NR Hrvatske radilo je, pod nadzorom stručnjaka Zavoda, na novoj topografsko-katastarskoj izmjeri.

Reformom geodetske službe (1961) osnovano je poduzeće od posebnog društvenog interesa Zavod za fotogrametriju u Zagrebu i četiri Zavoda za izmjeru zemljišta u Zagrebu, Osijeku, Rijeci i Splitu. Zavod za izmjeru zemljišta u Zagrebu se u međuvremenu ugasio, dok ostali, tadašnji zavodi za izmjeru zemljišta nastavljaju uspješno poslovanje kao Geodetski zavodi, u Osijeku, Rijeci i Splitu

i uvode fotogrametrijske metode izmjere u svoje poslovanje, i to:

- Geodetski zavod u Rijeci nabavkom prvog analitičkog stereoinstrumenta AP-C/2 tvrtke OMI (1971). Instrument je bio posebno interesantan jer je po konstrukciji bio daleko ispred svoga vremena, visoku točnost mjerenja osiguravao je stereokomparator, a podatke obrađivalo računalo (Bendix). Izlazni podatci su bili analogni jer digitalne u to vrijeme nije nitko mogao koristiti.
- Geodetski zavod u Splitu nabavkom autografa A10 tvrtke Wild (1971)
- Geodetski zavod u Osijeku nabavkom autografa A10 tvrtke Wild (1972)
- Zavod za katastar i geodetske poslove grada Zagreba nabavkom autografa A10 tvrtke Wild (1974)

Geodetski zavodi u Rijeci i Splitu danas koriste suvremene digitalne metode fotogrametrijske izmjere. Geodetski zavod u Osijeku je zapao u stečaj 2016. godine.

Šezdesetih godina, osim topografsko-katastarskih planova većih gradova i naselja, započeli su sustavni radovi na izradi Osnovne državne karte u mjerilu 1:5000 (u početku kombinirano s plošnim nivelmanom, kasnije isključivo fotogrametrijski), a izvode se radovi i u inozemstvu (Geodetski fakultet u Alžiru, Burmi, Egiptu, Iranu i Tunisu, Zavod za fotogrametriju u Libiji). Godine 1969. Policija (tadašnji Sekretarijat unutrašnjih poslova SR Hrvatske) nabavlja fotogrametrijsku opremu za snimanje prometnih nesreća (stereokamere C40 i C120 te autograf A40 tvrtke Wild).



comparator, while the data was processed by a computer (Bendix). The output data was analogue because no one could use digital data at that time.

- The Geodetic Institute in Split by purchasing a Wild A10 autograph (1971)
- The Geodetic Institute in Osijek by purchasing a Wild A10 autograph (1972)
- The City of Zagreb Office for Cadastre and Geodetic Affairs by purchasing a Wild A10 autograph (1974)

The Geodetic Institutes in Rijeka and Split today use modern digital methods of photogrammetric surveying. The Geodetic Institute in Osijek went bankrupt in 2016.

In the 1960s, in addition to topographic and cadastral plans of larger cities and settlements, systematic work began on the creation of the Basic State Map at a scale of 1:5,000 (initially combined with levelling, later exclusively photogrammetric), and work was also carried out abroad (Faculty of Geodesy in Algeria, Burma, Egypt, Iran and Tunisia, Institute of Photogrammetry in Libya). In 1969, the Police (then Secretariat of Internal Affairs of the Socialist Republic of Croatia) purchased photogrammetric equipment for recording traffic accidents (Wild C40 and C120 stereo cameras and the A40 Autograph).

In the 1970s, the Faculty of Geodesy carried out significant work on terrestrial photogrammetric surveying of cultural monuments (the city of Zagreb, Dubrovnik and Budva after the catastrophic earthquake on the Montenegrin coast in 1979), developed an inverse photogrammetry analytical method (future objects on the 'northern tangent' in Zagreb), and used the first satellite images (Landsat-3). Following such activities, the 5th International Symposium for Photogrammetry in Architecture and Conservation of Monuments was held in Šibenik in 1978, organized by the Faculty of Geodesy, University of Zagreb (formally the Association of Geodetic Engineers and Surveyors of Yugoslavia), which gave Croatian photogrammetry the deserved recognition of ICOMOS and CIPA. The Symposium papers were published in the Proceedings (31 foreign and 3 domestic authors). After the first agreements in 1976 (V. Donassy, B. Košćec and Z. Tomašegović), in 1979 the Council for Remote Sensing and Photointerpretation of the Yugoslav Academy of Sciences and Arts was founded (today the Scientific Council for Remote Sensing of the Croatian Academy of Sciences and Arts), which, in addition to surveyors/photogrammetrists, brings together experts from the fields of archaeology and historical heritage, geophysics, geography, geology, hydrometeorology, hydrotechnics, engineering design, oceanography, pedology, agriculture, spatial planning, forestry and environmental protection. On the occasion of the publication of the book by nobleman F. Kružić (1897), the Council organized an international scientific conference

in Zagreb in 1998 entitled "One Hundred Years of Photogrammetry in Croatia" and published Proceedings in which the lectures given at the conference were printed (11 foreign and 35 domestic titles, 51 authors).

### Introduction of Computers to Photogrammetry

Photogrammetric companies initially used analogue stereo instruments, except for the Geodetic Institute in Rijeka, which from the very beginning used the OMI AP-C/2 analytical photogrammetric stereo instrument. In the 1970s, more than a decade before the advent of the PC (the first Personal Computer came out of IBM's workshops on 12 August 1981) and before operations were able to use numerical data from measurement and mapping records, analogue stereo instruments were upgraded with devices for automatic registration of model coordinates (in 1970, the Institute of Photogrammetry purchased the EK5 recorder, and in 1975, the Faculty of Geodesy purchased the EK22, both from Wild). Data was stored on paper punched tapes, punched cards and magnetic tapes. Calculations were first performed on computers at the Faculty of Electrical Engineering, and later at the University Computing Centre. As early as 1980, a Hewlett-Packard 9845S desktop computer (acquired in 1978 at the Faculty of Geodesy) was connected to the autograph via EK22 and the first, fully automatic, numerical mappings were performed. Until the appearance of the first operational, commercial computer and graphics programs that could be used for photogrammetric needs, a whole series of mostly interactive programs was developed, first on HP and later on PC, including programs for absolute model orientation, calculation of aerotriangulation of a series of independent models, transformations, displacement vectors, off-line mapping, calculation of perspective, etc. Analogue stereo instruments with built-in A/D converters on measurement spindles were successfully used for numerical mapping (analogue analytical hybrid systems; after classical relative orientation, absolute orientation and mapping were performed on a PC), until the use of analytical or digital photogrammetric workstations. In most facilities, the ISM SystemMap program and the Bentley MicroStation were used (the first installations in 1991 were on the A7 and A8 autographs of the Faculty of Geodesy).

### Analytical and Digital Photogrammetry

In the 1990s, several analytical stereo instruments were purchased (Leica BC3/Aviolyt in 1991 at the Faculty of Geodesy, Leica SD 3000 in 1996 at the Rijeka Institute of Geodesy and the Split Institute of Geodesy) and the first digital photogrammetric systems (DVP, a gift from Leica in 1993 and Intergraph ImageStation Z in 1997 at

Sedamdesetih godina na Geodetskom fakultetu izvode se značajni radovi terestričkog fotogrametrijskog snimanja spomenika kulture (grad Zagreb, Dubrovnik i Budva nakon katastrofalnog potresa u Crnogorskom primorju 1979. godine), razvijena je analitička metoda inverzne fotogrametrije (budući objekti na 'sjevernoj tangenti' u Zagrebu), koriste se prve satelitske snimke (Landsat-3). Slijedom takvih aktivnosti 1978. godine u Šibeniku je održan 5. internacionalni simpozij za fotogrametriju primijenjenu u arhitekturi i zaštiti spomenika kulture u organizaciji Geodetskog fakulteta Sveučilišta u Zagrebu (formalno Saveza geodetskih inženjera i geometara Jugoslavije), čime je hrvatskoj fotogrametriji iskazano zasluženno priznanje ICOMOS-a i CIPA-e. Radovi simpozija tiskani su u Zborniku (31 stranih i 3 domaća autora). Nakon prvih dogovora 1976. godine (V. Donassy, B. Koščec i Z. Tomašegović) 1979. godine osnovan je Savjet za daljinska istraživanja i fotointerpretaciju JAZU (danas Znanstveno vijeće za daljinska istraživanja HAZU) koji osim geodeta/fotogrametara okuplja stručnjake iz područja arheologije i povijesnog nasljeđa, geofizike, geografije, geologije, hidrometeorologije, hidrotehnike, inženjerskog projektiranja, oceanografije, pedologije, poljoprivrede, prostornog planiranja, šumarstva i zaštite okoliša. Povodom izlaska iz tiska knjige F. pl. Kružića (1897), Vijeće je 1998. godine u Zagrebu organiziralo međunarodni znanstveni skup pod nazivom "Sto godina fotogrametrije u Hrvatskoj" i izdalo Zbornik radova u kojem su tiskana predavanja održana na skupu (11 stranih i 35 domaćih naslova, 51 autora).

### Uvođenje računala u fotogrametriju

Fotogrametrijske tvrtke su u svojim počecima koristile analogne stereoinstrumente, osim Geodetskog zavoda u Rijeci, koji je od samih početaka koristio analitički fotogrametrijski stereoinstrument OMI AP-C/2. Sedamdesetih godina, više od desetljeća prije pojave PC-a (12. kolovoza 1981. godine iz IBM-ovih radionica izašao je prvi Personal Computer) i prije nego je operativna bila u stanju koristiti numeričke podatke zapisa mjerenja i kartiranja, analogni stereoinstrumenti dograđeni su uređajima za automatsku registraciju modelnih koordinata (1970. godine poduzeće Zavod za fotogrametriju nabavlja registrator EK5, 1975. godine Geodetski fakultet EK22 oba tvrtke Wild). Podatci se pohranjuju na papirnatim bušenim trakama, bušenim karticama i magnetnim vrpcama. Računanja se izvode prvo na računalima Elektrotehničkog fakulteta, a kasnije Sveučilišnog računskog centra. Već 1980. godine stolno računalo Hewlett-Packard 9845S (nabavljeno 1978. godina na Geodetskom fakultetu) povezano je s autografom preko EK22 i izvedena su prva, potpuno automatska, numerička kartiranja. Do pojave prvih operativnih, komercijalnih računalnih i grafičkih programa koji su se

mogli koristiti za fotogrametrijske potrebe, razvijen je čitav niz uglavnom interaktivnih programa prvo na HP-u, kasnije na PC-u kao što su programi za apsolutnu orijentaciju modela, računanje aerotriangulacije niza nezavisnih modela, transformacije, vektore pomaka, off-line kartiranje, računanje perspektive i dr. Analogni stereoinstrumenti s ugrađenim A/D pretvaračima na mjernim vretenima uspješno su se koristili za numerička kartiranja (analogno-analitički hibridni sustavi; nakon klasične relativne orijentacije, apsolutna orijentacija i kartiranje izvodi se na PC-u), sve do upotrebe analitičkih ili digitalnih fotogrametrijskih radnih stanica. U većini pogona korišten je program SystemeMap tvrtke ISM i MicroStation tvrtke Bentley (prve instalacije 1991. godine bile su na autografima A7 i A8 Geodetskog fakulteta).

### Analitička i digitalna fotogrametrija

Devedesetih godina nabavljeno je više analitičkih stereoinstrumentata (BC3/Aviolyt tvrtke Leica 1991. godine na Geodetskom fakultetu, SD 3000 tvrtke Leica 1996. godine Geodetski zavod Rijeka i Geodetski zavod Split) i prvi digitalni fotogrametrijski sustavi (DVP poklon tvrtke Leica 1993. godine i ImageStation Z tvrtke Intergraph 1997. godine na Geodetskom fakultetu). Analogno kartiranje zamijenjeno je digitalnim, izrađuju se prve digitalne ortofotokarte (1994), u okviru službene kartografije započela je izrada digitalne topografske karte u mjerilu 1:25 000 (1997), prvi digitalni model reljefa oznake DMR5 (od 1997) iz Osnovne državne karte u mjerilu 1:5000, a i nova karta u mjerilu 1:5000 izrađuje se digitalno pod imenom Hrvatska osnovna karta. Državna geodetska uprava 1992. godine pokreće projekt za obnovu i uređenje geodetskog prostornog sustava i sustavno radi na propisima za podatke o zemljištu (2002. godine donijet je model podataka CROTIS kojim se standardizira način prikupljanja i obrade topografskih podataka) i njihove baze s ciljem uspostave jedinstvenog geoinformacijskog sustava Hrvatske.

Nakon osamostaljenja Hrvatske strane fotogrametrijske tvrtke, kod kojih su radili hrvatski stručnjaci, koriste povoljne uvjete za poslovanje i osnivaju svoje pogone u Hrvatskoj. Tako je u Zagrebu, švicarska tvrtka Geofoto iz Lugana, 1990. godine otvorila ispostavu s analitičkim stereoinstrumentom SD 3000 tvrtke Leica (ispostava je bila preteća najveće geodetske tvrtke u Hrvatskoj, Geofota sa sjedištem u Zagrebu), a njemačka tvrtka Bildmesstechnik iz Affalterbacha je 1992. godine osnovala tvrtku Digital Aeroplan Croatia s analitičkim stereoinstrumentom Planicom P2 tvrtke Zeiss.

Danas (2025) većina fotogrametrijskih tvrtki za kartiranje koristi najrazličitije digitalne fotogrametrijske radne stanice (SupreSoft VirtuoZo, Z/I IMAGING SSK PRO, SOCET SET, Z/I ImageStation 2001, SoftPlotter i PhotoMod). Trodimenzionalna fotogrametrijska izmjera,



the Faculty of Geodesy). Analogue mapping was replaced by digital, the first digital orthophoto maps were produced (1994) within the framework of official cartography, the production of a digital topographic map at a scale of 1:25,000 began (1997), the first digital relief model marked DMR5 (since 1997) from the Basic State Map at a scale of 1:5,000, and a new map at a scale of 1:5,000 was also produced digitally under the name Croatian Basic Map. In 1992, the State Geodetic Administration launched a project for the renewal and organization of the geodetic spatial system and systematically worked on land data regulations (in 2002, the CROTIS data model was adopted, standardizing the topographic data collection and processing method) and their databases with the aim of establishing a single geoinformation system for Croatia.

After Croatia gained independence, foreign photogrammetric companies, where Croatian experts worked, took advantage of favourable business conditions and established their facilities in Croatia. Thus, in Zagreb, the Swiss company Geofoto from Lugano opened a branch office in 1990 with the Leica SD 3000 analytical stereo instrument (the branch office was the predecessor of the largest geodetic company in Croatia, Geofoto, headquartered in Zagreb), and the German company Bildmesstechnik from Affalterbach founded the company Digital Aeroplan Croatia in 1992 with the Zeiss Planicomp P2 analytical stereo instrument.

Today (2025) most photogrammetric mapping companies use a variety of digital photogrammetric workstations (SupreSoft VirtuoZo, Z/I IMAGING SSK PRO, SO CET SET, Z/I ImageStation 2001, SoftPlotter and PhotoMod). Three-dimensional photogrammetric surveying, especially for the purpose of aerotriangulation or the creation of digital relief models, is almost completely automated by automatic image correlation procedures, which include the recognition and measurement of key points of details on all images on which that detail was mapped. Artificial intelligence methods are increasingly contributing to the successful interpretation of individual objects in photographs and their photogrammetric measurement today, drastically reducing the time-consuming and tedious work of subjective stereoscopic interpretation and measurement.

## Aerial Imaging

According to available data, the first aerial imaging jobs for the territory of Croatia were carried out:

- In 1929 and 1930, by the 1st Airborne Regiment from Novi Sad. They photographed the city of Zagreb (several oblique shots and a photo mosaic are located in the Zagreb City Museum)
- From 1934 to 1937, by the Hydroplane Command of the Kingdom of Yugoslavia. They photographed the

Adriatic coast and islands (the images are kept in the Hydrographic Institute of the Republic of Croatia)

- In 1939, probably by the Military Geographical Institute from Belgrade. They photographed the Sava River from Podsused to Ivanja Reka for regulation purposes (the photomosaic is kept in Hrvatske Vode)
- Before World War II, in preparation for the occupation, the Reichsluftfahrtministerium from Berlin photographed probably the entire territory of Croatia (photo enlargements of the Krka River, the Neretva estuary, Dubrovnik, Korčula, etc. are preserved at the Faculty of Geodesy, University of Zagreb)
- In 1943, by the Croatian Air Force. They photographed the terrain on which the pilgrimage site of Marija Bistrica would be built (the photographs have not been found).
- In 1944, the British systematically photographed the coast and islands in preparation for the invasion (there are about 10,000 of them in the Hydrographic Institute of the Republic of Croatia and they are kept under the label 'Allied'). There must have been a huge number of photographs from the war, but they were mostly destroyed.
- In 1947, by the Geographical Institute of the Yugoslav National Army from Belgrade. They photographed the coast and islands for the needs of the Hydrographic Institute of the Navy (the images are kept in the Hydrographic Institute of the Republic of Croatia)
- In 1950, with a camera from the Geographical Institute of the Yugoslav National Army (Wild RC5). The wider area of the city of Zagreb was photographed
- In 1953, by the Geographical Institute of the Yugoslav National Army. They recorded the wider area of the Plitvice Lakes National Park

All aerial imaging until 1970 was carried out exclusively by a specialized service of the Geographical Institute of the Yugoslav National Army, later the Military Geographical Institute from Belgrade (with the Wild RC5a, RC8 and RC10 cameras). That year, civilian aerial imaging services were established in Belgrade (Geopremer with the Wild RC8 camera) and Ljubljana (Geodetic Institute of the Republic of Slovenia with the cameras Wild RC8, RMK A and later Zeiss LMK 21). Since that time, aerial films have been archived in the Geodetic Administration of the Republic of Croatia and are available to users (the Administration keeps records of the photographed areas). Imaging is carried out in a variety of scales for the needs of road construction, archaeology, geology, hydrography, forestry, and mostly for geodetic surveying (production of the Basic State Map and cadastre). Since 1994, Croatia has had its own aerial imaging service (in the spring of 1994, the company Geofoto from Zagreb carried out the first surveys with a Leica RC20 camera, and soon after, the Geodetic Institute from Osijek also took photographs



**Slika 5.** Vexcel UltraCAM digitalna aero-fotogrametrijska kamera.

**Fig. 5** Vexcel UltraCAM digital aero-photogrammetric camera.



**Slika 6.** DMC digitalna aerofotogrametrijska fotogrametrijska kamera.

**Fig. 6** DMC digital aerophotogrammetric photogrammetric camera.

posebno u svrhu aerotriangulacije ili izrade digitalnih modela reljefa, gotovo je u potpunosti automatizirana postupcima automatskih slikovnih korelacija, što obuhvaća prepoznavanje i mjerenje ključnih točaka detalja na svim snimkama na kojima se taj detalj preslikao. Uspješnoj interpretaciji pojedinih objekata na fotografiji i njihovoj fotogrametrijskoj izmjeri danas sve više doprinose metode umjetne inteligencije, čime se drastično smanjuje dugotrajan i zamoran posao subjektivne stereoskopske interpretacije i izmjere.

## Aerosnimanje

Prema dostupnim podacima prva aerosnimanja za područje Hrvatske izveli su:

- 1929. i 1930. godine 1. vazduhoplovni puk iz Novog Sada. Snimili su grad Zagreb (nekoliko kosih snimki i fotomozaik nalaze se u Muzeju grada Zagreba)
  - 1934. do 1937. godine Hidroplanska komanda Kraljevine Jugoslavije. Snimila je obalu Jadrana i otoke (snimke se čuvaju u Hrvatskom hidrografskom institutu)
  - 1939. godine vjerojatno Vojno-geografski institut iz Beograda. Snimio je rijeku Savu od Podsuseda do Ivanje Reke za potrebe regulacije (fotomozaik se čuva u Hrvatskim vodama)
  - prije II. svjetskog rata, u pripremama za okupaciju, Reichsluftfahrtministerium iz Berlina. Snimljeno je vjerojatno cijelo područje Hrvatske (na Geodetskom fakultetu Sveučilišta u Zagrebu sačuvana su fotopovećanja područja rijeke Krke, ušća Neretve, Dubrovnika, Korčule i dr.)
  - 1943. godine Hrvatsko ratno zrakoplovstvo. Snimilo je teren na kojem će se izgraditi hodočasničko mjesto Marija Bistrica (snimke nisu nađene)
  - 1944. godine Englezi su sustavno snimali obalu i otoke u pripremama za invaziju (u Hrvatskom hidrografskom institutu ima ih oko 10 000 i čuvaju se pod oznakom 'Saveznički'). Snimki iz rata mora da je bilo ogroman broj, ali su uglavnom uništene.
  - 1947. godine Geografski institut JNA iz Beograda. Snimio je obalu i otoke za potrebe Hidrografskog instituta Ratne mornarice (snimke se čuvaju u Hrvatskom hidrografskom institutu)
  - 1950. godine kamerom Geografskog instituta JNA (RC5 Wild). Snimljeno je šire područje grada Zagreba
  - 1953. godine Geografski institut JNA. Snimio je šire područje Nacionalnog parka Plitvička jezera
- Sva aerosnimanja do 1970. godine obavljala je isključivo specijalizirana služba Geografskog instituta JNA, kasnije Vojnogeografskog instituta iz Beograda

with a Wild RC8 camera and, since 2001, with a Zeiss RMK TOP 15). Both companies have acquired digital photogrammetric cameras. Geofoto acquired the Vexcel UltraCAM camera (Fig. 5), and the Geodetic Institute of Osijek acquired the Z/I DMC camera (Fig. 6).

Unfortunately, both companies no longer exist and Croatia no longer has its own aerial imaging service. Geodetski zavod d.d. from Osijek went bankrupt in 2016 due to debts, while Geofoto d.d. went bankrupt in December 2017.

The use of aerial imaging was restricted for years by the military with various prohibitions on photography and mapping, complicated acquisition of imaging permits and inspections (which could take months). By declaring the photo material 'confidential' and dangerous for the country's security (at one time, the content of the image was even physically removed by retouching it), the use of the images was significantly hampered. Upon gaining independence, Croatia significantly liberalized the use of aerial photography with the Regulations on Aerial Photography (1993 and 2003). Since 1997, the territory of the country has been surveyed from the air cyclically every four years (the survey scale is approximately 1:20,000). The specifications for aerial photography and orientation points ver 2.1 from 2017 prescribe the use of an aerial photogrammetric digital camera functionally integrated with an inertial measurement system (GNSS/IMU).

## Social Organization

In 1910, Austrian E. Doležal founded the International Society for Photogrammetry (ISP, later ISPRS) and in 1913 organized the 1st Congress of the Society in Vienna. Until Croatia's independence, Croatian photogrammetrists participated in the work of ISP/ISPRS

through the Association of Geodetic Engineers and Surveyors of Yugoslavia. In 1996, the Section for Photogrammetry and Remote Sensing of the Croatian Geodetic Society (later the Section for Photogrammetry and GIS) was established, and in the same year at the 18th Congress in Vienna, the General Assembly of ISPRS admitted Croatia to membership. In 2003, the Section organized the ISPRS WG VI/3 workshop in Zagreb under the title "Geoinformation for practice" with more than 500 participants from 26 countries. Contemporary photogrammetric scientific and professional achievements were also presented to a wider interested public through participation in the work of the Scientific Council for Remote Sensing of the Croatian Academy of Sciences and Arts (HAZU). The task of the Council is to encourage, advance, coordinate, assist and organize scientific and professional research of the Earth using remote sensing methods. After the advent of digital cameras in everyday life, measurements and interpretation of images are increasingly used in a large number of human activities. Therefore, measurement and interpretation of photographic images are studied at several faculties of the University of Zagreb. At the same time, computer and computing advances, especially artificial intelligence, enable the construction of a system whose cognitive capabilities are increasingly approaching human vision. In order to facilitate cooperation among experts involved in surveying and interpreting images, the Centre of Excellence for Computer Vision was established at the Faculty of Electrical Engineering and Computing in 2012, one of the founders of which is the Faculty of Geodesy of the University of Zagreb.

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Dubravko Gajski ■*



(kamerama RC5a, RC8 i RC10 Wild). Te godine ustrojene su civilne službe aerosnimanja u Beogradu (Geopremer s kamerom RC8 Wild) i Ljubljani (Geodetski zavod SR Slovenije s kamerama RC8 Wild, RMK A i kasnije LMK 21 Zeiss). Od tog vremena aerofilmovi se arhiviraju u Geodetskoj upravi SRH i dostupni su korisnicima (Uprava vodi evidenciju o snimljenim područjima). Snima se u najrazličitijim mjerilima za potrebe izgradnje prometnica, arheologije, geologije, hidrografije, šumarstva, a najviše za geodetsku izmjeru (izradu Osnovne državne karte i katastar). Od 1994. godine Hrvatska ima vlastitu službu aerosnimanja (u proljeće 1994. godine tvrtka Geofoto iz Zagreba izvela je prva snimanja kamerom RC20 Leica, a ubrzo nakon toga snima i Geodetski zavod iz Osijeka kamerom RC8 Wild i od 2001. godine s RMK TOP 15 Zeiss). Obje tvrtke su nabavile digitalne fotogrametrijske kamere. Geofoto je nabavio kameru Vexcel UltraCAM (sl.5), a Geodetski zavod Osijek kameru Z/I DMC (sl.6).

Na žalost, obje tvrtke više ne postoje i Hrvatska više nema vlastitu službu aerosnimanja. Geodetski zavod d.d. iz Osijeka je zbog dugova zapao u stečaj 2016. godine, a Geofoto d.d. je otišao u stečaj u prosincu 2017. godine.

Upotrebu aerosnimaka godinama je ograničavala vojska raznim zabranama snimanja i kartiranja, kompliciranim dobivanjem dozvole za snimanje i pregledima (što je znalo potrajati mjesecima). Proglašavajući fotomaterijal 'povjerljivim' i opasnim za sigurnost zemlje (retušem je jedno vrijeme i fizički uklanjan sadržaj snimke) korištenje snimki je bilo znatno otežano. Osamostaljenjem, Hrvatska znatno liberalizira upotrebu aerosnimki. Uredbama o snimanju iz zraka (1993. i 2003. godine). Od 1997. godine teritorij države snima se iz zraka ciklički svake četiri godine (mjerilo snimanja je približno 1:20 000). Specifikacijama za snimanje iz zraka i orijentacijske točke ver 2.1 iz 2017. godine propisana je upotreba aerofotogrametrijske digitalne kamere funkcionalno integrirane s inercijalnim mjernim sustavom (GNSS/IMU).

## Društvena organiziranost

Godine 1910. austrijanac E. Doležal osnovao je Međunarodno fotogrametrijsko društvo (ISP, kasnije ISPRS) i 1913. godine organizirao I. kongres društva u Beču. Do osamostaljenja Hrvatske hrvatski fotogrametri učestvovali su u radu ISP/ISPRS-a preko Saveza geodetskih inženjera i geometara Jugoslavije. Godine 1996. osnovana je Sekcija za fotogrametriju i daljinska istraživanja Hrvatskoga geodetskog društva (kasnije Sekcija za fotogrametriju i GIS) i iste godine na XVIII. kongresu u Beču, Generalna skupština ISPRS-a primila je Hrvatsku u članstvo. Godine 2003. Sekcija je organizirala u Zagrebu ISPRS WG VI/3 workshop pod naslovom "Geoinformation for practice" s više od 500 sudionika iz 26 zemlje. Suvremena fotogrametrijska znanstvena i stručna postignuća predstavljaju se široj zainteresiranoj javnosti i sudjelovanjem u radu znanstvenog vijeća za daljinska istraživanja Hrvatske akademije znanosti i umjetnosti (HAZU). Zadatak Vijeća je poticanje, unapređivanje, koordiniranje, pomažanje i organiziranje znanstvenih i stručnih istraživanja Zemlje s pomoću metoda daljinskih istraživanja. Nakon pojave digitalnih kamera u svakodnevnom životu, mjerenja i interpretacije na snimkama se sve više koriste u velikom broju djelatnosti. Stoga se izmjera i interpretacija fotografskih snimki izučava na nekoliko fakulteta Sveučilišta u Zagrebu. Istovremeno, napredak računala i računarstva, posebno umjetna inteligencija, omogućuju izgradnju sustava koji se po svojim kognitivnim sposobnostima sve više približavaju ljudskom vidu. Da bi se olakšala suradnja među stručnjacima koji se bave izmjerom i interpretacijom snimki, na Fakultetu elektrotehnike i računarstva je 2012. godine osnovan Centar izvrsnosti za računalni vid, čiji je jedan od osnivača i Geodetski fakultet Sveučilišta u Zagrebu.

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