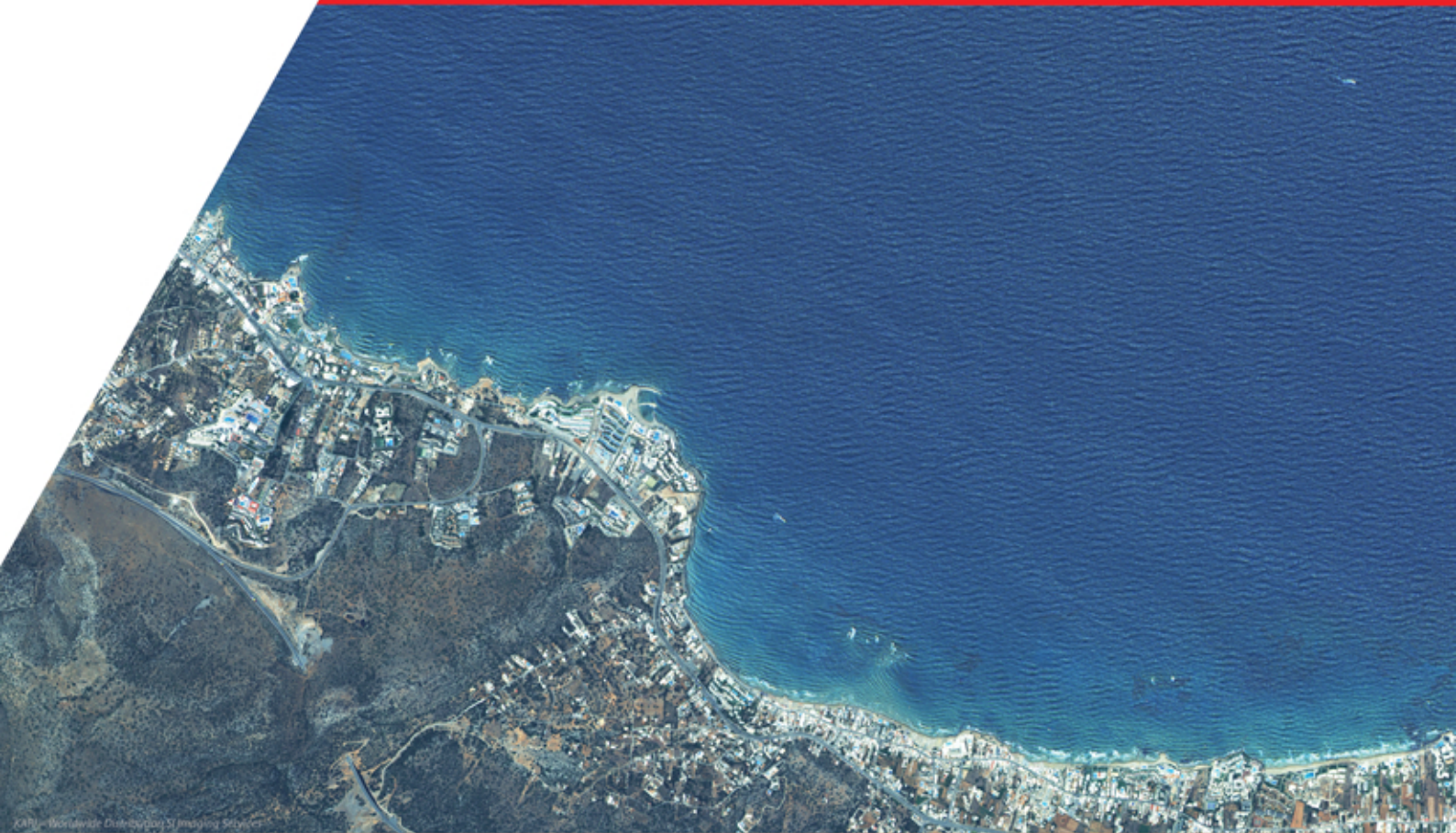


FROM IMAGERY TO DIGITAL REALITY:

Earth Remote Sensing & Photogrammetry

18th International Scientific and Technical Conference

Conference Proceedings



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25 YEARS IN THE FIELD OF **PHOTOGRAMMETRY, GIS AND REMOTE SENSING**



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Dear colleagues!

Perhaps there is no more mysterious place in the world than Crete: hundreds of legends, thousands of traditions, and the birth and outcome of civilizations. The history of Crete is a history of the genius of human thought. For the first time, multistory buildings appeared here, along with natural and artificial lighting, sanitation, ventilation, heating, and paved roads—prototypes of the current “smart” cities. It was hardly possible without understanding how geographical space was arranged.



This year we set ourselves to the task of stretching the bridge between the achievements of the past, the present, and the future. We wanted to connect the history imprinted on the maps of Ptolemy, the labyrinths of the Palace of Knossos, and the photo of Gaspard-Félix Tournachon with the modern systems of digital reality, based on the photogrammetric processing of remote sensing data.

Digital reality is measured spatial information that is used in almost all directions of society’s technological developments, be it land management, navigation, autonomous transport systems, smart cities, robotic technologies, and much more. Digital reality provides a cartographic basis for the Internet of Things, and it allows building space-time models for sustainable development of society.

This year the history of Racurs—the one and only organizer of the conference—will cross the twenty-five-year milestone. This is quite insignificant in comparison with the centuries-old history of Crete, but this quarter of the century fell into the most exciting period of development of remote sensing technologies.

We have something to be proud of. Welcome to Crete!

*Sincerely yours,
the Head of the Organizing Committee
Victor Adrov*

18th International Scientific and Technical Conference
“FROM IMAGERY TO DIGITAL REALITY: ERS & Photogrammetry”
September 24-27, 2018, Crete, Greece.



2018

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How Fast Time Flies: A Quarter of a Century in the Geoinformation Market

Victor Adrov, Racurs, Moscow, Russia

How fast time flies! It seems that our company, Racurs, celebrated its 20th anniversary not too long ago, but now a more serious date has come: a quarter of a century. We somehow can't believe that for 25 years, we have been doing the same work — maybe not the most financially profitable and governmentally significant, but for sure, very interesting work: the development and use of photogrammetric technologies.

Founding a private company 25 years ago, we, a group of researchers of the Russian Academy of Sciences, didn't think that the company would become our "business of life" and the main place of our work for a long time to come. We didn't think that the word "PHOTOMOD," invented as a temporary name for our first version of photogrammetric system the night before the ISPRS conference in which we participated in 1995, would become one of the most known photogrammetric brands in the world.

Of course, 25 years of work in the challenging geoinformation market couldn't be completely cloudless. Along with the economic changes in Russia, our industry has also changed. There have been ups and downs, interesting companies

have appeared and disappeared, and technological trends have changed.

While celebrating our anniversary, we want to recall the history of the company, its successes, employees, and partners, to whom we owe much. We are proud of the close cooperation with the enterprises of Roscosmos, the Ministry of Defense, Roscartography, and many other large and small organizations. Not every Russian company working in the field of high technology can boast that such a vast part of the world is using its developments. Specialists from more than 80 countries around the world are familiar with PHOTOMOD system, effectively using it for solving their tasks.

If we review the statistics of our achievements, we can note that in 25 years, our program solutions have been installed in 900 organizations, 470 of which are in Russia, and taking into account the network architecture of the software, we created about 10,000 workplaces.

We are proud of the history of Racurs, but we still consider ourselves a developing and active company, so we look forward to the future and to new developments.



PHOTOMOD users map

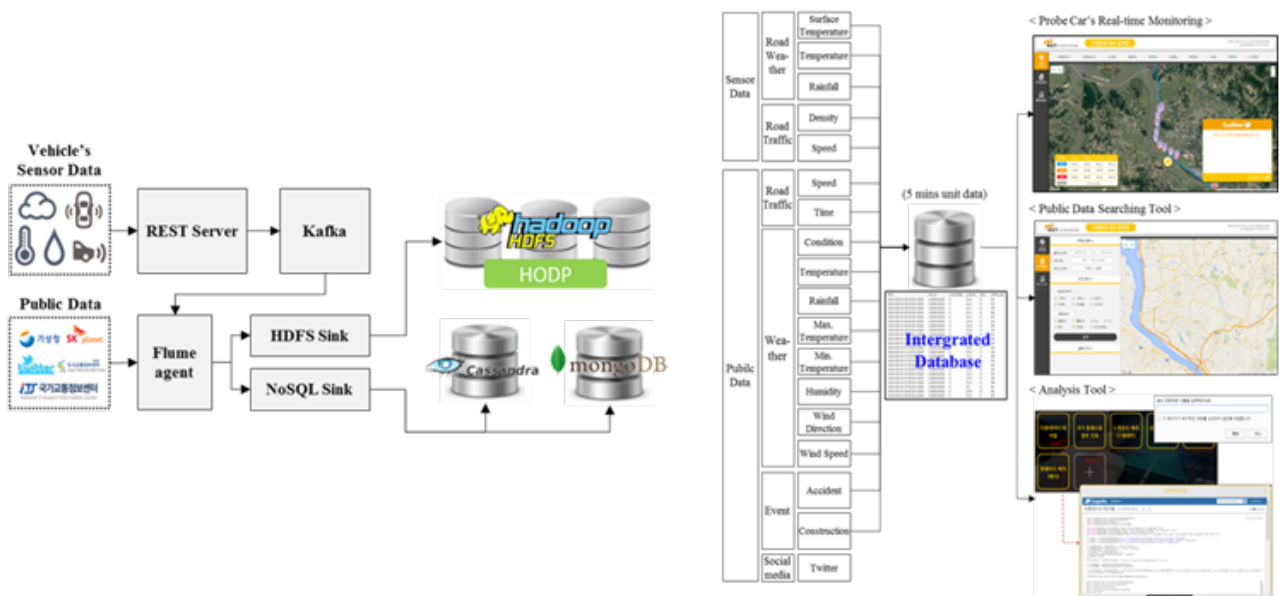
Development of Big Data Platform for Analysis of Driving Environment Based on Vehicle Sensor

Sung Hong ki, Chong Kyu soo, Korea Institute of Civil Engineering and Building Technology (KICT), Goyang-si, South Korea

The big data in everyday life are gradually increasing due to the explosive increase in the use of the Web, such as by mobile phones, the Internet, and social media, and to the increase of new types of smart devices, such as smart watches and smart bands. In addition, as the world is entering the fourth industrial revolution that integrates all the industrial sectors based on big data, there is a growing need to expand and utilize big data through the Internet, artificial intelligence, etc. As the opening and utilization of public data increase, various contents are being developed for the utilization of big data in various fields, such as the IT industry. Now is the time to look for ways to actively use big data, such as massive public data, and to create and utilize new-value data through the analysis of various big-data convergence cases.

The data productivity and scalability are rapidly increasing due to the development of technology in road traffic. For example, since the development of sensor measurement technology for general personal vehicles as well as business vehicles such

as buses, taxis, and trucks, mobile observation technology such as detection sensors, navigation systems, and black boxes in fixed observation technologies such as loop detectors, image detectors, and CCTV It has become extensible. Accordingly, it is expected that the use of big data in the road traffic sector will become more active, and it is essential to develop an intelligent IT environment and platform capable of collecting, storing and analyzing various types of data such as fixed data and unstructured data. Therefore, in this paper, the development direction of the road environment prediction platform based on the road traffic big data that meets the technology development trend and the social demand is presented and the expected effect is shown. To do this, we analyzed the level and trends of technology development of Big Data Platforms related to domestic and foreign markets and analyzed the differentiation and expected effects of platform to develop in this study.



Pic.1 .Process of Data Store Tool

Detection of Active Deformation Areas Based on Sentinel-1 Imagery: an Efficient, Fast and Flexible Implementation

José A. Navarro, María Cuevas-González, Anna Barra, Michele Crosetto

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1. Introduction

The MOMIT project (see [4] for details) aims at developing and demonstrating a new use of remote sensing technologies for railway infrastructures monitoring. MOMIT solutions will mainly aim at supporting the maintenance and prevention processes within the infrastructure management lifecycle. The overall concept underpinning MOMIT project is the demonstration of the benefits brought by Earth Observation and Remote Sensing to the monitoring of railways networks both in terms of the infrastructure and of the surrounding environment, where activities and phenomena impacting the infrastructure could be present. MOMIT will leverage on state of the art technologies in the fields of space-based remote sensing and RPAS (Remotely Piloted Aircraft Systems) based to perform different kind of analysis thanks to the wide variety of sensors they could be equipped with.

To achieve its goals, six demonstrators showing how these data and technologies may contribute to such objectives are being built, namely:

1. Ground movements nearby the infrastructure.
2. Hydraulic activities nearby the track.
3. Global supervision for natural hazards.
4. Electrical system monitoring.
5. Civil engineering structures monitoring.
6. Safety monitoring.

The Division of Geomatics of the CTTC (Centre Tecnològic de Telecomunicacions de Catalunya) takes care of building some of the components integrating the first demonstrator, whose objectives are detailed in [4]. The goal most relevant to the work presented here is to use the Persistent Scatterer Interferometry method for monitoring the sites of interest, allowing the measurement of differential deformation of the ground and each single structure, with millimetric / centimetric precision.

Several software applications are needed in the context of this demonstrator. This paper describes the first of these, the ADAFinder, a tool to detect and update ADAs (Active Deformation Areas) using Sentinel-1 imagery and the Persistent Scatterer Interferometry technique. The main goal of such application is to update and assess the geohazard activity (volcanic activity, landslides or ground subsidence among other phenomena) of a given area.

A procedure to perform the identification and assessment of ADAs was presented in [1]. In that work, the authors explain in detail the procedure to identify the active deformation areas and also to assess the certainty of such findings; the set of points making each ADA as well as its area of influence and the quality index stating the goodness of the assessment are the most relevant outputs. The input, the set of PSs (Persistent Scatterers, aka the points) covering the area to analyze.

The aforementioned procedure relies heavily on the use of a GIS (Geographic Information System) tool and the expertise of its operator; therefore, it is a time-consuming, error-prone process, which requires qualified human resources.

This paper presents an implementation of the method described in [1], the ADAFinder application. Its goals are (1) to automate the procedure to avoid unnecessary human errors, (2) to reduce the time needed to identify de ADAs, thus opening the door to more frequent updates, and (3) to reduce the expertise required to obtain such results, therefore requiring less qualified people or no human intervention at all, being possible to integrate the process in an automated production workflow, if necessary.

Figure 1 shows a few ADAs and their assessed quality — shown as green (best quality), blue (good), yellow (not so good) and red (bad) areas.

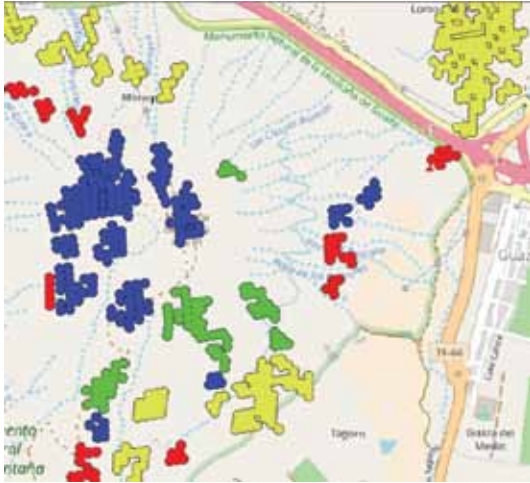


Figure 1: example of a few ADAs.

2. The procedure in a nutshell. Why clustering is so important

The procedure to identify and assess the ADAs is exhaustively described in [1], so it will only be sketched here for the sake of clarity and completeness. The parts of the method that deserved

special attention in the implementation of the ADAFinder will be, on the contrary, highlighted.

Figure 2 depicts the method, which is divided into three main steps, namely filtering, ADA extraction and quality assessment. The second and third steps are mainly related to number crunching – qualitatively, not quantitatively speaking – and classification. The mathematics involved there imply the computation of a few correlations, autocorrelations, minimum, maximum and mean values among other miscellaneous intermediate results; although the mathematical part of an algorithm may always be somehow optimized for better performance, such improvements are not the target of this paper. Note, however, that the ADAFinder does optimize all the mathematical operations.

Instead, the way to find groups of points is much more interesting and challenging, becoming the path leading to a fast implementation of the ADAFinder. Thus, this paper concentrates specifically in the clustering solution implemented

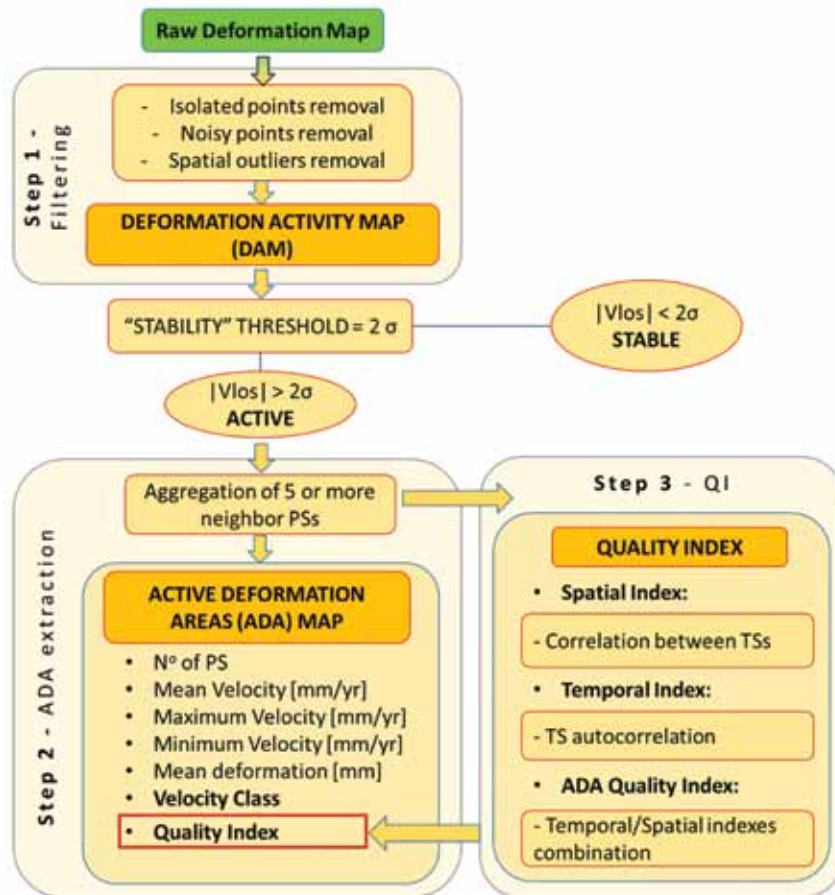


Figure 2: flowchart depicting the algorithm to generate the Active Deformation Areas (source: [1]).

by this application.

The filtering step of the algorithm in Figure 2 takes care of removing isolated points. In the context of the procedure, isolated stands for points with zero or one neighbors – or, in other words, finding groups including only one or two points. Step 2, the ADA extraction, also expects to find groups, in this case containing five or more points (neighbors), to afterwards check whether these become ADAs or not.

To decide if two points are neighbors, that is, whether they are part of the same group because they are close enough, distances must be computed and then compared to a discriminating threshold. Problems immediately show up when the number of points to check increases. A naïve approach to solving this problem would take all the possible couples of points and compute their respective distances, thus leading to an $O(n^2)$ implementation. Since the number of points usually found in this kind of problems may easily reach hundreds of thousands if not millions, the simple approach just described is simply unacceptable.

3. The clustering algorithm. The point set seen as a graph

The approach adopted by the ADAFinder to find groups (or clusters) of points is to interpret these as a graph and then use a classic algorithm, relying on a DFS (Depth First Search), to identify its connected components. See, for instance, [3] for further details on this algorithm.

However, the input to the ADAFinder is a set of points that are in no way connected; that is, data are not organized as a graph (see Figure 3a).

The idea – which makes possible to use the algorithm to find connected components – is to interpret distances as candidate arcs: two points are connected, and therefore an arc exist between these, if and only if the distance d between the points is less than some threshold d_t (see Figure 3b). Having thus a graph, the connected components found by the DFS algorithm are groups of points that are close enough to become clusters – which is the goal sought

The problem here is that the distance arcs are not present in the dataset and a process to determine on-the-fly whether these exist is required, which,

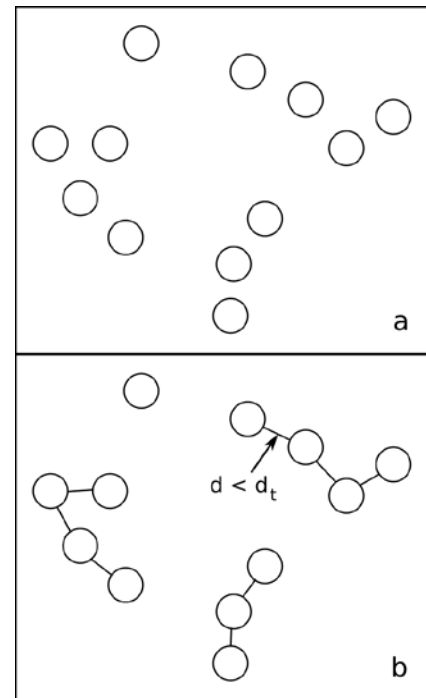


Figure 3: the point dataset (a) seen as a graph with some connected components (b) linked with "distance" arcs.

as stated in section 2, may be a costly operation if addressed in a naïve way.

The solution adopted to reduce the computational burden of the clustering algorithm consists, essentially, in sorting the input data, the points, appropriately: two values are used as sort criteria; first, the x coordinate, then, the y coordinate. The way the array of points is rearranged allows for a minimum set of operations and comparisons.

For instance, the algorithm to find a single connected component takes point i as the first candidate to be included. Its x coordinate, x_i , is then compared to that of the next point in the array, x_{i+1} . If the distance d – obtained just subtracting x_i from x_{i+1} – is less than the threshold distance d_t , then, and only then, the full Euclidean distance between points i and $i+1$ is computed and checked once more for the threshold condition. Points satisfying the distance criterion are marked as belonging to the current connected component and stacked for further processing (so its neighbors may be included too in the connected component if these also match the distance criterion). On the contrary, those points too far apart ($d > d_t$) are left aside for later inclusion in other potential connected components.

The key for reducing drastically the number of

operation lies in the fact that if the first comparison between x_i and x_{i+1} only – not the full Euclidean distance comparison – fails because these x coordinates are already too far apart, it is not necessary to continue the search for additional points close to reference point i . Since the points have been sorted first by x , then by y , it is possible to guarantee that if the distance d_{ij} between points i and j is greater than the threshold, then d_{ik} , for all $k > j$ will also exceed such limit.

Figure 4 shows a recursive version of the connected components finder algorithm just described using pseudocode. The actual implementation avoids recursion and resorts to an iterative version using a stack for performance reasons.

```

PROCEDURE find_component (start, last, cc)
  # start and last and the first and last
  # positions to search in the array of
  # points. cc is a connected component.
  x1 = x_coordinate[start]
  y1 = y_coordinate[start]
  FOR (index between (start, end))
    x2 = x_coordinate[index]
    IF (x2 - x1 > threshold) FINISH
    y2 = y_coordinate[index]
    d = distance(x1,y1,x2,y2)
    IF (d < threshold)
      flag index as visited
      cc.insert(index)
      find_component(index+1, last, cc)
    END_IF
  END_FOR
  FINISH
END_PROCEDURE

```

Figure 4: recursive version of the algorithm finding a single connected component using “distance” arcs between points.

Since the goal of the clustering algorithm is to find all the connected components in the dataset, the procedure described above is invoked repeatedly until all the points have been flagged as visited – thus being part of one or another component, even 1-element clusters.

4. Implementation and performance

The ADAFinder application has been implemented in C++ to boost performance. Other popular languages, as Python, have been avoided precisely for that reason.

Although developed using Microsoft’s Visual Studio, special precautions have been taken to make the source code portable, particularly for the most popular C++ compiler used in the Linux operating system, i.e. gcc.

In order to ease the integration of the application in a regular production – or research – workflow, the relevant inputs and outputs of the application are ESRI shapefiles (see [2] for a formal description of this popular format). Shapefiles are accepted as a regular input / output mechanism by many GIS environments. Among these, ArcGIS or Quantum GIS – aka QGIS – are notorious examples. Therefore, using shapefiles to store the relevant data eliminates the impedance that other formats might introduce.

The files using the shapefile format include the input points (PSs) file, an optional polygon file to define the limits of one or more areas of interest to be processed and, finally the output file including the ADAs identified by the application.

Working with shapefiles in C++ is solved by means of the “Shapelib C library” (see [6]).

However, shapefiles are files that may adopt many shapes. The main input of the application, the file containing the points to process, may have been originated in many different ways; therefore, the actual contents may vary from one source to other.

This is especially true in the case of the dbf file, where the attributes of the several entities present in the shapefile itself are stored. The set of these attributes may vary quite a lot, depending on the application that created the shapefile.

This variability might become a serious problem for ADAFinder, since the input module should be adapted for each kind of shapefile that should be processed with this tool. However, the use of read-map files avoids this problem.

There is a minimum set of attributes that must be present in the input dbf file for the ADAFinder to work properly. These are, for each point in the file, the x & y (projected) coordinates, its velocity

and the time series stating the different movements undergone by the point. Any other attributes that might be present in the attributes file are simply ignored.

Providing that a dbf file includes the aforementioned attributes, knowing their (column) positions makes possible a general read procedure in ADAFinder, thus avoiding the problem of format variability. Such positions are provided by means of a simple file, namely the read map file, including label / value pairs defining the positions of the required attributes (see Figure 5 for an actual example).

POSITION_X	= 5
POSITION_Y	= 6
POSITION_VELOCITY	= 9
POSITION_TIME_SERIES	= 11
N_VALUES_TIME_SERIES	= 50

Figure 5: an example of a read-map file, showing where to find the different mandatory attributes in some dbf file.

Usually, read map files are valid for whole projects, where the format of the input shapefiles (and related attribute, dbf files) do not vary. At any rate, changing a simple plain text file is enough to adapt the application very quickly – providing that the mandatory attributes exist.

The results of the procedure described in [1] and sketched in Figure 2 depend on the values of a set of parameters; for instance, the stability threshold is 2σ ; or the minimum number of points in a cluster to consider it as a candidate ADA is 5. These values (2 and 5 in this case), that might be perfect for some data set, might need some fine-tuning when other data are processed.

Therefore, hardwiring these values in the source code of the application would imply the need to modify it in case they had to be changed.

The ADAFinder identifies all the values that an operator might wish to change in search of better results and lets him / her modify these via an external options file.

Again, as in the case of the read map files just described, option files are very simple, consisting of a series of label / value couples in a plain text file.

The ADAFinder is available in three flavors:

- A library, the ADAFinderLib, ready to

be used by any other software components, thus embedding the capability of identifying ADAs in other applications.

- A command-line executable of ADAFinder, ready to be integrated in offline (batch) workflows.

- A GUI (Graphic User Interface) version, aimed at interactive use. See Figure 6 for a graphical depiction of the main screen of the application. For portability reasons, the GUI has been implemented using the Qt framework (see [5]).

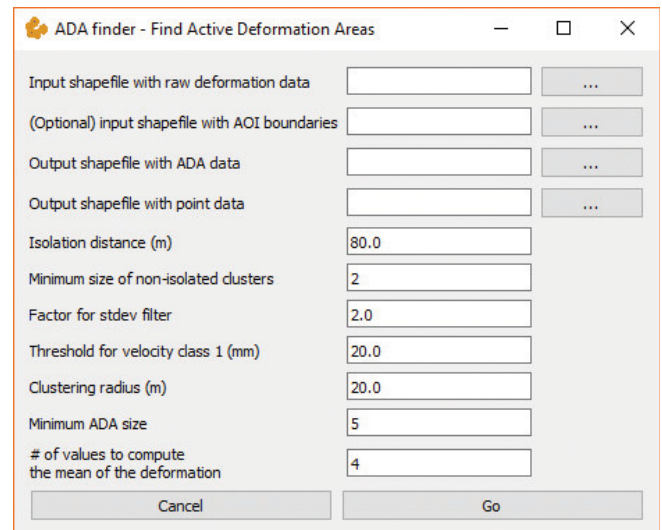


Figure 6: the interface of the GUI-based version of the ADAFinder.

Note that both the command-line and GUI-based versions of the applications rely on the ADAFinderLib library. In fact, these are just a way to collect the information required by the library to work, since it is in the library where the actual logic resides.

The command-line tool collects such information directly from the option and read map files just described. The GUI version reads a “seed” options file to offer its values as defaults in its main screen (see again Figure 6) so the operator may change these at his / her will.

Concerning performance, the application needs just a bare second to produce the output ADA map when the number of points (PSs) to process is below 50.000. This makes the ADAFinder a truly interactive tool. Load tests addressed to check the ability of the application to deal with much higher number of points were also conducted. An area covered by almost a million of points was processed; the tool needed less than 3 minutes to produce the output ADAs. It is difficult to state how

long an operator would have needed to complete the same work since it depends on his / her level of expertise and the power of the computer used, but it is reasonable to assume that 30 minutes would be a close guess.

It is worth to note that the equipment used to obtain such results is a regular laptop sporting 8 Gb of RAM (Random Access Memory), a rather old, 5th generation Core i5 processor and a classic magnetic disk (that is, not a much faster SSD, Solid State Disk). No GPU (Graphic Processing Unit) processing nor parallelization techniques have been used, so there is still room for improvement – if needed. Consequently, any computer able to run GIS (Geographic Information System) software – a usual environment used for this kind of applications – may be used to run the ADAFinder (either the command-line or GUI versions).

5. Conclusions and outlook

ADAFinder is the first tool that will be part of the first demonstrator (“Ground movements nearby the infrastructure”) of the MOMIT project.

This tool, in either of its three incarnations (library, command line, GUI) automates the methodology presented in [1], empowering its users with the ability to perform ADA detection and assessment in very short times, freeing them from the prone-error, manual process required should a GIS environment be used instead. The clustering algorithm implemented makes possible a comparatively very good performance boost (at least 10 times faster than manual operation).

The tool is also flexible, being able to adapt itself to different data formats just changing the file defining how the input point’s attributes are structured. This, together with the ability to change the set of parameters controlling the behavior of the application – the options file or the GUI in the interactive version – makes the ADAFinder a very suitable tool to check how different scenarios would change the results; thus increasing the analysis capacity of the operator.

The ADAFinder may be easily integrated in either ArcGIS or Quantum GIS – there is no need to modify the source code; this may be done using the mechanisms provided by these GIS tools.

In this way, the ADAFinder may be seen as one more tool in the regular work environment of the operator, avoiding unnecessary disruptions in his / her workflow.

Other tools will follow in the context of the MOMIT project and its first demonstrator. The next one, already being implemented is the ADAClassifier, a tool to identify the kind of ground movement the ADAs are exposing (as, for instance, sinkholes, subsidence, landslides, thermal effects or constructive settlements).

Acknowledgements

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Nana Beach Resort, Crete Island
June 3rd, 2018 / KOMPSAT-3

KOMPSAT Series Introduction

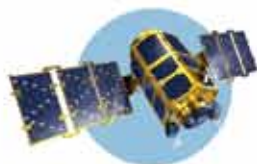
Korean Multi-Purpose SATellite

KOMPSAT program is a part of the Korean government's space development program, which aims at providing very high resolution (VHR) satellite imagery to the national and international users. Since the first launch of KOMPSAT-1 (6.6m, Optical), Resolution has been evolved to 40 cm and has been widened to X-band SAR satellite imagery.

KOMPSAT is dual-use program. Korea Aerospace Research Institute (KARI) is in charge of KOMPSAT operation, and SI Imaging Services (SIIS) has worldwide exclusive distribution rights of KOMPSAT imagery. As a national space program, data continuity of KOMPSAT is guaranteed for both VHR Optical and SAR.

KOMPSAT-6 is scheduled to be launched in 2020 as the second SAR satellite of Korea. And KOMPSAT-7 is scheduled to be launched in 2021 equipped with 30cm camera payload as the follow-up model of KOMPSAT-3A.

Technical specification



KOMPSAT-2

Product resolution

PAN: 1.0 m / MS: 4.0 m

Local imaging time

10:50

Spectral bands

PAN/BLUE/GREEN/RED/NIR

Imaging mode

Strip (max. 7,900 km)
Single point target



KOMPSAT-3

Product resolution

PAN: 0.5 m / MS: 2.0 m

Local imaging time

13:30

Location accuracy

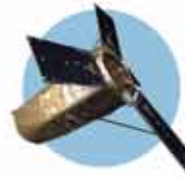
11.80 m RMSE,
< 17.90m CE90 with POD/PAD
(Measured in June, 2018)

Spectral bands

PAN/BLUE/GREEN/RED/NIR

Imaging mode

Strip (max. 4,000 km)
Multi point
Single pass stereo
Wide area along (max. 100 km)



KOMPSAT-3A

Product resolution

PAN: 0.4 m / MS: 1.6 m

Local imaging time

13:30

Location accuracy

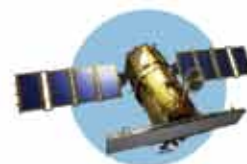
5.7 m RMSE,
< 8.65 m CE90 with POD/PAD
(Measured in June, 2018)

Spectral bands

PAN/BLUE/GREEN/RED/NIR

Imaging mode

Strip (max. 4,000 km)
Multi point
Single pass stereo
Wide area along (max. 204 km)



KOMPSAT-5

Product resolution

X-band SAR
UHVHR/EH: 0.85 ~ 1 m
ES/ST: 2.5 ~ 3 m
EW/WS: 20 m

Orbit repeat cycle

28 days (hSAR)

Local imaging time

05:00 / 18:00

Location accuracy

4.82 m RMSE, < 7.32 m CE90

Imaging mode

Spotlight
- swath: 5 km
Strip (max. 840 km)
- swath: 30 km
Wide swath (max. 840 km)
- swath: 100 km

Retrieving Lake Levels From Landsat Imagery Using Lake Inundation Area-Lake Level Rating Curves Constructed From Lidar Data

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The methods for retrieving lake level from Landsat imagery using the lake inundation area-lake level rating (IALLR) curve constructed from LiDAR data are developed and tested over the Wowachi (WWC) lake in northwest China. A terrestrial LiDAR system manufactured by Leica Geosystems is utilized to produce 1-m resolution digital elevation model (DEM) data. The LiDAR derived 1-m resolution DEM data is used to construct the IALLR curve. 53 cloud-free Landsat images during 2009-2015 downloaded from the U.S. Geological Survey are processed for mapping lake inundation areas. The kNN (nearest neighbor) classification method is applied for Landsat image classification and identifying water-body pixels. Using the Landsat measured lake inundation areas, 53 lake levels are estimated based on the constructed IALLR curve. The average root mean square error (RMSE) and the coefficient of determination (R²) of the estimated lake levels against the measured lake levels are

0.48 m and 0.87, respectively, which demonstrate that the IALLR curve can be constructed from LiDAR derived DEM, and the constructed IALLR curve can be used for estimating lake levels from Landsat measured lake inundation areas. In this study, three commonly used image resampling methods, i.e., the nearest neighbor, bilinear interpolation, and cubic convolution, are also applied to resample the Landsat images from 30-m resolution to 1-m resolution. The results show that using the resampled Landsat images can reduce the RMSEs of the estimated lake levels by 6 cm. The difference in the estimated lake levels among these three resampling methods is insignificant, although the bilinear interpolation method produces slightly better results than other two methods.

Keywords: lake level, lake inundation area, LiDAR, Landsat, the kNN method, image resampling

Small Spacecraft Aist-2d: Technical Features, Results of Operation and Development Prospects

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Experimental and technological (ET) small spacecraft (SSC) Aist-2D was launched on 28 April, 2016 from Vostochniy spaceport via rocket Soyuz-2 stage 1a with Volga upper stage in cooperation with Lomonosov spacecraft (designer – Corporation VNIIEM, JSC) and self-unit module of scientific and technical hardware Contact-Nanosputnik (designer – Samara University).

JSC SRC Progress is designer and operator of the Aist-2D SSC which provide the control and data reception and processing.

The main priorities of SSC mission are the development and demonstration of new technical solutions, development and certification of target hardware, scientific hardware, support systems and software for further using in advanced development of JSC SRC Progress.

Additionally to payload onboard AIST-2D it had been installed the optoelectronic high-resolution equipment AURORA which provides survey of the Earth surface in panchromatic range and 3 narrow channels of visible range. The data obtained by this hardware are of practical importance for wide range of customers and allow solving different thematic tasks:

- Delimitation of agriculture fields and agriculture seeding;
- Control of illegal common minerals extraction places;
- Control of illegal solid domestic waste dumping areas;
- Control of unauthorized economical activity;

- Control of deforestation because of negative effects;
- River network mapping;
- Monitoring of water protective areas;
- Flood flows detection in high water period and other tasks.

From the very beginning of AIST-2D SSC regular operation the space survey materials had been highly appreciated by specialized organizations which process and distribute the Earth remote sensing data.

To involve the wide range of AIST-2D SSC data customers, the distribution agreements with GIA Innoter, Closed corporation SPC Rakurs Projects, as well as agreement with JSC Glavkosmos under which the AIST-2D SSC data should be applied to international project on seacraft monitoring had been concluded.

The key users of information products based on remote sensing data obtained from AIST-2D SSC are such organizations as JSC Glavkosmos, EMERCOM of Russia, International Civil Defense Organization, Ministry of Forestry, Environment protection and Natural Management of Samara Region.

When SSC designing, the platform approach had been used that allowed to create multitask SSC with wide range of target hardware. The further development of this project should enable to get the series of SSC with target characteristics which should provide high-detail wide-span stereoscopic survey.

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Automated Complex of the Meteor-M-2 Satellite Payload Data Quality Analysis

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The automated complex is designed by JC “CTT Group” for “VNIIEM Corporation” JC. The hardware-software complex is developed as a part of the chief designer’s technological kit for the analysis and quality control of Meteor-M-2 satellite payload data.

The complex is designed to meet the following challenges:

- Assessment of compliance between the information obtained at payload ground metrological certification, calibration, alignment and geometric certification, and the results of test flights and operation
- Payload data quality assessment at all stages of the satellite lifetime
- Information support of the satellite designers regarding payload data quality assurance
- Comparison of the payload data to the similar data of the other satellites (including foreign ones) considering the level of information processing.

Monitored payload consists of:

- KMSS VIS Scanning Imager
- MSU-MR Scanning Radiometer
- IRFS-2 Infrared FTS (Fourier Transform Spectrometer)

- MTVZA-GY Imaging/Sounding Microwave Radiometer

Payload data analysis and quality assurance is carried out on the basis of the following methods:

- Payload data quality assessment for each payload
- Comparison of the payload data characteristics to the characteristics of similar data of the other satellites (including foreign ones)
- Payload data quality assurance for each payload, including an analysis of the reasons for payload data quality decrease and the development of recommendations for their elimination.

The software includes:

- Payload data input and storage
- Automatic and interactive payload data quality analysis
- Payload data quality monitoring
- Automatic control of the payload data presence and transmission.

The complex is a spatially distributed system located at two sites (NTS OMZ and VNIIEM) connected by a data transmission channel.

Automatic object detection and identification on the remote sensing imagery of the sea surface

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The process of sea and ocean surface remote sensing monitoring has a number of principal features in comparison with the process of land monitoring. To detect and identify objects from the survey data produced from an ERS satellite (for space imagery) or UAV (for aerial photography), a large number of images of the coverage area have to be processed, of which only percentages can contain significant information [1].

To select significant images for further detailed analysis, it is possible to use a number of automation tools for processing large arrays of survey data, based on software-implemented methods for detecting and identifying objects on sea surface images. The result of their consistent application is information about the presence of objects of interest in a pre-designated search area, its geographical coordinates and characteristics.

- Defining the boundaries of the search area

The initial data for this complex process are [2]:

- Data on the search area (vertex points coordinates of the polygon that limits the fishing area for which analysis should be proceeded);
- Time range (start and end date and time, indicating the time interval);
- Historical oceanographic and meteorological data, on the basis of which the probability of finding a fish cluster of a designated type of commercial fishery is estimated;
- Fishing vessels trajectories operational data for the given area.

As a result of the operation of the methods in and search algorithms for the Object of Interests (OI), the coordinates of fragments of marine areas should be obtained for which, according to high-resolution space imagery, the detection and identification of OIs recorded in these imagery is proceeded [3].

When searching for OI, two main methods and related algorithms are used:

- Method of searching for OI by oceanographic meteorological characteristics;

- The method of searching for OI from data based on the activity of fishing vessels.

- Object detection on satellite-based images

In the vast majority of cases, objects of several different types can appear on the image. In this case, object detection can be performed simultaneously with their classification. When implementing a simple detection, all types of objects that must be recognized can be combined into one class.

In this form, the detection task is to recognize the presence on the image of an object of a given type with a certain probability and to predict its position on the picture in the form of a corresponding bounding box.

- Object segmentation

Segmentation is understood as the division of an image into areas corresponding to different objects. It is required that the constructed areas as accurately as possible cover the objects of the image, taking into account their complex shape and the inevitable overlays.

Images of this kind of objects are areas characterized by certain textural features and having fuzzy blurred boundaries (see Figure 1).

- Objects of interest classification

The classification of objects of interest is understood as the assignment of image areas obtained through detection and segmentation procedures to one of the predefined types.

For a full solution of the problem posed in the study, it is important not only to highlight the rectangular area in which the OIs are located, but also to accurately determine the boundaries of the alleged objects, since the shape of the object boundary in some cases is an important identifying feature used to classify the object of interest to a particular type. Among the objects under consideration, not only the fish accumulations that are of primary interest are represented on the photographs, but also other objects, and in many cases it is possible to distinguish the classes of objects among themselves precisely in the form of boundaries.



Fig. 1. Commercial fish accumulation and the difference in depth (underwater relief)

- Object of interest boundaries reconstruction

For the initial delineation of boundaries, the well-known operators of Gabor, Canny, and Sobel are applied to the image. After applying this procedure, a system of lines appearing on the boundaries of various objects of interest appears on the image. As a rule, these lines are intersected and interrupted. In Figure 2 a snapshot of an oil spill that was "cut" by a passing vessel and the boundaries identified after some filtration are presented.

For successful processing of such situations, it is necessary to solve the task of tracing the boundary of the object of interest in conditions of overlaying the image of another object and its boundaries.

This problem reduces to the task of reconstructing the interrupted curves in the image.

To solve it, the approach to solving the problem of recovering damaged images was used [4], which, in addition to the obtained sections of smoothed curves, takes into account also the original image itself, which improves the quality of the solution of the problem. The proposed method is universal, it can work both with a flat image and with a spherical image, i.e. defined in a region on a sphere of sufficiently large radius.

- Object detection and classification algorithm for satellite images processing

For today in object recognition problem, some set of the statistical features formed at the output



Fig.2. Identification of the boundaries of the spot on the sea surface and the track from the passing vessel

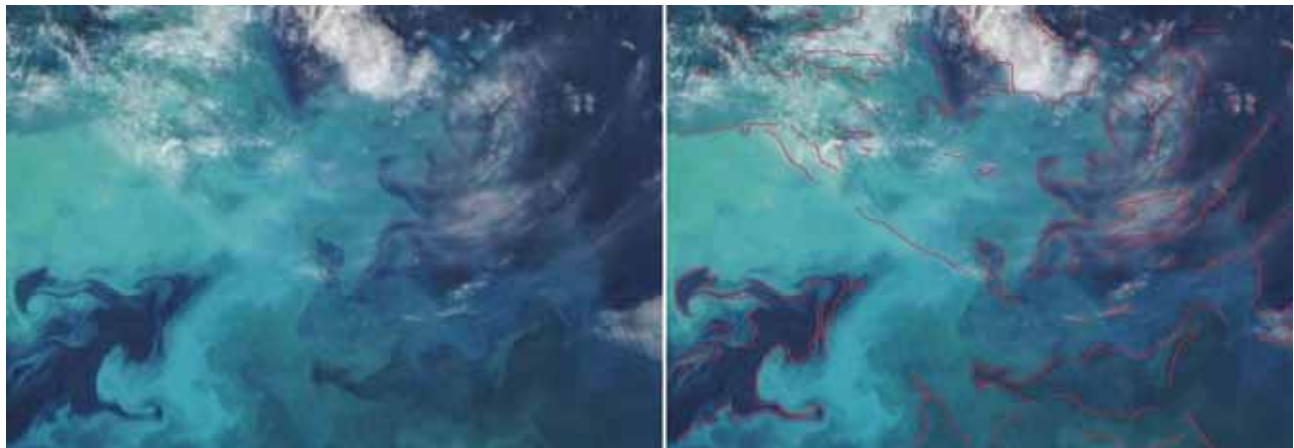


Fig. 3. Application of the boundaries of the phytoplankton development area against the background of the atmospheric cloudiness

of some convolutional neural network (SNC) processing the image [5] are usually selected as classification characteristics. The closest application can be considered to be the type of network with so-called "U-net" architecture, often used to solve segmentation problems of an object with a fuzzy outline on an uneven background, for example, such as scanning human organs (c); processing of remote sensing data [6], etc. The algorithm based on the architecture of a network of the U-net type is able to use a smaller, in comparison with other, set of data for "learning" the network, which is critical for the problem considered in this paper [7].

As the training datasets, satellite images of objects of 4 classes on the sea surface, available in a small amount at the moment, were used:

- fish accumulations
- algae / plankton
- pollution

- sea surface without objects.

as well as generated synthetic images of similar objects.

Fig. 4 presents the results of constructing masks of objects obtained as a result of training the network according to the available data set with subsequent testing on some test examples.

To date, the described methods of processing remote sensing data with respect to the task of monitoring the sea surface are implemented as a complex of software. In the near future, it is planned to conduct their testing on arrays of both synthetic data and real data of high-resolution satellite imagery.

The work was carried out with the financial support of the state represented by the Ministry of Education and Science of Russia within the framework of the project RFMEFI60716X0153.

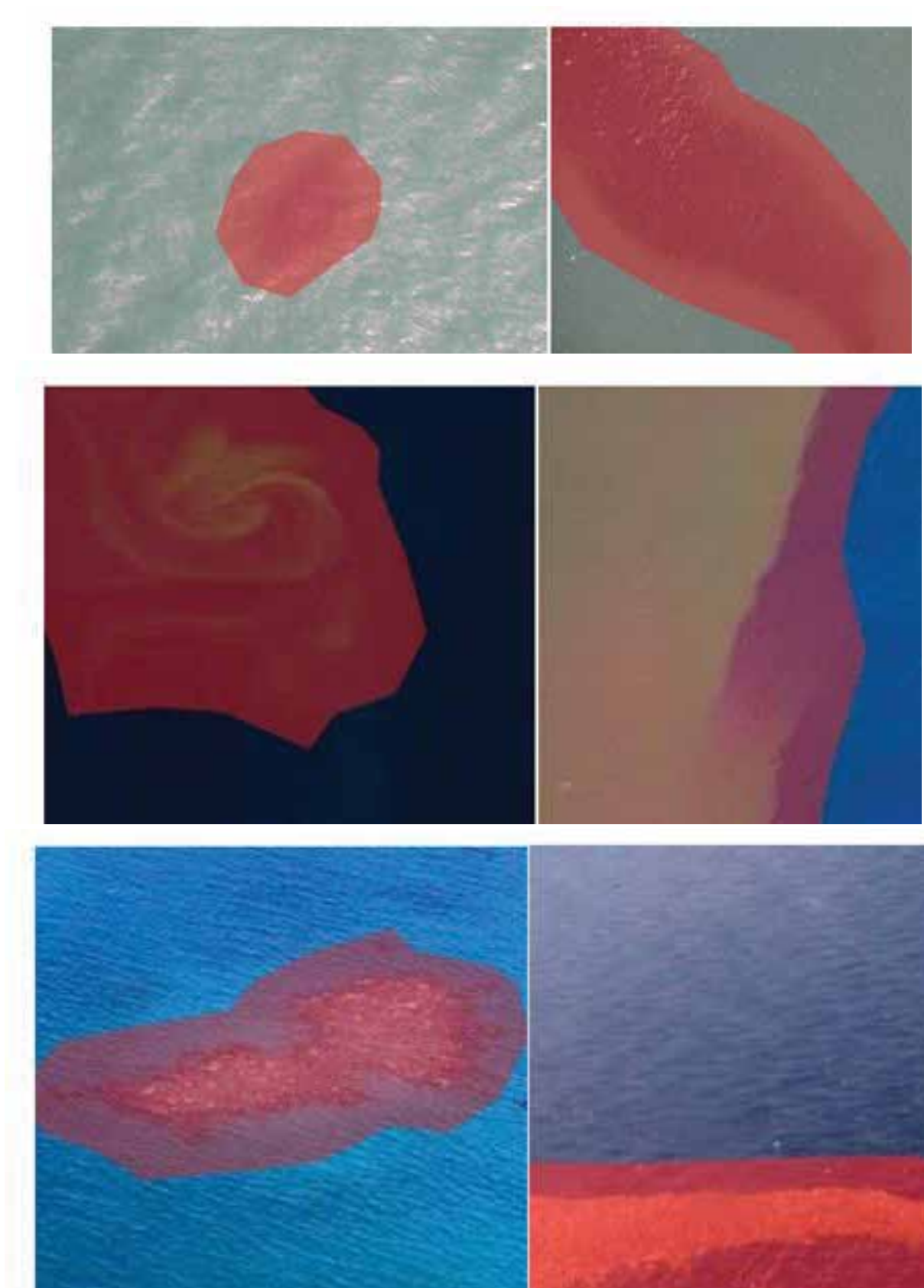


Fig.4. Masks of objects obtained for the OI class "fish aggregation", "algae" and "garbage".

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3D Photogrammetry & Virtual Reality. First experience.

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The ability to combine 3D BIM models of individual buildings and constructions with 3D GIS information allows planning and modeling the development of the city, holding discussions within the virtual model of the city and completely refusing the outdated approach of creation of paper-mache models to the side of information models

Pilot VR project of information model of Yekaterinburg central part was presented at VR Concept booth during the exhibition Innoprom 2018. The model was based on vector 3D model, created by Racurs on the basis of stereo-photogrammetric processing of satellite data and BIM models of future buildings.

Wearing helmets of virtual reality, specialists moved around virtual Yekaterinburg and discussed with colleagues, connected remotely from another city, arrangement of new buildings from existing

BIM projects in current GIS model of the city, measured, changed and moved objects etc.

Virtual information model of the city or CIM (CITY INFORMATION MODELLING) – is a new concept that appeared just at the end of 2000s. CIM genetically has grown from BIM, whose ideology has been counting its history since late 80s – early 90s of the last century. BIM as a method of complex information representation of a building (architecture, constructions, engineer infrastructure, etc.), was quite sufficient for one or maximum group of buildings. But to describe the model of the city this is not enough. Geology, construction, transport network, demography, ecology, etc. require other principles of modeling and visual presentation.

VR means appearance of new market for technologies of RSD photogrammetric proceeding.



Fig. 1. VR 3D models — live demonstration during the exhibition Innoprom 2018.



Fig. 2. 3D model on the basis of stereo-photogrammetric processing of satellite images.

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