Introduction.

The remote sensing (remote-sensing, télédétection, distanţionnoe zondirovanie Zemli) means to obtain information about objects or phenomena in the environment, using sensor devices beeing not in contact with the objects, but remote.

În principle, remote sensing involves the acquisition of information remotely.

Its official definition is:

"the set of knowledge and techniques for determining the physical and biological characteristics of objects by measurements made remotely without material contact with them". (COMITAS - Commision ministérielle de la terminologie de la télédétection aêrospatiale - 1988).

The introduction go on with the history of using aerial images in different domains, and the first spatial images obtained in different spatial missions. All these images are the basis for the first remote sensing satellite "LANDSAT" and the important and reach imageries obtained by this important remote sensing mission.

Although the idea of an artificial satellite of Earth dates probably from 1870 [Britain Encyclopidia], just after 1957 - the year of the first artificial satellite launches, have been placed in orbit around Earth, several hundreds of such satellites for both scientific research and other purposes, such as communications, weather, Earth resources management, and also in the military domain.

Systematic observation using satellites in orbit around the Earth began in 1960 with the launch of satellite TIROS 1, the first weather satellite that used an image acquisition system with low resolution. The following satellite, named NIMBUS, part of the program - IRLS (Interrogation, Recording and Location System) developed by NASA, program designed to demonstrate the feasibility of using artificial satellites for collecting meteorological data.

The main space research programs in remote sensing field are also presented in the first chapter of the thesis, in which an important space is allocated for LANDSAT mission.

In the same chapter are presented the usage of remote sensing technics for the Earth natural satellite research – the Moon.

Is also included a short presentation of Global Navigation Satellite Systems.

Global Navigation Satellite System (GNSS) is the term used for satellite navigation systems that provide geospatial positioning independently anywhere on Earth. In other words, the existence of a GNSS allows small electronic receivers, to determine with an acceptable accuracy, their position using time signals transmitted along a sightlines, by the satellite radio system.

A table with technical orbital characteristics of all these satellite missions presented in first chapter, is included also hear.

Main remote sensing satellite missions.

Satellite	Orbite Type	H (km)	i	T (sec)	Cicle (days)
LANDSAT MSS 1-2-3	Sun synchronous, near polar	919	99,09^o	6180	18
SEASAT	non Sun synchronous	800	108^o	6006	152
LANDSAT – TM 4-5	Sun synchronous; near polar	705	98,2^o	5940	16
LANDSAT- ETM 6-7	Sun synchronous; near polar	705	98,2^o	5940	16
EOS – AM1	Sun synchronous; near polar	705	98,2^o	5940	16
EO – 1	Sun synchronous; near polar	705	98,2^o	5940	16
EOS – PM1(A-Train) • Aqua • Aura • PARASOL • CloudSat • Calipso • Glory • GCOM – W1	elliptical Sun synchronous; near polar	708 691	98,14^o	5904	16
OrbView – 1	Sun synchronous; near polar	740	98,2^o		< 2
OrbView – 2	Sun synchronous; near polar	708	98,2^o	5940	< 2
OrbView – 3	Sun synchronous; near polar	470	97,25^o		< 3
OrbView – 4	Sun synchronous; near polar	470	97,25^o		< 3
OrbView – 5	Sun synchronous; near polar				
Earlybird	Sun synchronous; polar	480	97.3^o	5648	2-5
Quikbird	non Sun synchronous	600	66^o		
Ikonos 1-2	Sun synchronous; near polar	681	98,1^o	5880	2.9
WorldView – 1	Sun synchronous; near polar	496		5904	1.7
WorldView – 2	Sun synchronous; near polar	770		6000	1.7
MOS	Sun synchronous	909	98,2^o	6180	17
J – ERS	Sun synchronous	568	98^o	5760	44
TRMM	Sun synchronous	346	35^o	5478	
ADEOS	Sun synchronous	800	98,6^o	6060	41

Satellite	**Orbite Type**	**H** (km)	**i**	**T (sec)**	**Cicle (days)**
ADEOS – 2	Sun synchronous	802.9	98,62^o	6060	40
ALOS	Sun synchronous	700	98^o		
SPOT	Sun synchronous; near polar	832	98,7^o	6087.6	26
FormoSat – 1		600	35^o	5802	
FormoSat – 2	Sun synchronous Circular	891	99,1^o		1
IRS	Sun synchronous	817	98,69^o	6030	24
IRS – P4 (Oceansat-1)	Sun synchronous near-circular	727	98.4^o	5964	
EROS – A	Sun synchronous	480		5400	
EROS – B	Sun synchronous	600		5400	
CartoSat 1	Sun synchronous Elliptical	632 621	98,87^o		
CartoSat 2	Sun synchronous; near polar	630	97.91^o	7200	
ERS faza 1	Sun synchronous; near polar	785	98,516^o	6000	3
ERS faza 2	Sun synchronous; near polar	782	98,543^o	6000	35
ERS faza 3	Sun synchronous; near polar	770	98,491^o	6000	168
ENVISAT	Sun synchronous	799,8	98,55^o	6035.4	35
RADARSAT	Sun synchronous	798	98,6^o	6042	24
RESURS – 01	Sun synchronous	678	98,04^o	5880	21
OKEAN O – 1	Circular	664	98^o	5880	21
CBERS China Brazil Earth Resources Satellite	Sun synchronous	778			
COSMO SkyMed • COSMO – 1 • COSMO – 2 • COSMO – 3 • COSMO – 4	Circular	619	97.86^o		½
RazakSat	NEO – Near Equatorial Orbit Sun synchronous near-circular	695 675	9^o		
RapidEye • Tachis • Mati • Choma • Choros • Trochia • Argo (Taiwan)	Sun synchronous Circular	620	97.79^o		

II.The general problem of fixed centers.

In the second chapter is presented a minimal problem of celestial mechanics, the problem of mouvement of a material point under the mutual forces generated by some fixed centers. The material point have any action on fixed centers and so we consider to have a passive action.

Each fixed center have a finite mass and his action is only on material point and no on other fixed centers.

The force, which each fixed center point acts on free material point, point being in passive motion, is assumed to be oriented in the direction joining these points. As the size, this force is assumed proportional to the product of the masses of these items and in a some dependence with the distance between them. In the most general case, this function can also be dependent on the first two derivatives of specified distance with respect to time.

If the fixed centers number is equal to two, and the force law is the law of Newtonian gravitation, i.e. inversely proportional to the square of their mutual distance, we have the classical problem of two fixed centers.

The solution of the two fixed centers problem was done by Euler [Euler 1760] for the case of movement in a plan. The general case was solved by Lagrange [Lagrange] and Jacobi [Jacobi 1843].

The trajectories equation, for certain types of movements were given by Legendre, who developed the theory of elliptic integrals [Legendre]. From the many works on this issue is worth mentioning that of J. Andrade [Andrade, 1890], dedicated to a method of obtaining the parametric equations of the orbit, and that of Königsberger [Königsberger 1860], who proposed solving the problem by expressing the elliptic integrals function of Euler integrals.

We can mention also the works of Weld [Weld 1889, Weld 1890], Hiltebeitel [Hiltebeitel 1911] Charlier C.L. [Charlier 1966] Tallqvist H. [Tallqvist 1927] and Badalijan G. [Badalijan 1934, Badalijan 1939] *).

This problem, in classical celestial mechanics had only a theoretical value, and gained a practical value, lately, having regard to new developments of this science – namely, the theory of motion of artificial satellites around a planet from our Solar System.

So we could mention the works published by R. Newton [Newton 1959], Demin V.G. [Demin 1960], E.P. Aksenov, E.A. Grebenikov and V.G. Demin . [Aksenov and others 1961 and 1963] for the problem of two fixed centers, the last of them, giving the generalized solution of the problem of two fixed centers, solution used for the calculation of intermediate orbits of artificial satellites of Earth.

In the following years (1970 – 1985), a lot of research effort go in the direction of theoretical development, and not only, for the fixed centers problem. Such we mention the works of Kozlov I.S. regarding the problem of four fixed centers, [Kozlov 1974, Kozlov 1975], the works of Arazov G.T. for the problem three or five fixed centers [Arazov 1975, Arazov 1976, Arazov and Gabibov 1977, Arazov 1980, Arazov 1981, 1983 and Arazov and Gabibov 1984], and those of Lukaşevici E.L., for the six fixed centers problem [Lukaşevici 1979 a, Lukaşevici 1979 b, Lukaşevici 1979 c]. We need to mention the contribution of Duboşin G.N. [Duboşin 1978] for generalize the problem to n fixed centers.

So, in this second chapter, are presented all these problems, and for the six fixed centers problem, we put in evidence some coefficients that assure the equivalence between the generalized solution of the problem of two fixed centers and the similar six fixed centers problem. We named them **Lukaşevici coefficients**, and based on a FORTRAN program, author contribution, we compute these coefficients for the remote sensing satellites described in first chapter.

Table 2.6.
The Lukaşevici coefficients for a lot of remote sensing satellites.

Satelit	H	i	$L^*_\xi * 10^{-7}$ ($L_\xi = 1+L^*_\xi$)	$L_{\eta 1}$	$L_{\eta 2} = L_0$ ($* 10^{-3}$)
LANDSAT MSS	919	99,09°	2.942728	-10.501590	-2.460190
SEA SAT	800	108°	3.060146	-10.501613	-2.500835
LANDSAT - TM	705	98,2°	3.139510	-10.501623	-2.535572
LANDSAT-ETM	705	98,2°	3.139510	-10.501623	-2.535572
EOS – AM1	705	98,2°	3.139510	-10.501623	-2.535572
EO - 1	705	98,2°	3.139510	-10.501623	-2.535572
EOS – PM1	705	90°	3.126032	-10.501617	-2.536502
Orb View	740	70°	3.049409	-10.501590	-2.526819
Early bird	480	97.3°	3.376486	-10.501664	-2.619449
Quik bird	600	66°	3.177974	-10.501609	-2.578848
Ikonos	681	98,1°	3.163214	-10.501627	-2.544288
MOS	909	98,2°	2.950229	-10.501591	-2.463689
J - ERS	568	98°	3.280290	-10.501647	-2.586023
TRMM	346	35°	3.380542	-10.501620	-2.682854
ADEOS	800	98,6°	3.049034	-10.501608	-2.501594
ADEOS - 2	802.9	98,62°	3.046364	-10.501607	-2.500569
ALOS	700	98°	3.144156	-10.501624	-2.537401
SPOT	832	98,7°	3.019661	-10.501603	-2.490338
IRS	817	98,69°	3.033410	-10.501605	-2.495600
Oceansat - 1	727	98,4°	3.118244	-10.501619	-2.527618
ERS faza 1	785	98,516°	3.062945	-10.501610	-2.506906
ERS faza 2	782	98,543°	3.065805	-10.501611	-2.507967
ERS faza 3	770	98,491°	3.077067	-10.501613	-2.512233
ENVISAT	799,8	98,55°	3.049150	-10.501608	-2.501670
RADARSAT	798	98,6°	3.050897	-10.501608	-2.502300
RESURS - 01	798	98,04°	3.050105	-10.501608	-2.502334
OKEAN O - 1	664	98°	3.180175	-10.501630	-2.550498

III. Intermediate orbits

Artificial Earth satellite motion theory timeline cover two successive lines of approach:

* Unperturbed movement theory - apparently theoretical;
* Perturbed movement theory - practice visible.

Ȋn many works on the theory of perturbed motion, the intermediate orbit is chosen as Kepler elliptical orbit, resulting from the solution of the classical problem of two bodies.

This approach, we see in some works of prestige, from which we mention: D. Brower [Brower 1959, Brower and Hori 1961], I. Kozai [Kozai 1959, Kozai 1961 a,b, Kozai 1962]. In this works was used one of the most powerful methods - namely Delaunay's - von Zeipel method.

Choosing the intermediate orbit as Kepler orbit, has the advantage that for the computed perturbations it can use the detailed achievements of classical celestial mechanics, that is, with insignificant changes, developments in power series of coordinates of the movement undisturbed. However, having in mind the context in which they were designed and developed these theories. Natural Bodies in the Solar System, characterized by very small inclinations of the orbits, the time frame in which movement is studied, corresponding to hundreds of revolutions, by far the conditions are not met in the problem of motion of artificial satellites of the earth, whose prediction in question are taken hundreds and thousands of revolutions of the satellite.

On the other hand, a series of satellites in orbit around the Earth have orbits with very large excentricity, exceeding known limits of Laplace (e = 0.667), which defines the convergence of development in series of coordinates and therefore, also the development in series of perturbation function.

An alternative to classical methods of perturbation theory, is the use of intermediate nonkeplerian orbits.

Probably the first attempt in this direction is the work of R. Newton [Newton 1959], about the possibility of applying the problem of two fixed centers on satellites movement theory around a spheroidal planet. This idea is found in development offered by Demin [Demin 1961].

Significant in this direction are the works of B. Garfinkel [Garfinkel 1959], R. Barrar [Barrar 1961], and especial the works of John Vinti [Vinti1959 a, b, 1961, 1962, a, b] respectively Kislik [Kislik 1959], on choosing an intermediate orbit for unperturbed artificial Earth satellites for the particular case of a spheroidal body with symmetry to the equatorial plane.

We need to mention that Barrar's solution, characterized by a special simplicity, has found application in the construction of artificial satellite motion theory for high Earth orbits.

Aksenov, Grebenikov and Demin [Aksenov and others 1963] have presented a generalization of the problem of two fixed centers, for which Vinti, Barrar and Kislik solutions are particular cases or limit case of generalized solution.

In this chapter is developed this theory.

IV. Author Involvement in Romanian program for space and remote sensing activities.

The first concerns regarding the assimilation and use of remote sensing techniques, in Romania, was in Department of photogrammetry from the Faculty of railways, roads, bridges and buildings of the Institute of Geodesy, Bucharest, under leadership of PhD Eng. Nicolae Oprescu NASA PI (Principal Investigator) Code G - 27 940 [Oprescu 1977].

Subsequently, concerns were supported and coordinated by the Romanian Commission for Space Activities of the National Council for Science and Technology, who also assure the publication of the Romanian Remote Sensing Bulletin.

Joining this team, the author has developed a software package for digital processing LANDSAT images [Vais 1980], used in all research contracts for which the Faculty Department of photogrammetry is in partnership.

This software package, a result of using knowledge of mathematics (statistical processing) and gained experience as a software author, together with the rich experience in photogrammetry and remote sensing of Professor Nicolae Oprescu, consisted of three components, namely:

- A component of the transformation of LANDSAT images in one format designed by us;
- A computing component;

- A component for unsupervised classification;

- A component of providing the necessary interpretation of reports obtained from both original and transformed data (ie, single and bi-dimensional histograms, histogram equalization and its application on the original image, thematic maps).

All programs, with one exception, namely data acquisition program from non-standard format provided by the supplier, necessarily in assembly language, was developed in COBOL language for Felix – 1024 romanian computer, mathematical functions being generated in this language, by the author. The choice of language was imposed by the COBOL facilities for working with large volumes of data, unlike the FORTRAN language developed for high volume of entry computing but with small number of entry data.

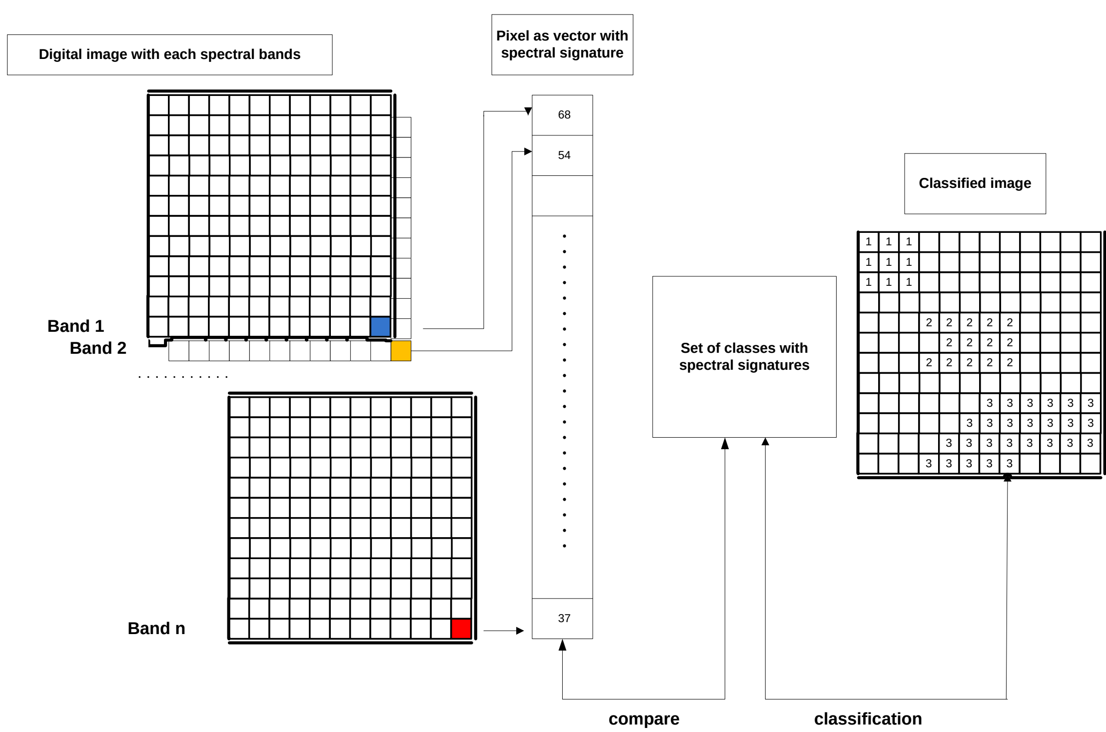
Computing component is based on Karhunen – Loeve transformation, providing compression of a minimum four-dimensional space, as in LANDSAT – MSS image, in each pixel (pixel = picture element) is characterized by four spectral answers, in two – dimensional vector space. Also known as principal component transformation, it classifies the software package, in application type class named PCA (Principal Component Analysis). At the same time, for the histogram equalization, we used the numerical Fourier Transform algorithm.

This format is based on consideration of the pixel as part of a vector space of spectral answers. At the same time each pixel have the line and column reference number inside the image, allowing recovery of the original image format.

Record structure is:

Number of scan line	Pixel number inside line	Pixel as vector of spectral signature					Pixel as vector of PC signature					Sample code
		Spectral Band 1	Spectral Band 2	Spectral Band 3	Spectral Band	Spectral Band n	Principal compo-nent 1	Principal compo-nent 2	Principal compo-nent 3	Principal compo-nent	Principal compo-nent n	

Training schema of this vector space is given below including the associated unsupervised classification schema:



Note that, in determining the format of input data, we have in mind the possibility of using this software package for any multispectral image (LANDSAT TM, LANDSAT ETM, SPOT, etc..), by extending the space dimension of spectral answers.

After 1991, establishing of Romanian Space Agency (RSA), diversified cooperation between the author and the mention above team, by some research contracts [Vais 1993, Vais 1995 and Vais 1996], the results being presented in various international scientific events [Vais, Oprescu and others 1995, 1996, 1997, 1997a, 1998]. In 1996, the author obtained from PETROM side a scholarship for a documentation and practice stage at the Laboratory for Remote Sensing and GIS from the Department of Geography, Nottingham University, under Prof. Paul M. Mather leadership. The practice consisted in the processing of LANDSAT images, regarding the territory of Romania, using ERDAS software. The results were included in the ASR contract research report [Vais 1996].

In the oil company where I worked, I created and implemented projects for the use of GIS and for usage of remote sensing data and images I generated a project for monitoring oil slicks (spills) presented as Case study in Chapter 5. The news in this approach is materialized in use both the radar images and the pseudo multitemporale images. Pseudo images are obtained either by merging panchromatic images, with higher resolution, with lower-resolution multispectral images, either by merging multispectral imaging radar images with the same resolution or different, either by merging the same type of images acquired at different time moments.

A new approach means the usage of hyperspectral images. For these latter images I will build a database with spectral behavior for both oil and marine algae colonies, specific processes in marine pollution monitoring.

In the same chapter is included the FORTRAN software for intermediate satellite orbit computing, that include a special branch for six fixed centers as I mention in third chapter.

V. GIS and remote sensing techniques used for oil spills monitoring in marine environment – Case study.

After GIS and remote sensing techniques presentation I include the following case study:

Black Sea oil spills could be the result of an accident in the work of exploration, drilling wells or in the activities of mining (extraction) of oil and gas or an irresponsible actions of the discharge from containers oil waste in the sea.

These kinds of pollution accidents must be reported to the international offices and in the same time, the reports with the monitoring actions in terms of environmental impact.

Such accidents on seas, oceans or coastal areas, unlike river pollution, involve large areas for which monitoring actions requires airborne and satellite remote sensing resources. Here we can find the necessity of remote sensing satellite missions in order to supplement other airborne observations.

The multitude of operational satellite missions requires a strategy and methodology in the selection and use of satellite remote sensing images.

Satellite images obtained by optical sensors (black – white panchromatic images or color images - multispectral) have some disadvantages, namely:

• Reduced visibility, cloud cover conditions, or generally, in other unfavorable weather conditions;

• false alarms due to sun glare, due to incorrect reflection characteristics of the sea bottom;

• cloud shadow;

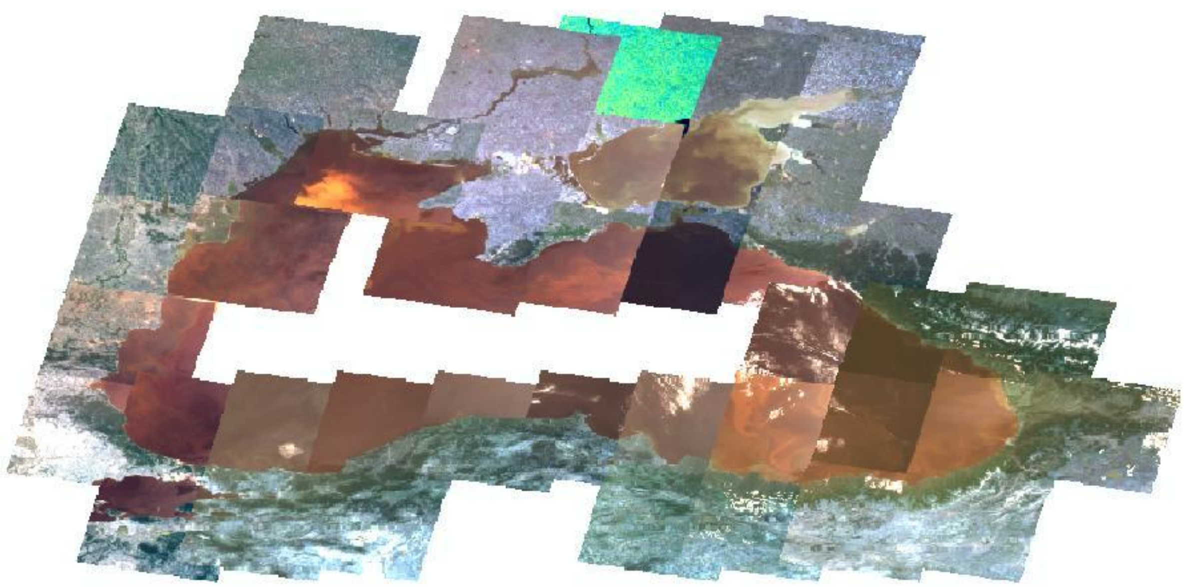
• biological materials that look like oil stains;

• Situations in which petroleum products can not be seen or distinguished from the environment;

These disadvantages can be filled by election radar image that does not depend on the illumination surface water.

Radar image processing techniques implemented in new versions of software - ERDAS and ENVI, provide identification of oil spill even for the thin spots.

To illustrate the usage of images from remote sensing, we selected 41 images LANDSAT ETM+, processed them using specialized software in the remote sensing image processing - ENVI (ITT Solution), their georeference in ArcMap (GIS software, ESRI) and the mosaic image using components from ArcGIS Desktop software, resulting in a coverage area including the Black Sea coast.



Coverage with Landsat ETM images for the Black Sea area.

Color differences come from different periods of image acquisition, we use "free" images but in the development of a project we will take into account the necessity to be purchased images compatible in time. The following table shows the index LANDSAT ETM + images and geographical coordinates of their corners measured in degrees of arc and seconds of arc converted to decimal degrees.

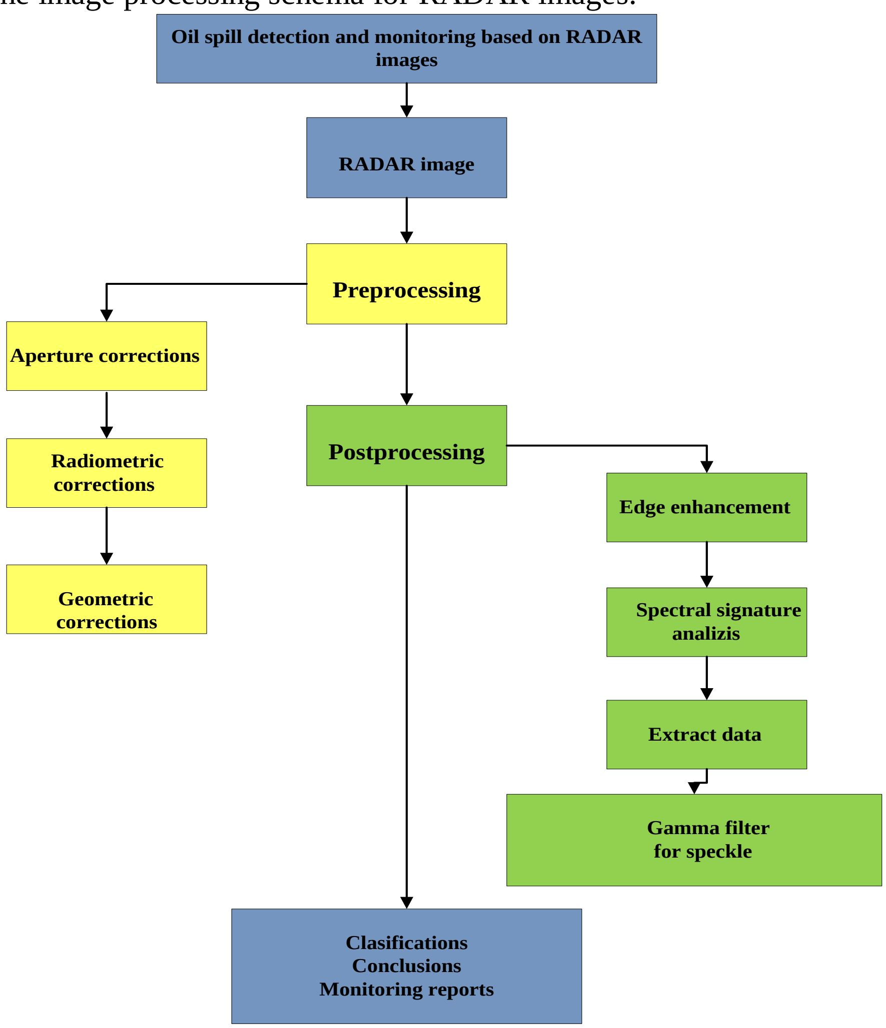
LANDSAT ETM+images regarding Black Sea area..

Or-bit Li-ne	Ima-ge Data	Geographic coordinates for corners							
		Left - up		**Right - up**		**Left - down**		**Right - down**	
		X = longitude	**Y = latitude**	**X = longitude**	**Y = latitude**	**X = longitude**	**Y = latitude**	**X = longitude**	**Y = latitude**
181 28	**25.05 .2001**	28,0930253	47,0103412	30,4548008	46,6643278	27,5306109	45,3996551	29,8292663	45,0664424
181 29	**07.06 .2000**	27,6221596	45,5876630	29,9268388	45,2399744	27,0835447	43,9699711	29,3294641	43,6447459
181 30	**23.07 .1999**	27,1689595	44,1456460	29,4193742	43,8155703	26,6484673	42,5382168	28,8436606	42,2190098
181 31	**25.07 .2000**	26,6951158	42,7228899	28,8922823	42,4014750	26,1938696	41,1107494	28,3392791	40,7992531
180 27	**21.07 .2001**	30,1390855	48,4262567	32,5665791	48,0715310	29,5552150	46,8187892	31,9141208	46,4756503
180 28	**19.08 .2000**	29,6397434	47,0029054	32,0047186	46,6580670	29,0787571	45,3963797	31,3790554	45,0612630
180 29	**02.07 .2000**	29,1464523	45,5731361	31,4517776	45,2367252	28,6079755	43,9658233	30,8524651	43,6390724
180 31	**02.07 .2000**	28,2071621	42,7187305	30,4056036	42,3965088	27,7050327	41,1070481	29,8522450	40,7964046
180 32	**02.07 .2000**	27,7607740	41,2897370	29,9121148	40,9756191	27,2752056	39,6764047	29,3762315	39,3722922
179 28	**14.05 .2002**	31,1989577	47,0165244	33,5630328	46,6702439	30,6372483	45,4049192	32,9370543	45,0704412
179 31	**12.06 .2001**	29,7508906	42,7259485	31,9506504	42,4056188	29,2478687	41,1104411	31,3932572	40,7989187
179 32	**12.06 .2001**	29,3054929	41,2986371	31,4568218	40,9859130	28,8198694	39,6815329	30,9198321	39,3761666
178 27	**21.08 .2000**	33,2462203	48,4251597	35,6720435	48,0692204	32,6637958	46,8196351	35,0219926	46,4770361
178 28	**21.08 .2000**	32,7286356	47,0016437	35,0915932	46,6555859	32,1684218	45,3942689	34,4675429	45,0605156
178 29	**21.08 .2000**	32,2307561	45,5765879	34,5364223	45,2397066	31,6933048	43,9684315	33,9392674	43,6415328
178 31	**21.08 .2000**	31,2912890	42,7218410	33,4911123	42,4001295	30,7893926	41,1085303	32,9355194	40,7972519
178 32	**04.07 .2000**	30,8513546	41,2896509	33,0010638	40,9762176	30,3665720	39,6771616	32,4666874	39,3717137
177 27	**16.07 .2001**	34,7775285	48,4239999	37,2044619	48,0681909	34,1914461	46,8159793	36,5515156	46,4741101
177 28	**03.07 .2002**	34,2872327	47,0096049	36,6533200	46,6632838	33,7239358	45,3967976	36,0267993	45,0639392
177 29	**10.05 .2000**	33,8036765	45,5760943	36,1097590	45,2382145	33,2658063	43,9686661	35,5138509	43,6431470
177 31	**13.07 .2000**	32,8507206	42,7206318	35,0490583	42,3985223	32,3510463	41,1091747	34,4939720	40,7976103
176 27	**09.05 .2002**	36,3365051	48,4381792	38,7650895	48,0833906	35,7496860	46,8283307	38,1092422	46,4855442
176 28	**09.05 .2002**	35,8167504	47,0148935	38,1833422	46,6699971	35,2545059	45,4038260	37,5558607	45,0695368
176 29	**22.09 .1999**	35,3580309	45,5775219	37,6651836	45,2409585	34,8186097	43,9711743	37,0650069	43,6441522
176 31	**01.08 .1999**	34,4318061	42,7248683	36,6316838	42,4023926	33,9318703	41,1144220	36,0744782	40,8032701
175 27	**21.07 .2002**	37,9039454	48,4299464	40,3300221	48,0743944	37,3172786	46,8190431	39,6753776	46,4762463
175 28	**13.06 .2000**	37,3663746	46,9987745	39,7304710	46,6533956	36,8074218	45,3929220	39,1075571	45,0586065
175 29	**02.07 .2001**	36,8852911	45,5793531	39,1910633	45,2426989	36,3457522	43,9679023	38,5915718	43,6413260
175 31	**04.08 .1999**	35,9718106	42,7209734	38,1720416	42,3992182	35,4694734	41,1102679	37,6148862	40,7984551
175 32	**13.06 .2000**	35,4835347	41,2913880	37,6351741	40,9786641	34,9987542	39,6786046	37,0982310	39,3735711
174 29	**09.08 .2000**	38,4397217	45,5744691	40,7451342	45,2369640	37,9011819	43,9665143	40,1466593	43,6401537
174 30	**09.08 .2000**	37,9612349	44,1490026	40,2096390	43,8201577	37,4413897	42,5376519	39,6374954	42,2184533

Or-bit Li-ne	Ima-ge Data	Geographic coordinates for corners							
		Left - up		Right - up		Left - down		Right - down	
		X = longitude	Y = latitude	X = longitude	Y = latitude	X = longitude	Y = latitude	X = longitude	Y = latitude
17431	22.06.2000	37,4671408	42,7189404	39,6666638	42,3977030	36,9648822	41,1079146	39,1098463	40,7972177
17432	22.06.2000	37,0208227	41,2903802	39,1721357	40,9766026	36,5376802	39,6773236	38,6357556	39,3726226
17330	06.09.2001	39,4893372	44,1480586	41,7380770	43,8183817	38,9695082	42,5349019	41,1657077	42,2156894
17331	19.09.2000	39,0470423	42,7232860	41,2468421	42,4002047	38,5445212	41,1095886	40,6989334	40,7985002
17332	17.07.2000	38,5840858	41,2943234	40,7348797	40,9803629	38,1004910	39,6804392	40,1991799	39,3765100
17230	18.09.2000	41,0363373	44,1491727	43,2842907	43,8198239	40,5153336	42,5379758	42,7109478	42,2196999
17231	10.07.2000	40,5747038	42,7181160	42,7718679	42,3958068	40,0729430	41,1057495	42,2173425	40,7957776
17232	10.07.2000	40,1290300	41,2887678	42,2767060	40,9743009	39,6447272	39,6749411	41,7443830	39,3713760
17131	05.09.2000	42,1162208	42,7216241	44,3101968	42,4009028	41,6154885	41,1084951	43,7584886	40,7972658

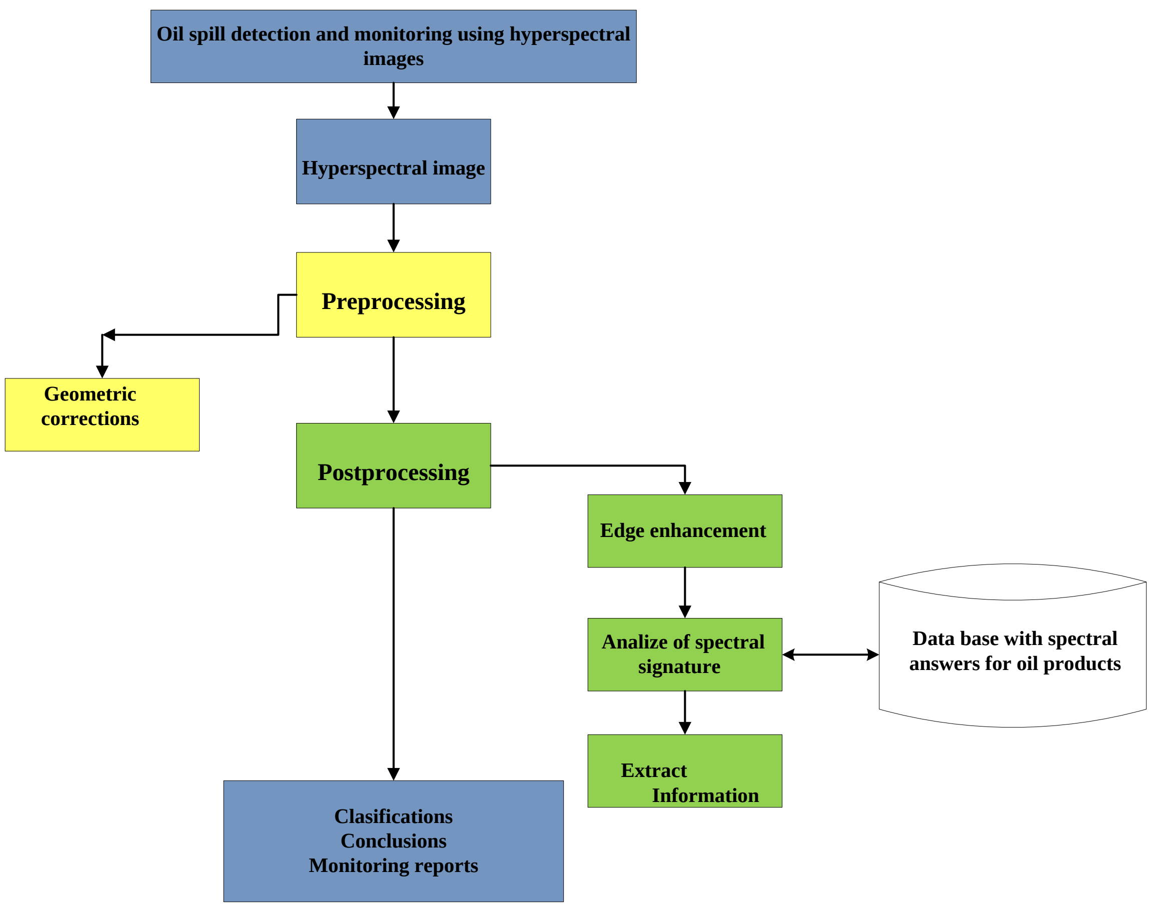
Spectral response - the signature – of the pollution agent, in our case petroleum products can be used in the assessment of surface water concentration, and thus to distinguish the different thicknesses of oil slicks.

Here is the image processing schema for RADAR images:



Another result of the processing of satellite imagery is the dynamic of oil spills. This can be achieved by creating multitemporal images. The images acquired during the monitoring activity, in different moments of time, may be subject for such change detection analysis (identifying changes). We can obtain information regarding speed and slick movement due to wind or marine currents, thus decreasing their actions cleaning (cleaning), or increasing the load if the accident continues. These multitemporal images can be used, depending on the extent of the casualty, a modeling process that serves to establish a work plan for cleaning and removing the effects of pollution accident.

Outside multitemporal images, additional images can be created through the merge process of images with finer resolution (usually the panchromatic image) and multispectral images – the process called Pansharpening, or by merging multispectral images with radar images. All these image processing can be done either during or after the monitoring process in a process of assessment of pollution accident.



Hyperspectral image processing schema.

In the absence of hyperspectral satellite images, they are not yet sold, we can obtain such images from Airborne hyperspectral remote sensing images - AVIRIS sensor.

The methodology used in monitoring oil slicks in the Black Sea.

Monitoring of oil slicks in the marine environment is currently a topic on the agenda of big oil companies to work off-shore.

The project consists of:

• Identify all remote sensing satellites overflying the area of interest;
• Compute overflight schedule;
• Identifying dealers for the satellite images;
• Framework contracts for emergency situations;
• image processing procedures;
• Reports results.

Monitoring activity consist from daily tracking the size and movement of oil slick and showing them if necessary. Indicate the accident spot size dynamics and possible remediation measures to limit negative environmental impact.

Remote sensing satellite images that can be used for monitoring:

• multitemporal multispectral images from the same satellite
• multispectral images of different resolutions and spectral bands;
• Radar images (we consider the system COSMO - SkyMed, Constellation of Small Satellites for Mediterranean basin Observation, a constellation consisting of four satellites with radar sensors with the possibility of acquisition of images to the left - right with a resolution of 1 meter, polar orbit - 97.86 degrees inclination, sun sincronous, with an altitude of 619 km).
• Hyperspectral iImages.

Monitoring steps:

• initial phase involves an onsite inspection with the acquisition, using mobile GIS equipment, of coordinates to define areas of interest;
• Request satellite imagery in disaster mode showing parameters of sea currents in the affected area;
• Collaboration with the Naval Authority for the Environment, in order to obtain necessary data on sea currents;
• Finding changes based on their area of interest;
• Processing of the satellite images obtained, load them in GIS database for monitoring and reporting in all period in which the oil spill exist;
• Stop the acquisition of satellite imagery when monitor cease.
• After monitor cease, load in the GIS database multitemporal pseudo image, fusion of different resolution images - multispectral with panchromatic or multispectral with radar.
• Reports to improve the monitoring methodology.

Conclusions on the use of remote sensing images to monitor oil slicks on the sea surface.

The monitoring of oil slicks in marine water areas, is mainly based on RADAR images, because images are not affected by weather conditions.

It should be noted however, that even in the radar image identifying and distinguishing between oil spill and similar spots are possible. For fixe this issue is necessary to acquire also other satellite images like panchromatic, multispectral with near infrared spectral bands (NIR) and even remote sensing images from hyperspectral airborne sensors.

Such coordinated actions are often present in oil companies to work off - shore. Even if the radar image provided by COSMO SkyMed mission have a frequency of two daily images, do not eliminate the possible use of RADAR from other missions such as RADARSAT sensor 2 C - Band SAR, ERS, Envisat (ASAR or MERIS sensors) and even satellite images acquired by the Japanese ALOS (Advanced Land Observing Satellite).

The classification of oil slicks is the direction that will guide the author's concerns in the future.

VI. General conclusions.

PhD thesis **" Contributions to remote sensing artificial satellite movement and usage of remote sensing images for oil pollution in marine environment"** focuses the author activity for more then 30 years in this area - remote sensing.

This paper aims to solve practical problems using remote sensing satellite imagery and theoretical issues regarding the computing of Lukaşevici coefficients for the six fixed centers problem with which the orbits of satellites, in general, ie the remote sensing, in particular, can be calculated with an improved accuracy.

It is presented a detailed history of remote sensing, developments at global and national level, with each country program description.

Are analyzed, in a consistent manner, all information related to remote sensing data available in Romania;

The software developed by author **[Vais 1980],** for LANDSAT MSS multispectral images, provided to all research teams tools such as spectral response histograms, histograms equalized, spectral profiles, unsupervised classification based on principal component analysis, thematic maps, taking into account the conditions that, at that moment for Romania, member of the Warsaw Treaty, the acquisition of a specialized software was very difficult. (Note the research groups, Department staff of the Institute of Civil Engineering Bucharest photogrammetry and related staff of the Faculty of Forestry Department of Brasov that used this software).

Completion of this software program with the computing of intermediate orbits of remote sensing satellites give the opportunity for images assessing needs, establishing remote sensing missions needed in the proposed project, linking these missions, in order to have a correct sizing and cost plans for geospatial analysis project which aims to use for this purpose remote sensing satellite data.

Made application for the problem of computing the Lukaşevici coefficients for six fixed centers, for remote sensing satellites so far launched, in FORTRAN language, is a matter of fundamental research which brings a substantial contribution to improving accuracy in calculating the orbit of artificial satellites.

Remote sensing is increasingly used more in all areas, especially in land, agriculture, geology - geophysics, military, etc..

In recent years the image resolution became comparable with the resolution obtained from photogrammetric flights.

For this reason, applications have expanded, attracting beneficiaries that only 10 years before don't think to remote sensing as a serious option.

One of these areas is geology - geophysics, remote sensing field previously used only for large areas and general studies, not in details.

It is presented an original way to detect geological faults using remote sensing images.

Analyzing how the recognition of faults in satellite remote sensing images **[Vais 2011], it appears** that not all faults can be recognized on a remote sensing image, but only normal faults.

For these reasons, there is not always a total coincidence, differences that can come from either tectonic movements that took place, either from errors of assessment so that it is necessary a decision for reassessment of hydrocarbon deposits.

We have analyzed the possibilities and areas of use of both satellite images and airborne remote sensing and generating pseudo images (drawing on the synthetic images obtained by satellite or airborne remote sensing missions) required in geospatial analysis activity **[Vais 2011 a].**

The environmental monitoring activities, the case study presented **[Vais 2010],** and monitoring performed by the remote sensing satellite imagery, find opportunity multitemporal analysis on synthetic images, that can to highlight the dynamic behavior of the monitored phenomenon (pollution, landslides, etc..).

Thus, the work represents an original theoretical and practical contribution on how to detect oil slicks and the faults using remote sensing images.

Also the updating of a geospatial database (GIS) with these images, that means using GIS techniques with remote sensing techniques such as satellite and airborne, provide to all interested users the possibility for viewing in geographic context the results, including partial results, from research activities, topographic determinations, environmental monitoring, respectively.

This integration, acquisition, modeling, analysis and management of spatial reference data is subject of a modern disciplines - **geomatics.**

This paper presents a new approach in Romania regarding the use of remote sensing images in geology - geophysics and marine petroleum exploitation.

Given the achievements to date in Romania in this field I believe that the work brings an important theoretical and practical contribution.