Title: PROCESS AND DEVICE BASED ON INTELLIGENT SYSTEMS - ARTIFICIAL INTELLIGENCE - ARTIFICIAL NEURAL NETS, FOR DETERMINATION AND CONTROL IN REAL TIME OF CANTAMINANTS IN PHYSICAL AND/OR CHEMICAL AND/OR BIOLOGICAL SYSTEMS

Abstract: For use in the control and analysis of contamination and/or adulteration and/or modification of physical and/or chemical and/or biological systems, having the capability to analyze said system in gaseous, liquid and/or solid phases and/or mixtures of those phases, through techniques of artificial intelligence, artificial neural networks measurements of physical and/or chemical and/or biological properties through sensors and/or bio-sensors; these measurements being done on site, in real time, and at room temperature. Examples of systems that can be analyzed are: fuels, medicines, aquatic systems, systems of gases, contaminating systems, refrigeration systems, system of environmental control, industrial systems, systems of clinical analyses, alcoholic drinks, industrial waste, biological material, material for clinical analyses, chemical standards, physical standards, biological standards, chemical markers, or systems for which the standard properties can be previously defined.
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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"PROCESS AND DEVICE BASED ON INTELLIGENT SYSTEMS -- ARTIFICIAL INTELLIGENCE -- ARTIFICIAL NEURAL NETS, FOR DETERMINATION AND CONTROL IN REAL TIME OF CONTAMINANTS IN PHYSICAL AND/OR CHEMICAL AND/OR BIOLOGICAL SYSTEMS"

The present invention is characterized by a method and/or process of analysis of physical and/or chemical and/or biological systems as well as the construction of a device and/or equipment to determine in real time and at room temperature contaminants in systems such as gasoline, water, air, fuels in general, solid components and/or mixtures of those systems, but not limited to them, through the use of techniques of artificial intelligence, linked to one or more sensors and/or biosensors through a module consisting of electronic circuits for measurements of electric and/or magnetic signals; also including the use of analogical filters as well as analogical and/or digital circuits linked to microcircuits and microprocessors all interconnected inside of the module and this module connected to a computer but not limited which executes the artificial intelligence program, based on artificial neural networks, but not limited. This system, totally interlinked, will henceforth be called ISAC - Intelligent System for Analysis of Contaminants. The modifications in the physical and/or chemical and/or biological systems can happen through the addition of undesirable products and/or substances to the original system and, thus, are called contaminants of the system referred to. Such contaminants can, therefore, alter and/or adulterate and/or modify the physical and/or chemical and/or biological systems and
these modifications happen through alterations of the physical and/or chemical and/or biological properties, which are identified by laboratory analysis. The ISAC system additionally possesses a software, based on techniques of artificial intelligence, for instance, artificial neural networks, but not limited to them, that can learn the behavior of the system and later, through that learning, can compare the standard for conditions previously learned with the measurement, in real time, on site and at room temperature, of the properties measured by the ISAC system and thus provide an immediate response to the condition of the physical and/or chemical and/or biological system or mixture of those, in the gaseous and/or liquid and/or solid phase in relation to the pattern of conditions learned previously. Other techniques of artificial intelligence can be implemented such as specialist systems, genetic algorithms, fuzzy logic, Hopfield neural nets, multilayer perceptrons, backpropagation, Levenberg-Maquardt or Gauss-Newton, SVM (Support Vector Machine), SOM (Self-organization method), Kohonen, ABAM (Adaptive Bi-directional Associative Memory) or even multivariate statistic methods. The prediction algorithms then can predict situations of "risk" or "danger" during measurement or monitoring, indicating anomalous situations.

The present invention, based on the ISAC system, permits analysis of complex systems, such as gasolines, but not limited to them, in which the adulterations and/or contaminations and the detection of these modifications, in
real time, at room temperature and on site, do not exist in the present state of the technique.

Identifying the existence of contaminants in physical and/or chemical systems can be considered of fundamental importance to different areas of society. For instance, in environmental systems, such as the aquatic systems - rivers and ponds, or the atmospheric systems or even in hospital systems in which a very high level of water purity is required. Other examples would be the fuels in which a high level of adulteration exists or the adulteration of medicines. In which way, identifying systems that suffer contaminations or adulterations is vital to the avoidance of irreparable losses in human lives or high financial losses.

From the point of view of noxious chemical contaminants to the health, there are several compounds that can cause simple diarrheas, for instance, the sulfates, or those that cause serious damage to health, such as p-dichlorobenzene, that attacks the liver and having a maximum concentration on the order of 0.075 mg/l or take o-dichlorobenzene, found in paints, cleaning products or components of machines, dyes and chemical residues. This substance provokes diseases in the liver, kidneys and in the cells of the blood. These substances are, in general, found in industrial waste. Another example is the antimony that appears in waste from petroleum refineries, fireworks and solders. It can increase cholesterol and, moreover, it reduces the glucose of the blood. Compounds associated with antimony are considered
cancerous substances and, therefore, strongly noxious to the human organism (www.springway.com.br).

Another example of uses of the present invention would be quality control of waters used in hemodialysis processes. Wrong conditions for the analysis process can result in serious damage to human health. For instance, recently two cases of death were reported by hospitals of the city of Recife in their units of hemodialysis treatment (Jornal do Comercio, Recife 03.04.2001). Also recently, the Sanitary Surveillance Department of the state of Pernambuco collected samples of water from the Victory of Santo Antão Clinic of the Kidney for analysis. There had been accusations of irregularities in the Clinic with hemodialysis patients (Jornal do Comercio, Recife – 03.04.2001). Such facts are due to the quality of the water for hemodialysis treatment procedures. It is known that the purity of the water used in the hemodialysis process should be high in relation to metals in the solution, being in the range of PPB – part per billion (www.intelilav.com.br/intelilav.htm or www.intelilav.com.br/saybot.htm or www.mediagua.com.br/hemodialise.htm). In addition to this example, there are applications in clinical analyses, where various standards are available and the systems can be interlinked easily with the technology of this invention (ISAC) thus making available processes that are more efficient in terms of time as well as money, in order to provide responses to the analyses that can be monitored and, providing, for instance, audible signals in case modifications in relation to a standard
system should be detected. Another possibility of application of the present invention consists of analysis, also in real time, in biological systems, through the detection of unexpected anomalies in the system that can be detected and differentiated from previously defined patterns. An example, but not limited to such, would be the culture of bacteria from which one of the sub-products would be a medicine. ISAC could monitor the system under analysis standardizing the process and the quality, indicating when the process deviates from an ideal situation.

Another problem of contamination concerns the air that we breathe. Atmospheric environmental control has been showing progress; however, adequate control has yet to guarantee a standard in real time. Atmospheric pollution is a typically urban-industrial phenomenon. The 67 municipal districts of the three metropolitan areas of São Paulo — (RMSP, 17.8 million inhabitants), Campinas (RMC, 2.3 million) and of Baixada Santista (RMBS, 1.5 million) — contributed 64% of the state’s GDP in 1997. Those three cities possess, besides the industrial emissions, the largest fleet of vehicles in the nation, which gives them, together with the city of Cubatão — important pole of the industrial petroleum, metallurgy, fertilizers and cement — a deterioration of the quality of the air that requires special care in the control of the atmospheric pollution. There is a network of automatic monitoring of contaminants measuring $\text{NO}_x$, CO, HCs and $\text{SO}_x$ (http://www.ambiente.sp.gov.br/agenda21/ag21sprev/05.pdf) which is being renovated
and enlarged, starting in 1996. According to the proposal, the first control phase will be operating, starting from this year, with the adoption of standards currently in use in Europe. The monitoring is done by 29 established stations and 30 manual stations that measure regulated atmospheric contaminants and meteorological parameters. The network includes the three metropolitan areas of the State, besides Sorocaba and São José dos Campos, cities that already demand more detailed monitoring due to the industrial load. The manual network was expanded in the last decade towards the rural parts of the State. It measures sulfur dioxide and particulate material in 36 places, 15 in areas distinct from the metropolitan areas named above. Moreover, it includes two mobile laboratories and 32 passive monitoring points located in non-metropolitan areas. Although it is an efficient method, those systems are expensive. However, even though it has a high operational cost, since 1992 regularly-timed vegetable bio-indicators are used in environmental diagnoses, mainly to solve questions involving the quality of the air and of the soil, such as studies on the control of sources of gaseous fluorides, precursors of tropospheric ozone and sulfur dioxides of sulfur. The fluorides are studied with the TI plant (Cordinine terminalis) in areas of aluminum and fertilizer production, and the ozone with tobacco production. The present methodology based on the ISAC system makes it possible, however, at a reduced cost, in real time and on site, to monitor the response(s) to the sensor(s) of these gases under varied conditions due to
variations of wind speed, humidity, etc., enabling the system to describe the real situation of the location, as compared to existent systems, which do not take into account those parameters in the development of their standards. Thus, information about the measurements caused by other parameters besides those mentioned herein, is unknown at the present time.

Specifically, in the case of contaminations of underground waters by combustibles, such as alcohol and/or gasoline and/or mixtures there has been heavy damage done to the environment. As described by Corseuil et al. (Technical Bulletin, PETROBRAS, Rio de Janeiro, 41 (3/4): 133-138, Jul/Dec 1998), 1,000 leaks per week have been estimated. In Brazil there are approximately 30,000 gas stations, the reservoirs of most being from 25 to 30 years old, and it is probable that the useful life of these tanks is close to ending. As pointed out by Corseuil et al., the consequence of this will be an increase in leaks in various locations throughout the country. To deal with this serious problem, the cities of Curitiba and Joinville (SC) already have specific legislation referring to the problem.

In a local analysis of the 65 existing stations in the city of Joinville, only one had no kind of contamination problem of the natural underwater resources (CADORIM, M. Verbal Communication. Foundation of the Environment, Joinville, SC, 1996).

In the case of contamination of lubricating oil, monitoring is fundamental to extend the useful life of vehicles, machines and/or equipment. Lubricating oils,
regardless of their brands, undergo countless contaminations during their use that make them differ from the technical specifications of adequate lubrication, exposing the mechanical components to high levels of premature wear and tear and high likelihood of breaking down. Evidently, as pointed out for example by Unipetro Lubrification Technology (http://www.unipetro.com.br/pageportugues.htm), it is not possible to radically eliminate all of the contaminants to which the lubricating oil in use is subject. However, it is possible to keep the highly noxious contaminations to certain limits, enabling the oil in use to offer lubrication at an adequate level for safety. In order to do that, it is essential to establish and to implement a program of lubricating oil analyses, because to maintain the oil in use within the acceptable technical standards for good lubrication it is necessary to monitor it frequently through analysis. It is true that any lubricating oil can suffer sudden contaminations at critical levels long before the established deadline for it to be replaced arrives. In this case, if the oil is not frequently being monitored through analyses of the oil in use in the vehicle, machine or equipment, its power of lubrication will be totally compromised, resulting in wear and tear and premature breakdowns, until its replacement time arrives and the oil is substituted. The mere substitution of the polluted lubricating oil doesn't solve the problem, if no analysis of the oil is conducted, since the cause of the original contamination (mechanical or operational) will simply begin
a new cycle, provoking more wear and tear and ending in the
total loss of the mechanical component. On the other hand,
sometimes the lubricating oil in service reaches its
established deadline to be replaced without suffering
critical contaminations, and could still have been useful
for more time if the oil change had not been done at the
pre-established time. In this case, the lubricating oil
still in good condition for use had been thrown out. Taking
both these cases into account, the only way to obtain
technically appropriate lubrication is through the
implementation of a program of oil analyses. Petrotest Oil
Analysis Kit, enables the industries of Automotive,
Industrial, Marine and Rail sectors, to maintain
lubricating oil in use frequently monitored, significantly
increasing the useful life of the vehicle, ship, machine or
equipment; reducing expenses spent on replacement of parts,
human labor, idle hours and volume of lubricating oil
consumed. Nevertheless, this Kit developed by Unipetro is
for laboratory use only, and analyses are not done in real
time with the oil in use. The present invention, utilizing
ISAC, can execute the same procedure, but in real time and
on site.

There is a recent proposal to numerically study
gasoline leaks into the soil, as described by Cordazzo et
al. www.sinmec.ufsc.br/artigos/cordazzo/Cordazzo/conem.pdf)
in which an efficient mathematical methodology is presented
in order to analyze the drainage in the saturated area of
the soil, known as natural underwater resources, in finite
volumes, with a model of biodegradation of 1st order,
adapted for the specific situation found in Brazil, that is, considering the influence of ethanol on the biodegradability of the elements found in Brazilian gasoline (BTEX) and the phenomenon of co-solvency of the ethanol in the gasoline, assuming that the solubility of the hydrophobic compounds in the water increases logarithmically. However, that procedure, although efficient, does not permit analysis, in real time, of the chemical and/or physical and/or biological system, as is proposed by the present invention, in which it is possible via ISAC to determine alterations of the system under analysis on site, in real time and without modifications of the samples.

Specifically for the problem of contamination of Brazilian gasoline, ANP - the National Petroleum Agency, has proposed technical norms with detailed specifications of the standard to be met. Quality of gasoline has been lowered in function of random mixtures of solvents, products of low cost and quality, inferior in terms of their values as fuels.

Brazilian specifications for automotive gasolines are established by the following laws: ANP n° 197/99 and technical regulation ANP n° 06/99. The parameters proposed by the National Petroleum Agency for regulation of the use of gasolines in Brazil are described in:


Although the parameters used by ANP are extremely useful for the identification of contaminants in laboratory analysis, real time and on site detection is not very
simple to implement. The proposal of the present invention is precisely to overcome such difficulties and, thus, the invention offers a simple and efficient way to detect contaminants and adulterations in real time and on site.

Data of ANP show, as presented in the table below, that adulterations of the continue increasing.

Acts of Monitoring - Historical Record

<table>
<thead>
<tr>
<th>Year</th>
<th>Action</th>
<th>Closed Stations</th>
<th>Citations</th>
<th>Citation Qual.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>10,022</td>
<td>514</td>
<td>2,385</td>
<td>383</td>
</tr>
<tr>
<td>2000</td>
<td>15,672</td>
<td>604</td>
<td>4,614</td>
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</tr>
<tr>
<td>2001</td>
<td>16,042</td>
<td>713</td>
<td>5,308</td>
<td>1,091</td>
</tr>
<tr>
<td>2002</td>
<td>22,374</td>
<td>1,260</td>
<td>9,684</td>
<td>1,964</td>
</tr>
</tbody>
</table>

Variation 2002 / 2001

| %    | 39.5 | 82.0 | 76.0 | 80.0 |

The number of stations cited for quality problems, in the table above, includes, besides the resell stations, other economic agents (http://www.anp.gov.br/petro/fiscalizacao.asp). In the state of Minas Gerais alone, during the period of 2000-2002 about 192 gas stations were cited by ANP, and in the state capital of Belo Horizonte that number was 51 stations. If the greater metropolitan area of Belo Horizonte is considered, including satellite towns of Betim and Contagem, that number reaches 78 gas stations. This number means that more than 40% of the gas stations were selling adulterated gasoline
(http://www.anp.gov.br/doc/fiscalizacao/fiscaliza_mg.pdf). It should be pointed out that the quality of fuels in the state of Minas Gerais is supervised by the Department of Chemistry of the Federal University of Minas Gerais (UFMG) and by the Technological Center of Minas Gerais - CETEC.

The effort that ANP has been demonstrating is enormous. In its Bulletin of Quality one can clearly note the mission of that agency:

The unceasing efforts of ANP toward improvement in the quality of fuels derived from petroleum, from natural gas and from the combustible alcohol are made through regulated specifications, reflecting the minimum quality necessary for correct performance of the product. Such regulation aids the National Energy Policies and the desire of society for adaptation to use, to the environment and consumers' interests, taking into account the nation's reality. Based on these principles the guidelines of the ANP's Policies for Quality of Products are:

1. To protect the consumer's interests, guaranteeing petroleum derivatives, natural gas and combustible alcohol adapted to uses.

2. To protect the interests of society, having in mind the quality of life and environmental questions in the specification of the quality of the products.

3. To preserve national interests, defining the quality of petroleum derivatives, of natural gas and of combustible alcohol, in accordance with the Brazilian reality.

4. To encourage development, by means of specifications that induce technological evolution.
5. To promote the free-market competition through specifications of products, avoiding protected markets.

6. To check credibility of the quality of products consumed in this nation.

With these objectives, the ANP’s Superintendent of Quality of Products takes into account the aspects of greatest importance for the quality of petroleum derivatives, of natural gas and combustible alcohol, among which the following are outstanding:

- structures of refining and of filling stations in the nation;
- quality of petroleum derivatives, natural gas and combustible alcohol in the world;
- demands of the environment;
- distribution by methods of transport in Brazil;
- evolution of equipment technology;
- use of alternative products;
- evaluation of the quality of imported products;
- efficient use of the products.

Recently, on April 8, 2003, by decision of the General Director of ANP, comments were requested about regulation for the use of unspecified liquid or gaseous fuels. From this, one can clearly see the importance of perfecting methodologies for analysis, enforcement and control of fuels, as published in the Diário Oficial da União (Official News of the Nation), on this date (http://www.in.gov.br).

The Research Nucleus of Chemical and Petro-chemical Energy – NEQP coordinated by Prof. Paulo Roberto Britto
Guimarães of the University of Salvador describes proposals for the development of technologies to analyze the quality of combustibles and lubricants as well as to detect contaminants and additives. His proposals also cover the formulation, production and recovery of fuels and lubricants, regulatory studies, use of natural gas as fuel and petro-chemical raw material, processing technologies and enrichment of natural gas, additives to gasoline and production processes and regulation of the petroleum industry - fuels, lubricants and natural gas. However, the current state of the technique does not demonstrate the proposals developed and tested (http://www.nuperc.unifacs.br/neqp).

To detect contaminants in gasoline, research presented in the 10th Internal Conference of Scientific Initiation of Unicamp, proposed by J. L. Paschoal and R. J. Poppi, uses the spectroscopy of close infrared. As described in the work, the technique is fast, economical, simple, and does not produce toxic and contaminating detritus of high selectivity compared to the classic methods of analysis. To verify which are the best variables to be used, the IFLS algorithm was applied. The idea of the algorithm is to develop PLS regression models for different parts of the spectrum using cross-validation as the criterion of choice for the best areas. The results obtained show that it is possible to develop an alternative methodology for the determination of the percentage of gasoline and of ethylene glycol in lubricating oil with few mistakes through
spectroscopy of close infrared close

Texaco of Brazil, besides following the norms of ANP
(www.anp.gov.br), has a specific quality control for its
gasolines sold throughout the country
(http://www.texaco.com.br/aempresa/normas/anp251/modelos/co
ntroleq/controleq.shtml).

Nevertheless, neither the norms used by Texaco nor
those defined by ANP, can guarantee effective quality
control of contaminants added after distribution. It is,
therefore, necessary to have efficient methodology that can
determine, at least qualitatively, in real time and on
site, possible adulterations, without the need for analyses
in laboratories in which, in general, require days to
provide results. The present invention, using ISAC,
provides responses on site and in real time. With this, it
becomes possible, at a much lower cost, to analyze a great
number of places at the same time, besides, but not limited
to, remote analysis.

It should be emphasized that in the specific case of
fuels, Texaco has a quality control program that uses a
fleet of Mobile Laboratories distributed throughout Brazil.
The vehicles are equipped with equipment and laboratories
with the latest technology directed by technicians of the
Falcão Bauer Laboratory of Analysis. The technicians of
these laboratories visit the Texaco Stations without
previous notice, verifying the quality and origin of all
the fuels (gasoline, alcohol and diesel). Texaco is
considered to be the only company that has a quality
control program that tests all their fuels: gasoline, alcohol and diesel. Besides doing tests to verify the presence of the marker, all of the fuels are analyzed to see if they meet ANP specifications (http://www.texaco.com.br/produtos/combustiveis/qualidade/controlequalidade/testes_qualid/tetestes_qualid.shtml).

Unfortunately, the tests of gasoline, alcohol and diesel are done in those mobile labs exclusively through visual analyses of aspects, such as color, density, content of alcohol, equivalent point and absorbance/concentration of the additive/marker.

A project developed by researchers of UFRGS consisted of the creation of a network of associated laboratories for research and monitoring of the quality of fuels in the state of Rio Grande do Sul - Qualicom-RS. The system enables an exchange of knowledge and experience from the "Laboratory of Quality of Fuels" inaugurated in the lQ/UFRGS, associated with and providing service to ANP since February of 2000. The network includes the Analytical Center/IQ-UFRGS, the Department of Chemistry/ UFSM, Dept. of Chemistry/Univ. of Passo Fundo, Dept. of Chemistry/Unijuí and CEFET/Pelotas (http://www.inf.ufrgs.br/qualicomrs/index.html).

Monitoring data collected by ANP for the analysis of the quality of automotive fuels in Brazil, during the period of January to July of 2000, show that 10% of the gasoline in the country is adulterated, whereas alcohol fuel presents a slightly lower rate, but no less worrisome, at a value of almost 8% (Science Today-Ciência Hoje, vol.
28 no. 165, 2000). Although there are enormous efforts to impede the contamination of fuels, with the involvement of several Federal and State Universities as well as Technological Centers, the number of gas stations is extremely large. To offer an example, there are in the state of Minas Gerais alone, 3,585 stations requiring observation in a total of 20 distinct regions of the state. The annual value of the contract between ANP and the Federal University of Minas Gerais, through the Department of Chemistry, as well as with the Technological Center of Minas Gerais, comes to an amount on the order of R$ 2,500,000.00 (source document: ANP Analyzes Quality of Fuels in Minas Gerais 07.02.01). Certainly a highly efficient supervision program with daily collections from all the stations is impossible due to the enormous contingent of teams and laboratories that would have to be involved in such a task. Besides that, collecting and sending the samples to the laboratories for analysis would take some time and the results would be supplied later. In other words, such a process would be economically inefficient, due to the time spent for the results to be provided. It is known that, through these measures of supervision agreements, ANP has been reducing the adulterations. It can be verified that the problem of adulterations is serious, as much from the social as from the economic point of view, and soon more efficient techniques, reducing the operational cost of analysis and providing faster determination of pollutants, such as that
being presented in this invention with the ISAC system, will be necessary.

The present invention is designed precisely to fill such a necessity by proposing a new methodology created exclusively for analysis and detection, in real time, of pollutants in chemical and/or physical and/or biological systems of low cost and high efficiency.

The objective of the present invention is to propose efficient and economically viable alternatives for the quality control of processes, in general, in which standards can be defined. Moreover, the present invention is also identified by the use of sensors and hardware that allow the use of various measurements of different physical and/or chemical and/or biological properties to be analyzed in real time. The hardware presented in the present invention allows the inclusion of new measurements, increasing the efficiency of the monitoring process.

Different processes have been proposed to define procedures for detection and analysis in real time. In Brazil, as in almost all countries, the development of efficient techniques is still recent with reference to measurements in real time. Besides adulterations of fuels and contaminations of water and natural underwater resources, another example that has already caused great damage financially and in the immeasurable loss of human lives refers to the contamination of medicines that has provoked the death of dozens of people (www.sintaema.com.br/rev10.htm) in the recent past. The
government has been modifying legislation, through amendments and regulation of medicines (http://www.anvisa.gov.br/medicamentos/medicamentos/falsificados/medidas.htm), but it is recognized that more effective measures are necessary to guarantee an efficient process to identify falsifications of medicines. The present invention is capable of providing such procedures through analysis, in real time, of physical and/or chemical and/or biological properties, for instance, of medicines.

The scandal regarding fuel adulteration, as detailed above, it is also recent and continues to proliferate. Financial damage has been enormous; however, the largest losses, without doubt, are the human lives lost to organized crime. Therefore, one of the advantages of the present invention is found in analysis of adulteration analysis through efficient supervision in an electronic form, thus avoiding the losses in human lives that were recently reported in the press (http://globo.com/GloboNews/article/0,6993,A210897-2,00.html) regarding the case of the public promoter from Belo Horizonte in 2002. That type of coercion is probably still going on, continuing, therefore, to place human lives in danger. In this way, an intelligent system able to monitor fuels and to be operated by the population would be extremely useful. In addition, the expenses of supervision contracts, involving several institutions, also cost millions (R$). Developing alternative and highly efficient processes is therefore necessary. The possibilities of applications of the present invention to the examples
mentioned as well as to other possibilities are almost limitless. Moreover, one should consider the various chemical markers developed by the several distributors to be used as references by the ISAC system that allow identification in real time and on site of the quality of the fuel.

In this way, the present invention is based on the proposal of equipment, methods and processes of analysis, to detect contaminants and to determine the properties of the system starting from pre-defined standards via classification and recognition of the patterns.

The present invention presents an efficient proposal for the determination of contaminants in chemical and/or physical and/or biological systems. This invention consists of a four part system: the sensor(s), the hardware component, the software component and a microcomputer but not limited. That structure is subject to modifications to make the system more compact, for instance, to include the hardware component and software and microcomputer together with the sensor. The first component is characterized by the capacity to analyze, in real time, the chemical and/or physical and/or biological properties of the system, previously defined as standards, which will be used for recognition of characteristics defined by the proposer and/or manufacturer via techniques of artificial intelligence. Those standard conditions are compared with the properties (physical and/or chemical and/or biological) defined, also in real time, by the hardware component. Through the recognition of established standards, the
proposed equipment is able to analyze, using the computer, unknown samples and, in real time, to inform the user whether there is contamination or not in the sample analyzed through the analysis of sensors' measurements as compared with the measurements obtained by the program based on techniques of artificial intelligence, artificial neural networks, but not limited, executed by the microcomputer, but not limited, possibly containing a program, for instance, in a microprocessor, but not limited, that will give a response as to the possible contamination of the system under analysis. Such information can be converted into different types of signals, such as, logical or analytical display, remote transfer signals, etc. In addition, the ISAC system/equipment can do analysis, through libraries of chemical and/or physical and/or biological constituent data or use libraries containing spectroscopic data in order to identify contaminants. The present invention can even be associated with domestic applications in situations in which it can define quality standards, such as in industrial processes, or even in implants through the use of monitoring of biological systems or even to control vital signals, also through measurements of biological systems. The present methodology can also be used for analysis and control of environmentally polluting systems. At the industrial level, the present invention presents vast applications through standards previously defined for the identification of unknown samples or through learning from databases which can be added to, but not limited, or
for adjustment of devices. It is also possible to determine the resistance of materials, as well as the useful lifetime of these materials when the standard condition is defined for those systems, just as, the quality of food products can be determined in function of their expiration dates, or the quality of alcoholic drinks, for instance, Brazilian rum, or non-alcoholic drinks, for instance, mineral water, or mineral, vegetable or synthetic oils, etc. Using the present technology perishable products can also be analyzed, when standards are defined. Another possibility for use of this technology would be linking of portable systems, permanent or mobile, for analysis of complex systems. Let us also mention the possibility of including the present technology in automotive vehicles, in the most critical situations or in which portability is most necessary, also in aircrafts, ships, for the detection of flaws, as well as for the analysis and identification of adulterated fuels during refueling. The processes that can be analyzed by the equipment and method proposed in the present invention are wide-ranging, so that the system to be analyzed could be found, for instance, in the gaseous or liquid phase or in solid-state systems or mixtures of these phases. The examples to be described focus on chemical systems in the liquid phase, but they are non-limiting. Moreover, it should be emphasized that in the present invention the capacity of the ISAC system (equipment/software/hardware) to expand and to update the database of physical and/or chemical and/or biological properties of the standards of known systems.
Systems and/or methods and/or processes for analysis in real time of contaminants have been shown to be efficient in varied applications in laboratories as well as industries. For instance, as Pedro E. Cohn describes (http://www.ysa.yokogawa.com.br), a high control level has been observed for analyzers of CO, CO₂, H₂ and N₂/Ar. However, the technical apparatuses involved present a high level of sophistication, such as the need to use a chromatographer.

There are various procedures and methods existing to identify adulterated systems. However, the development and the use of impact technologies, with a high level of efficiency and speed, has not been showing progress in the detection of adulterated systems with measurements in real time and on site. Although the detection of contaminants can be confirmed in the current state of the technique, responses still depend on collections, analyses and results a posteriori. Efficient examples of the state of the technique can be seen in the equipment marketed by Grabner Instruments (http://www.grabner-instruments.com). However, intelligent systems capable of making correct decisions regarding analysis and quality of the system being analyzed are not yet available, nor are those which give responses in real time and on site in an efficient and simple way. This is precisely one of the main characteristics that the present invention offers through an effective methodology via the ISAC system of (equipment/software/hardware).

Other detection processes and analysis of contaminants as well as the techniques necessary to supply detection are
found in the state of the technique and will be reported in this section. Huddart, et al. (1980) described in U.S. patent 4,199,984 a digital circuit to measure the volume of gasoline in fuel tanks by measuring the capacitance. That property of the material can also be used to identify contamination in chemical and/or physical and/or biological systems. Similarly, but introducing a new detection, the presence of water in a tank, Larson et al. (1983) proposed, in U.S. patent 5,739,916, methodology also based on the measure of the capacitance. The advantage of that technology in relation to that of Huddart is the possibility to detect the presence of water in the tank, which is considered undesirable. With more developed characteristics, J. R. Steller (1989) proposed, in U.S. patent 4,818,348, an instrument for field use that detects, identifies and quantifies, besides monitoring gases, liquids or solids, depending on the type of sensor used. The instrument even has small sensors that, when exposed to the unknown material form a set of electric responses and a set of characteristics of various materials, which having been previously analyzed, allow, being linked to a microprocessor, the results to be compared and then the materials to be identified in a display. The number of responses can be increased by changing the operating voltage, temperature or other conditions associated with one or more sensors, thus providing a large number of responses, obtained by each sensor or by several sensors. That instrument is able to identify a great number of liquids and solid materials. More specifically, the
portable instrument proposed by Steller identifies the composition of at least one component in a solid, liquid or gas through the conversion of the solid, liquid to a flow and then by comparison of the responses with the standards based on the sensors in the flow with one or more standards stored in the memory of the instrument. As described in the patent proposed by Steller, in spills of chemical or similar products, devices for detection of the presence of contaminants or noxious components have usually been associated with a specifically chosen component. Devices for detection of hydrogen sulphide, carbon monoxide and ammonia as well as similar elements can be considered representative. Essentially, these devices are used to detect one or a few pre-selected contaminants and do not individually identify contaminants. It is usually necessary to obtain samples of the materials and to send them to laboratories for analysis, which consumes a large amount of time for identification, possibly causing significant damage to human health and to the environment. Efficient alternatives, however expensive, have been introduced, such as semi-portable chromatography or infrared analyzers. In Steller’s methodology the device and the approach used is useful for detection, quantification and identification of contaminants in flow of such liquids as underground waters, flows, lakes and industrial effluents. However, Steller’s invention differs from the proposal of the present invention regarding the pre-modification of the sample in a flow, as proposed in U.S. patent 4,818,348, whereas in the invention described herein, the sample doesn't undergo any
modifications by the ISAC equipment. Analysis of the vaporization of liquid and solid materials is done using a gas sensor or the solid can be melted or the appropriate liquid sensor can be fed directly with the liquid. However, one of the main differences is in the methodology used to compare the value(s) standard(s) and result(s) of the measurement(s) of the sensor(s). In the present proposal techniques of artificial intelligence are used, such as artificial neural networks, instead of a database in the memory of the computer as described by Steller. Using polynomial estimates, as proposed by Steller, it is possible not to obtain an acceptable error margin for more complex functions that represent the appropriate behavior of the standards. In contrast, the proposal of the present invention, using techniques of artificial intelligence, such as neural networks, considered to be a method of universal interpolation, allows for greater flexibility and precision to be used in more complex applications, such as is the case with adulterations and/or contaminations of chemical and/or physical and/or biological systems. Moreover, in according to Figures 1 and 2 of U.S. patent 4,818,348 it can be observed that the samples are introduced and soon afterwards converted into steam in order to then be analyzed by the sensors. In the present proposal there is no need to modify the sample. The sample is directly inserted in the sensor(s) and a module (hardware) analyzes the signal(s), sending the results to a computer for the final response of whether or not contamination and/or adulteration of the sample exists. The
mathematical methodology used by Steller is also totally different. According to the description, a preliminary treatment of the data is necessary to eliminate blank readings and afterward the data need to be normalized. At that point candidates are selected for which there was a strong response by the sensors. Finally, there is a selection of more than one compound. The concentrations of each one of the probable candidates can be discovered by solving several algebraic equations simultaneously. At that point the proposal of the present invention differs completely, since no set of linear equations for identification of contamination or adulteration whatsoever are solved in the present invention. The results calculated are compared with those stored in the memory of the computer in Steller's proposal by means of a microprocessor built inside of the instrument that also differs of the present proposal in which the program developed just compares the data and makes the decision of informing the user with the computer's display whether there has been any modification of the sample or not, starting from the user's definition. Summarizing, the present invention (ISAC) differs from Steller's proposal in several points. In the present invention a previous treatment of the sample is not necessary and identification is not limited to the liquid medium, as in Steller's. The present invention can analyze more complex systems than what Steller proposed and can achieve from the first, greater precision in the results, since the method of artificial intelligence, artificial neural networks, is reported in the literature as a
universal multivariate function approximator (S. Haykin, *Neural Networks: A comprehensive foundation*, Prentice Hall, New Jersey, 1999). Moreover, the present invention can include qualitative data, such as appearance, color or probability, while polynomial approaches, such as in Steller's proposal, are extremely complicated or, in many cases, impossible to implement.

A system of control for automotive motors is described by Sakamoto et al. (1991) in Patent 4,991,102 in which the ratio of combustible air is controlled by the response of the concentration of oxygen detected in the gas exhaust with the response of the control system in a learning form, although the use of any techniques of artificial intelligence is not verifiable, seemingly (it is not mentioned explicitly in the patent) fuzzy logic is used with the characteristics IF-THEN-ELSE to analyze the response of the oxygen sensor, producing an effective control of the motor.

Lucero et al. (1991) U.S. patent 5,010,776 proposed a system for detection of contaminants in the environment. A sensor is adapted to collect a sample of the fluid to identify the presence of contaminants through steam pressure. As described, the same principle can be used to analyze masses of soils, liquids and gases. Similarly, Wohlstein et al. (1994) U.S. patent 5,296,843 proposed a device to diagnose fluids or steams through analysis of the light transmitted through the sample. When the ratios between the signal in the sample with the pre-established signal are outside of the defined limits, the system rings
an alarm indicating alteration in the sample. Smith et al. (1998) proposed in U.S. patent 5,751,415 a method in which Raman spectroscopy is used to analyze chemical compositions. As described, the invention is useful for analyzing continuous fluids containing products made of petroleum and biological and aqueous fluids. A laser source is used to produce excited electrons in a defined wavelength. The electronic signal is analyzed and converted by the computer into a chemical representation.

The methodology proposed by D. M. Johnson (1999), U.S. patent 5,966,477, describes a sensor for detection of fluids that can detect water in composed hydrocarbons, such as in the gasoline, not, however, presenting solutions for contaminants of other natures, it should be characterized, therefore, as a specific method.

In U.S. patent 5,739,916, proposed by Englehardt et al. (1998), a method and instrument are described to identify the concentration of species in a substance. The methodology is based on optical analysis, using a tungsten light source via transmission spectrum. The instrument and method can be used to identify and to distinguish several levels of contaminations of motor oils, diesel, hydraulic fluids contaminated with water, among others. As suggested, the instrument is appropriate for identification of oil quality.

In U.S. patent 5,748,002, proposed by Scott et al. (1998), electronic monitoring is described, using single-ended coupling of the load-pulled oscillator. In the examples given, two samples of gasoline, contaminated with
different amounts of water were analyzed through the calculation of the area under the curve of both measurements.

Clark et al. (2002) describe in U.S. patent 6,405,135 a detection system in real time of underground contaminants. The system consists of monitoring through acoustic wave sensors. The sensors detect polluting steams through alteration of the frequency of the acoustic wave. The communication method can be made through the Web with sites connected through the internet. The system is provided as part of a pollution detector and notification service through the payment of a registration fee.

Nathan S. Lewis describes in U.S. patent 6,170,318 (2001) a method for using devices to detect analites in flows. Similarly, U.S. patent 5,521,814 (1996) introduces a process of system control which couples performance or economical objectives and that can operate "on/off-line" and in real time. Artificial neural networks are used to correlate data with emphasis on control of processes.

Another example of analysis using neural networks can be found in U.S. patent 5,915,368 (1999), describing the control of the ratio of air/c combustible, which is obtained through the detection of several physical values at low temperatures and which are analyzed to identify the state of the motor. Similarly, S. Barbara Hoffheins et al. (1997) proposed in U.S. patent 5,654,497 an analyzer of fuel for motors of vehicles. Through semiconductor sensors, for detection in the gaseous phase, it was shown that the system is able to respond to any specific organic substance
in the mixture and, therefore, as proposed, can recognize the "signature" of a given substance. Such a procedure is based on recognition of standards and classification. U.S. patent 5,932,806 (1999) proposes a procedure for the detection of contamination of systems. The method is based on detection under a film of resonant waves. The detection and classification are used to identify contaminants on the surfaces of airplanes. It is based also on recognition of patterns. Differently, but within the same scope of analyzing systems through neural networks, U.S. patent 6,035,246 (2000) proposed a method to identify known materials in systems of unknown materials. The analysis is done through the training of a network neural through genetic algorithm and then, after the training, there is a crossing of the information of input/output from the network for the identification of the desired materials. The multivariate method of statistical analysis is also used for a reconfirmation of the precision of the analysis. Finally, U.S. patent 5,646,863 proposed by Stephen G. Morton (1997), describes a method and the necessary apparatuses to detect and to classify contaminants in water. The precision of the detection is in the range of parts per billion, ppb. Artificial neural networks are used for classification processes, supplying in real time, the measurements and responses, which can be transmitted remotely. Nonetheless, none of those inventions resembles the invention that we are now introducing. Although the patent of Morton presents characteristics close to the techniques used in the present invention; nevertheless with
that technology the measurements necessary for analysis of the samples require the addition of acids and bases (claim 45) for prepare them for transformation into analites. As consequence, that procedure uses materials that present laboratory characteristics and the production of highly corrosive materials, due to the toxic residues which can be poisonous to the environment and to human beings.

Moreover, the proposed system is highly complex, and should be classified as almost a mini-laboratory complex, with excessive numbers of stages to be executed for the identification of contaminants in water. The invention described herein is characterized by the non-modification of the sample through the analysis of physical and/or chemical and/or biological properties. Therefore, it is a simple procedure, non-corrosive and without poisonous sub-products, showing concern for protection of human beings and the environment.

A solid theoretical foundation considering techniques of expert systems such as, artificial intelligence (genetic algorithms, fuzzy logic, among others) and also developed neural networks, for example, through backpropagation methods, Levenberg-Marquardt, Hopfield, SVM (Support Vector Machine), SOM (Self-organization method), Kohonen, ABAM (Adaptive Bi-directional Associative Memory) as well as traditional mathematical methods (non-linear regressions) and even multivariate statistical methods, have been widely used in several solutions for the identification of contaminants in chemical systems. The techniques mentioned are well-established and used widely to solve varied

Cheng et al. (2001), in U.S. patent 6,236,908, used neural networks through data generated by the electronic motor control unit to monitor it, for instance, in the operation of fuel economy optimization, to control NOx emissions, for injection control and timing of ignition. Ishida et al. (1999) (U.S. patent 5,915,368) used neural networks to control the flow of air/combustible. A similar procedure adding the technique of fuzzy logic is also used by Trumpy (2000, U.S. patent 6,067,965) for the air/combustible control: Hoiffheins et al. (1997, U.S. patent 5,654,497) used neural networks for the recognition of patterns. The proposal consisted of identifying and classifying constituents of fuels through the composition of the gaseous phase via several sensors based on semiconductors. Additionally, in the patent of Hoiffheins there is the claim of the possibility of recognizing "signatures" in the system. The most common methods used in Hoiffheins' patent are Hopfield, Hamming and Boltzman; these last two methodologies having been used with more intensity. Still concerning the problem of air/combustible flow, Kong et al. (1996, U.S. patent 5,524,599) also proposed the use of fuzzy logic for flow control.

Similarly Kinoshita (1997, U.S. patent 5,602,966) used fuzzy logic for the identification of rules and functions to meet pre-defined characteristics. Among several applications of the SVM technique, the proposal of Vapnik et al. (2001, U.S. patent 6,269,323) uses that technique to
estimate the kernel of functions with applications in the reconstruction of associated images from data of positron emission. On the other hand, Perkins (2000, U.S. patent 6,159,255) uses the technique of multivariate statistics to predict properties of mixtures. Such a procedure is made through the measurement of correlated properties and mathematically correlates the concentration or the product of the concentrations of the components involved. Ashe et al. (1997, U.S. patent 5,699,269) uses the same technique to predict physical and chemical properties of raw oil and their fractions in the distillation. The same inventor, in U.S. patent 5,602,755 (1997), uses this technique to analyze complex mixtures of hydrocarbons via a set of training data to be used as references samples, containing the molecular characteristics of the types present in the mixture. Specifically in the analysis of fuels (gasoline) the SOM method (self-organization method), which is related to the KL method (Karhurem-Loeve), was used in U.S. patent 5,734,796 (1998) to analyze of the number of octanes in the gasoline. The patent proposed by Lewis (2001, US 6,170,318), describes the development of various chemical sensors (based on polymeric systems) for the detection of alteration in odors, in other words, modification of the composition of the gaseous constituents of the sample. Neural networks were used to compare the ideal behavior with the measurements of any kind of samples. Recently, techniques of artificial intelligence, artificial neural networks, have also been used, as in patent PI0103947-4 (2001), which proposed the analysis of contaminants in
chemical systems using as its example the mixture water/alcohol; however, it did not present examples describing the application of the methodology to gasolines as in the present invention. Alternatively, the following technologies can be used, whether or not linked to the present technology: RLC circuits, RLC bridge, associated with sensor plates, parallel cylinders, but not limited, to measure resistance, capacitance, when they are inserted in the liquid, or even data in the form of tables, that can be combined or not with present methodology to acquire the signal(s) from sensor(s) for analysis in real time and on site of chemical and/or physical and/or biological systems. The present invention can additionally be implemented to detect contaminations, for instance, in gasolines with sensor(s) implanted in gas pumps, constantly measuring the properties of the system and these sensors linked to the intelligent software, informing in real time and on site if that system (gasolines) differs or does not differ from the standard previously learned by the intelligent system. It is also possible to use the present technology in a way that it is unlinked in which the sensor is installed in the gas pumps, but not limited, and it supplies, in real time, and on site, the properties, but not limited, of temperature, resistance and capacitance of the gasoline, so that the user, at the moment of filling the tank, can read that information in a display attached to the gas pump and on a cellular or other device for numeric calculation to execute an intelligent program, based on artificial neural networks, but not limited, that processes, in real time,
the received signal and supplies, through the viewfinder of the cellular or other digital information device, but not limited, that will execute the intelligent program, the information and finding out if the gasoline to be supplied meets or does not meet the standards. Another possibility of application of the present invention consists of use of sensor(s) implemented in gas pumps, constantly measuring the properties of the system, and with those sensors linked to the intelligent software informing in real time and on site if that system (gasolines) is or is not different from the standard previously learned by the intelligent system. Other applications of this invention can be pointed out, for instance, in environmental systems to enable the acquisition of data from satellites linked to the present technology to monitor chemical and/or physical and/or biological systems in real time and on site.

Thus, it can not be found in the state of the technique any technology that uses in a simple, creative and low cost way an intelligent system able to identify alterations and/or adulterations and/or contaminations in physical and/or chemical and/or biological systems, as in the present invention.

This being true, the present invention comes to meet the current needs of society in presenting effective solutions for the analysis of physical and/or chemical and/or biological systems or even combinations of these, helping to ensure the original characteristics of the systems and, therefore avoiding adulterations, for
instance, of fuels, waters or medicines, but not limited to these, promoting sustainable development for the country.

All of the methods and procedures in the current state of the technique described above are applied to various problems in which standards are used, to be compared with the measurements collected via sensors and in real time. However, the present invention differs from those due to the use of sensor and/or bio-sensors (but not limited) for the analysis of physical and/or chemical and/or biological properties, and even physiochemical properties, in real time and on site, at room temperature as well as because of the use of samples without the need of physical and/or chemical alterations, not yet claimed in the state of the technique, for instance, in the detection of adulterations in fuels, gasolines, but not limited to these.

The newly developed topology can be better understood through the block diagram of figure 1. In the diagram of Figure 1, block (a) defines the measuring devices of physical and/or chemical and/or biological properties, but not limited, blocks (b), (c) and (d) were introduced to improve characteristics of the signal from sensor(s) and/or biosensor(s), with digital filters with digital signal processing, as well as the use of analogical filters and with analogical-digital converters, with optional block (d) which transmits the data to the computer, and if included, would be joined to block (b), with the filters, but but not limited. This hardware/software structure is designed to handle sensor signals, but not limited. Block (e) consists of the intelligent system, using artificial neural networks.
for analysis of the system under study through software, which is executed by a computer, but not limited. Finally, block (f) supplies the response of the ISAC system. Such methodology allows handling and/or analyzing of chemical and/or physical and/or biological systems for identification of contaminants and/or control of processes through instrumentation measurement. The measurers of physical properties (MPP) can be characterized, for instance, as capacitance meters, but not limited, in which an electronic circuit can be proposed to identify the capacitance of an element, through tension applied and measured afterward. Examples of that type of circuit are found in the literature, in textbooks (B. G. Street-man, S. Banerjee, Solid State Electronic Devices, 5th Ed., Prentice Hall, New Jersey, 1999) or on the Internet (http://fc.uni.edu.pe/lfgeneral/pdf/fiii-03-circuito%20rc.pdf), and other equivalent methods are possible.

In the present proposal the methodology employed worked on a digital generator of signals that generates a sinoid to excite the sensor, which consists of two parallel metallic plates, but not limited, which is also used to identify the resistance between the plates of the sensor. That resistance is measured through a synchronous demodulator of the type Lock-in, which can be built as described in the literature (R. E. Best, Phase-Locked Loops: Design, Simulation, and Applications, 4th Ed., McGraw-Hill, 1999) or obtained on the Internet (http://www.scitec.uk.com/lockin/wheatstone_bridge.htm). The modulator used must be to be synchronized, but not
limited, with the sinusoid of the sinusoidal signal generator, with one phase of 0°, but not limited, in such a way as to be sensitive only to the real part of the signal that passes through the sensor and, therefore, to its resistance. The diagram of the circuit used, but not limited, to measure the capacitance parameters and resistance, also not limited, is described in Figure 2. In Figure 2, (1) shows the digital sinusoidal generator in which the output (a) has the sinusoid and in the output (b) the phase; (2) shows the sensor containing R/C and block (3) the circuit measuring capacitance; (4) shows the circuit of variable gain and in (5) and (6) there is the lock-in and the filter of the lock-in respectively. Finally, (7) and (8) show the capacitance and resistance signals, respectively. After passing through those parameter measuring circuits, the signals go through analogical filters. These filters are well known in the state of the technique and they can be found in electronics literature with several types and orders (2nd, 3rd, Bessel, Cauer, etc.); or one can use digital filters (average, elliptic, FIR, IIR) or other algorithms for signals filtering, but not limited. In the case of digital filters, these can be applied when the signal has already been digitized. The analogical-digital (A/D) circuits used were the commercial of the type Burr-Brown AD574 and the microcontrollers used, also commercial, were PIC 16C74 for the microchip and Atmel 89C52, but not limited. The construction of those circuits allows the use of a phase and/or frequency modulation system to measure the signal
from the sensor(s), in ultra-thin band, but not limited, such as drift, i/n noise and thermal noises and applications requiring "ultra" precise measurements and/or trainings. The construction and use of those topologies and/or estimation algorithms in discreet time, permit the reduction of the set of training and/or measurement variations, enabling, if associated with artificial intelligence algorithms, the convergence of the method in situations in which the measurement signals from the sensor(s) and/or bio-sensor(s) have random and/or probabilistic components. Furthermore, the construction and use, but not limited, of analogical filters and/or signal limiters and/or signal conformers for adaptation of measurement/training in situations with noise and/or hysteresis, but not limited, in the sensor(s). Therefore, there is the construction and use of auxiliary topologies for identification and training of systems and/or sensors that contain hysteresis in their behavior.

This invention is further characterized by the possibility of measuring of a physical and/or physiochemical property such as: density and/or specific density, calorific capacity (C_p and/or C_v), enthalpy (of formation, of combustion, of dilution, of vaporization, of solution, of fusion), internal energy, Gibbs energy, entropy, Helmholtz energy, standard potential, specific volume, speed of sound, conductivity, pH, temperature, humidity, pressure, volume, Joule-Thomson coefficient, permittivity or dielectric constant, refraction index, molar refractivity, solubility, force constant, magnetic
susceptibility, ionization potentials, electronic affinities, dissociation and/or formation constants, coefficient activity, virial coefficients, coefficient of compressibility, superficial tension and other properties, but not limited, for systems in any phase, whether solid or liquid and/or gaseous and/or even mixtures of those, in physical and/or chemical and/or biological systems.

For a better understanding of the present technology, consider the contamination/adulteration of fuels, for instance, gasoline, but not limited to such. Through the techniques of artificial intelligence, using artificial neural networks, but but not limited, when measuring the physical properties of capacitance and resistance sensor(s) on parallel plates, but not limited, a set of standards is determined for the physical and/or chemical and/or physiochemical properties and these standards, after learning made by the training of the artificial neural network, are compared, in real time, with the measurements on-line of the respective properties, on site and at room temperature. As an immediate consequence, in this phase of the analysis, it can be determined that the chemical and/or physical and/or biological system is or is not contaminated, adulterated and/or or simply outside parameters or atypical. Equivalently, a combination of resistance and capacitance (impedance) is measured by the sensor when it is immersed in the liquid and these measurements are related with the conductivity and dielectric constant of the liquid that it is between the plates of the sensor. Other forms of measuring (topologies,
circuits, etc.) that measure those parameters directly are similar to the way presented here and can substitute this way without diminishing the capacity to measure the properties of the system. The sensor, by measuring the resistance and capacitance between parallel plates, determines tension values that are specific for the liquid system, but not limited, supplying values different from tension (resistance and/or capacitance) for different types of contaminated and/or adulterated liquids or systems. The values measured are transmitted regarding the information relative to the temperature of the system, to the hardware that transfers the digital data to a system of numeric calculation, containing the intelligent program to execute the training, through techniques of artificial intelligence, so that the correct response of resistance and/or capacitance, but not limited, will be adjusted for different temperatures characterizing the liquid system for various temperatures.

With the present technology that constitutes the ISAC system, it can be confirmed that the parameters of conductivity and dielectric constant, measured through a sensor of parallel plates, but not limited, supplying measurements of resistance and capacitance, that is linked with the conductivity and the dielectric constant of the material being analyzed, forms an excellent set of parameters to characterize, for instance, fuels (gasolines, alcohols) liquids and lubricants, but not limited. In the case of fuels, the need for such a set of parameters is very clear, as is confirmed by the example to be presented
later in this report and also, as described in the present invention, meeting the needs outlined by ANP.

The development of the present invention involves the use of several knowledge areas (physics, chemistry, mathematics, engineering, electronics) and, as consequence, it has great multidisciplinary and transdisciplinary qualities. Added to these the areas is Artificial Intelligence, as in artificial neural networks, but not limited, as complementation characterizing an efficient technology for the detection of adulterations and/or contaminations in chemical and/or physical and/or biological systems. The present invention involves the following elements and/or processes, but not limited:

- It is composed of one or more sensor(s) and/or bio-sensor(s) that do not modify the samples;
- It includes a metallic cylinder for storage of the sensor(s);
- The cylinder (compartment) it is connected to a module which is made up of several electronic components whose design is specific, but but not limited, for analysis of contaminants and or adulterations in physical and/or chemical and/or biological systems;
- The module is then connected to a computer that executes a specific software, but but not limited, to identify whether or not there is adulteration and/or contamination of the system under analysis.

- The software was built using techniques of artificial intelligence, for instance, artificial neural networks, but but not limited. The set of linked intelligent
systems, that is, hardware, software and sensor that characterize the ISAC system, when linked, allows it to detect microscopic modifications through physical and/or chemical and/or biological properties of the system without alteration of the sample;

- The present invention can also be defined and, therefore, characterized as a set of electronic circuits able to measure, in real time, physical properties through electronic signals of the system and, therefore, those that show properties deviating from a previously defined set of physical and/or chemical and/or biological properties;

- Applications of artificial neural networks (software) linked with a hardware system, through the joining of one or more sensor, which are connected to the software, that is interlinked to another hardware in turn, for instance, a computer, or an analogical exit that it supplies the result of the analysis. This whole procedure is characterized by execution in real time and on site and, therefore with economical characteristics strongly viable for adulteration detection, for instance, of fuels, but but not limited;

- Chemical and/or physical and/or biological process in which the sample is submitted for analysis in real time at room temperature. The present invention can also be identified as a new methodology for the mapping of processes and/or products.

The present invention is characterized by the use of methodology through equipment/hardware/software for
analysis and detection, in real time and on site of contaminants and adulterations in these systems: aquatic, atmospheric, environmental, rivers, lakes, and springs, and/or combinations of the above.

The present invention can also be characterized by the use of the equipment to detect adulterations, contaminations and/or modifications of the physical chemical and/or and or biological characteristics of medicines and associated products.

The present invention can be better understood in agreement with the description of the device and method for analysis and detection of adulterations and/or contaminants in chemical systems and/or associated materials, as examples, not being limited. To exemplify the applications of the present invention three specific problems were selected, but but not limited: gasoline type C supplied by Combustíveis AGIP (a petroleum corporation), water and medicine.

Figure 3 shows a cylinder (1) to protect the sensor(s) and the sample, containing a tube (2) which contains the sensors (3) and (4), having an upper opening (5) for entrance of the sample and an lower exit (6) for exit of the sample, having also a lateral exit (7) above for exit of air during the entrance of the sample and wires for electric contact (8). The openings for entrance and exit of the sample are closed during the acquisition and measurements of the properties and during the analysis of the system via ISAC. The sensor, consisting of the two parallel plates, but not limited, (3), could consist of
more plates and also built in a different format, permitting measurement of the capacitance and resistance between the plates; supplying the information of physical properties of the material, resistance and capacitance, in function of the temperature measurement, measured by the sensor (4).

Figure 4 presents the module (1) that contains the electronic circuits for acquisition of the electric properties, but but not limited, (2) being the module’s on/off button, (3) the LED indicator showing whether the module is or is not linked; the connection between the module and the sensor shown in (4); the module having another available connection (5), but not limited, having also a display (6) for communication verification, and the adjustments of the electronic circuits for the measurements of the properties made by the buttons (7) and finally the electric power source (8).

Figure 5 presents the microcomputer or laptop computer which executes a software, based on techniques of Artificial Intelligence - artificial neural networks, that it is connected to the module, from which the signals are analyzed in real time and the system provides a response in which the sample could conform or not to expectations. This response is presented on the screen of the computer, but not limited, and could also be presented either in a voice or by audible signal, transmitted by telemetry.

Figure 6 presents the data of an electric property acquired by the module for 5 different samples supplied by Distruibuidora AGIP which were previously informed to be
samples with no contamination. Those samples were used therefore as standard. Similarly and simultaneously, Figure 7 presents the other electric property measured by the sensor shown in figure 3 and analyzed by the module shown in figure 4.

Figure 8 presents the data of the electric properties of figures 6 and 7 treated mathematically and grouped in order to be presented to the neural network. Finally, figure 9 presents the results of the training of the neural network with the data of the electric properties presented in figure 8. The relative error between the exact value and that obtained through learning during the training was estimated to be sufficient to reach a value of 1x10^-7.

Figure 10 presents the complete equipment consisting of the sensor, the module and the computer. Finally, figure 11 presents a specific example of application of the present methodology, in which the ISAC system is installed in a car and in the panel of the vehicle the output of the equipment informs the user if, for instance, the fuel, gasoline, alcohol, oil or gas meets or fails to meet given standards.

The first example of analysis was type C gasoline from AGIP (a petroleum corporation). 10 bottles of 500 ml each were selected, containing 10 samples of gasoline type C. The samples were separated into 2 lots. Group 1: bottles from 1 to 5 were considered gasolines without any type of contamination and Group II bottles from 6 to 10 considered samples for test. The samples of Group 11 were prepared by AGIP without previous identification/information, if one,
more than one, or in fact all of the samples of that Group would be contaminated. The methodology described in the present invention was used on Group 1 first and soon afterwards, after the learning period, the equipment was used to detect if there was any contamination in any bottle from Group II. Two physical properties (electric) were selected, in function of temperature, to characterize the learning of the system.

The training of the data using the samples of the Group 1 was made for the temperature varying between room temperature (~20°C) and a temperature of approximately 40°C. The results of the physical properties of the samples of the Group 1 are shown in figures 6 and 7. Those data were used by an artificial neural network of the type "multilayer perceptron," but not limited, with a neuron in the input layer, two neurons in the output layer and an intermediate layer with 5 neurons. The learning error was on the order of 10^{-7} which constitutes a prediction error on the order of 0.01, equivalent to a network error on the order of 2%.

The samples of Group II (numbers 6 to 10) were introduced individually into the compartment containing the sensor, figure 3, and in real time, the signal was sent by the sensor to the module, figure 4, which processed the signal and sent it to the microcomputer, an arrangement of connections as shown in figure 5, which then executed a software based on artificial neural networks, but not limited, comparing the responses on site, at room temperature to measurements on-line provided by the
sensor(s) also processed by the module, figure 4. The possible responses of the equipment proposed are "Sample acceptable" or "Sample atypical," for the case in which it is impossible to confirm adulteration and/or contamination in relation to the standard in a pre-established range, which in the present example were responses with less than 5% of deviation, but not limited, in both properties, or "Deviant" or "Sample atypical" for the case in which it is possible to confirm adulteration or contamination in relation to the standard for deviations above 5% in the properties tested. For the present example, the table below shows the two Groups, I and II, with samples corresponding to bottles 1 to 10. As can be observed, only bottles 6 and 7 show the results "Deviant." This response was later confirmed by AGIP Distribuidora as the samples which had been contaminated and/or adulterated.

<table>
<thead>
<tr>
<th>AGIP Samples</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottle 6</td>
<td>Deviant</td>
</tr>
<tr>
<td>Bottle 7</td>
<td>Deviant</td>
</tr>
<tr>
<td>Bottle 8</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Bottle 9</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Bottle 10</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>

The equipment supplied the response "Acceptable" in approximately 10 seconds for each sample analyzed, with two samples, bottles 6 and 7, considered "Deviant" in relation
to the samples of the Group 1 that were used as reference standards.

Another example used to test the present technology consisted of using the standards from AGIP, Group 1, to test different distributors' samples. For this, samples from several gas stations in Belo Horizonte were selected from several distributors: ALE, SHELL, IPIRANGA AND BR-PETROBRÁS. All of those samples were acquired in the same day in appropriate plastic containers, corresponding to a volume of 1L from each distributor. The samples were transferred later to amber glass bottles and stored in an aerated place, at room temperature. A volume of 40 ml from each of them was removed and introduced into the sensor for analysis. The ISAC system supplied the responses, after learning, and the results are presented in the table below, also considering deviations less than 5% in the simultaneous case of both properties measured:

<table>
<thead>
<tr>
<th>Gas Station</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALE</td>
<td>Acceptable</td>
</tr>
<tr>
<td>SHELL</td>
<td>Acceptable</td>
</tr>
<tr>
<td>IPIRANGA</td>
<td>Acceptable</td>
</tr>
<tr>
<td>BR-Petrobrás</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>

Another test was conducted, using a known sample that had been removed from a car Marea in the Fiat Strada Car Dealership of Belo Horizonte. According to the managing mechanic of that dealership, the vehicle was having
problems in its motor due to adulterated fuel. A sample was
given to us and we tested its conformity in function of the
standard from AGIP. We also verified in approximately 10
seconds that the sample registered “Deviant” from what was
provided by the supplier of the sample.

Another application, but not limited, of the present
technology would be to analyze the water, for instance, in
domestic showers. Initially one could train an artificial
neural network using the same electric properties, the
dielectric constant and the resistance, in function of the
temperature for samples of water of a residential shower.
After the training, it could consider several samples
collected at different time intervals for a person’s shower
during a total time of, for instance, 20 minutes. The first
5 minutes would collect data of the water without the
addition of soap (Group I), in the interval from 6 to 15
minutes samples of the water would be collected, but with
the use of soap (Group II) and finally, from 16 to 20
minutes there would be a sample collection of water without
the soap (Group III). The ISAC system could analyze, in
real time and on site, the different samples in order to
verify that, as expected, the samples from Groups I and III
should not have contamination. That methodology would allow
the reuse of the water, for instance, to water gardens. In
the example described, one could obtain, in principle, an
savings of 50% of the volume of water used. Such technology
enables, therefore, reduction of water waste through its
re-use as non-potable water, proving the significant
ecological aspects of the methodology being presented here.
Equivalent to the example of the water described above, the present technology can be used to analyze deviations from pre-defined physical characteristics for a specific medicine. The ISAC system, as experimentally tested in the case of the gasoline, can learn properties of the medicine and a strategy for measurement subsequently defined, for instance, through a bar code supplied by the manufacturer and printed on the package, and thus the system can measure the selected property and compare it with the property learned during the training phase of the artificial neural network. During that stage, the system, when comparing the measurement made on site to the response learned by the neural network, can respond whether there is a probable adulteration in the medicine in question.
CLAIMS

1. PROCESS AND DEVICE BASED ON INTELLIGENT SYSTEMS -- ARTIFICIAL INTELLIGENCE -- ARTIFICIAL NEURAL NETS, FOR DETERMINATION AND CONTROL IN REAL TIME OF CONTAMINANTS IN PHYSICAL AND/OR CHEMICAL AND/OR BIOLOGICAL SYSTEMS characterized by enabling measurements in real time and on site of physical and/or chemical and/or biological properties, in solid, liquid and/or gaseous states, and/or mixtures of those states, through sensors and/or biosensors, using techniques of artificial intelligence, artificial neural networks, but not limited, for learning of the system and subsequent detection of modifications and/or alterations and/or adulterations of those systems and/or equivalent systems in relation to the acquired learning of the system previously defined as standard.

2. PROCESS AND DEVICE BASED ON INTELLIGENT SYSTEMS -- ARTIFICIAL INTELLIGENCE -- ARTIFICIAL NEURAL NETS, FOR DETERMINATION AND CONTROL IN REAL TIME OF CONTAMINANTS IN PHYSICAL AND/OR CHEMICAL AND/OR BIOLOGICAL SYSTEMS in agreement with claim 1, characterized by at the least a measurer of physical and/or chemical and/or biological properties in which the signal measured passes through an adjuster of signal or signals, but not limited, so that the resulting signal of that adjustment is converted into a digital signal, which is given to an algorithm based in techniques of artificial intelligence, artificial neural networks, but not limited, which is executed by a microcomputer or microprocessor or a unit of numeric calculation in which the program based on techniques of
artificial intelligence, artificial neural networks, enables learning of physical and/or chemical and/or biological properties of the system under analysis in solid, liquid and gaseous phases and mixtures of these phases and later the learning to detect alterations and/or modifications and/or adulterations of equivalent systems.

3. PROCESS AND DEVICE BASED ON INTELLIGENT SYSTEMS -- ARTIFICIAL INTELLIGENCE -- ARTIFICIAL NEURAL NETS, FOR DETERMINATION AND CONTROL IN REAL TIME OF CONTAMINANTS IN PHYSICAL AND/OR CHEMICAL AND/OR BIOLOGICAL SYSTEMS in agreement with claims 1 and 2, characterized by being able to report modifications in chemical and/or physical and/or biological systems either by voice or by audible signal, or even by means of telemetry.

4. PROCESS AND DEVICE BASED ON INTELLIGENT SYSTEMS -- ARTIFICIAL INTELLIGENCE -- ARTIFICIAL NEURAL NETS, FOR DETERMINATION AND CONTROL IN REAL TIME OF CONTAMINANTS IN PHYSICAL AND/OR CHEMICAL AND/OR BIOLOGICAL SYSTEMS in agreement with claims 1, 2 and 3, characterized by detecting, in real time, on site and at room temperature contaminants and/or adulterations and/or alterations and/or modifications in physical and/or chemical and/or biological systems with the capability to analyze the system in the gaseous, liquid and/or solid phases and a mixture of these phases, through the use of techniques of artificial intelligence, such as neural networks, specialist systems, genetic algorithms, fuzzy logic, Hopfield networks, multilayer perceptron networks, backpropagation, Levenberg-Marquardt or Gauss-Newton, SVM (Support Vector Machine), SOM
(Self-organization method), Kohonen, ABAM (Adaptive Bi-directional Associative Memory) or even through multivariate statistical methods, but not limited, for learning and control characterizing the intelligent system for analysis and control of contaminants henceforth denominated ISAC, further linked to a hardware system that receives electric signals through the use of sensors and/or by any other device or even typewriting of these, which detect information of chemical and/or physics and/or biological properties during the analysis, in real time, of chemical and/or physical and/or biological systems, transferring them to the module, (4), which consists of several electronic circuits, (2), in which there are circuits to measure physical chemical and/or biological properties, another circuit of analogical filters and/or to improve the electric signal to be analyzed and which furthermore has another circuit consisting of an analogical-digital converter linked to another circuit consisting of microcircuits and/or microprocessors, used to prepare the signal to be supplied thereafter with the smallest possible level of noise to the software, a computer program, executed by a microcomputer, but not limited, designed based on techniques of artificial intelligence, artificial neural networks, but not limited, that learn the behavior of the sample introduced into the compartment containing sensor(s), (3); subsequently learning the physical and/or chemical and/or biological properties of the system under analysis; it is also used to detect contaminations and/or alterations and/or
modifications and/or adulterations of the systems which deviate from the standard previously defined and/or established during the learning stage and finally the software, a computer program, provides the result of the analysis, in real time, on site and at room temperature.

5. PROCESS AND DEVICE BASED ON INTELLIGENT SYSTEMS -- ARTIFICIAL INTELLIGENCE -- ARTIFICIAL NEURAL NETS, FOR DETERMINATION AND CONTROL IN REAL TIME OF CONTAMINANTS IN PHYSICAL AND/OR CHEMICAL AND/OR BIOLOGICAL SYSTEMS in agreement with claims 1 to 4, characterized by allowing the implementation of the present invention to detect contaminations, for instance, in gasolines by means of sensor(s) implemented in gas pumps, constantly measuring the properties of the system and those sensors linked to the intelligent software informing in real time and on site whether or not that system (gasoline) is different from the standard previously learned by the intelligent system.

6. PROCESS AND DEVICE BASED ON INTELLIGENT SYSTEMS -- ARTIFICIAL INTELLIGENCE -- ARTIFICIAL NEURAL NETS, FOR DETERMINATION AND CONTROL IN REAL TIME OF CONTAMINANTS IN PHYSICAL AND/OR CHEMICAL AND/OR BIOLOGICAL SYSTEMS in agreement with claims 1 to 6, characterized by introducing a liquid sample, for instance, gasoline, alcohol, water, and/or mixtures of these, or even contaminations of those systems or additionally modifications of properties of medicines, alcoholic drinks, non-alcoholic beverages, for quality control in the production of those systems, but but not limited, in the sensor, (1), in the upper part, after the whole container (2) is full, the parallel plates (3)
receive an electric signal of electron excitation and transfers it to the module and that signal, through connection of the terminals (8) to (1), which is received in the module by the entrance of the signal in (4), is processed by the circuits electronic adjusted properly by the pins in (7) shown in (2) that transmit the capacitance and resistance measurements, but but not limited, to a computer, which is connected to the module as described in (8) and those signals of the measurements of the physical properties are then processed by a computer program that uses techniques of artificial intelligence, artificial neural networks, but but not limited, which processes the learning of the chemical and/or physical and/or biological system—examples of the measurements presented in (4) and (5), capacitance and resistance measurements of samples of gasolines, but not limited, and after learning, the same computer program can analyze another equivalent system, for instance, other sample of gasoline, but not limited, to compare the measurements in real time and at room temperature of the capacitance and resistance properties, but not limited, with the results of the learning done by the intelligent system, artificial neural networks, but not limited, with the possibility of using other techniques of artificial intelligence to execute such learning, such as specialist systems, genetic algorithms, fuzzy logic, Hopfield neural networks, multilayer perceptrons, backpropagation, Levenberg-Maquardt or Gauss-Newton, SVM (Support Vector Machine), SOM (Self-organization method), Kohonen, ABAM (Adaptive Bi-directional Associative Memory)
and/or combinations of those techniques and/or also using multivariate statistical methods;

7. Process in agreement with claims 1 to 6, characterized by using the set of filters or signal adjustment or even the possibility of analyzing the signals within the unit of numeric calculation digitally implemented.

8. Process according to claims 1 to 6, characterized by using one or more measuring devices of physical properties with characteristics improved so that it is not necessary to use a filter and adjust the signals.

9. Process according to claims 1 to 6, characterized by non-use of filters, and non-use of analogical-digital converter and microcontrollers so that the intelligent algorithm based on techniques of artificial intelligence, artificial neural networks, but not limited, is implemented through analogical circuits.

10. Process according to claims 1 to 6, characterized by use of analogical circuits implemented jointly with techniques of artificial intelligence, artificial neural networks, but not limited, for analysis of adulterations, modifications, contaminations of physical, and/or chemical and/or biological systems.

11. Process according to claims 1 to 6, characterized by not using the system linked as was described in (10), including the construction, for instance, of a module in a separate place that measures the information of the properties of the system and another module of numeric calculation with the intelligent system based on techniques of artificial intelligence, artificial neural networks, but
not limited, having learned the behavior of the system that can receive the information on site and respond about the modification and/or alteration and/or adulteration of the system, for instance, to a person with a microcontroller typing the information of the sensors placed in locations to measure physical and/or chemical and/or biological properties.

12. Process according to claims 1 to 6, characterized by the possibility of the measuring of physical and/or physiochemical properties, such as: density and/or specific density, calorific capacity (Cp and/or Cv), enthalpy (of formation, of combustion, of dilution, of vaporization, of solution, of fusion), internal energy, Gibbs energy, entropy, Helmholtz energy, standard potential, specific volume, speed of sound, conductivity, pH, temperature, humidity, pressure, volume, Joule-Thomson coefficient, permittivity or dielectric constant, refraction index, molar refractivity, solubility, force constant, magnetic susceptibility, ionization potentials, electronic affinity, dissociation and/or formation constant, coefficient activity, virial coefficients, compressibility coefficient, superficial tension, resistivity, inductance, bandgap tension, temperature, Josephson potential, or combinations of those, Q quality, reduction coefficient and other properties but not limited for systems in any phase (solid and/or liquid and/or gaseous and/or even mixtures of those) in physical and/or chemical and/or biological conditions.
13. Process according to claims 1 to 6, characterized by use in miniaturized form to be implemented in more critical situations or when portability is needed, for instance, in automotive vehicles, aircrafts, ships, or in implants, monitoring of biological systems, but not limited.

14. Process according to claims 1 to 6, characterized by the use of electronic filters, analogical-digital converters, microcontrollers, microprocessors and lock-ins as presented in (2), but but not limited, to be used in the analysis of the electric signals originating from sensors and/or bio-sensors in measurements of physical and/or chemical and/or biological properties, but but not limited.

15. Process according to claims 1 to 6, characterized by the use of the method of artificial neural networks for analysis of chemical and/or physical and/or biological systems through measurements, in real time, of physical and/or chemical and/or biological properties.

16. Process according to claims 1 to 6, characterized by the use of sensors and/or bio-sensors for the identification of physical and/or chemical and/or biological properties.

17. Process according to claims 1 to 6, characterized by the use of hardware/software the analysis of detectable measurements of physical and/or chemical and/or biological properties and identification of deviations from chemical and/or physical and/or biological standards.

18. Process according to claims 1 to 6, characterized by the capacity to identify contaminants and/or
adulterations and/or modifications and/or their control in fuels.

19. Process according to claims 1 to 6, characterized by the identification of contaminants and/or alterations and/or their controls in water for hemodialysis processes, clinical analyses, alcoholic and/or non-alcoholic beverages.

20. Process according to claims 1 to 6, characterized by the identification of contaminants and/or alterations and/or the control of chemical and/or physical and/or biological standards and chemical markers.

21. Process according to claims 1 to 6, characterized by the identification of standard deviation of samples of perishable products through the physical and/or chemical and/or biological properties.

22. Process according to claims 1 to 6, characterized by the identification of modifications of characteristics of aquatic systems through the physical and/or chemical and/or biological properties.

23. Process according to claims 1 to 6, characterized by the identification of adulteration and/or modifications in medicines through the physical and/or chemical and/or biological properties.

24. Process according to claims 1 to 6, characterized by the identification of modifications and/or deviations from standards in industrial processes.

25. Process according to claims 1 to 6, characterized by the identification and/or detection and/or modifications
and/or deviations from standards in environmental contaminant systems.

26. Process according to claims 1 to 6, characterized by the linking of physical and/or chemical and/or biological techniques.

27. Process according to claims 1 to 6, characterized by the linking of portable, fixed or mobile systems, and/or complementary equipment linked to other devices.

28. Process according to claims 1 to 6, characterized by the identification and gauging of equipment based on samples.

29. Process according to claims 1 to 6, characterized by the identification of properties of the system.

30. Process according to claims 1 to 6, characterized by detection methods, in real time, for identification and analysis of climatic conditions through physical and/or chemical and/or biological properties.

31. Process according to claims 1 to 6, characterized by methods of detection, in real time, for analysis and identification of standard conditions of physical and/or chemical and/or biological systems.

32. Process according to claims 1 to 6, characterized by control of vital signals in measurements of biological systems.

33. Process according to claims 1 to 6, characterized by the identification of the resistance of materials and useful lifetimes of physical and/or chemical and/or biological systems.
34. Process according to claims 1 to 6, characterized by the accompaniment, in real time, of the quality of food products in function of their expiration date through physical and/or chemical and/or biological properties.

35. Process according to claims 1 to 6, characterized by the accompaniment, in real time, of the quality of products, such as white rum, alcoholic drinks, in function of the change in concentration of metals such as copper, altering the physical and/or chemical and/or biological properties.

36. Process according to claims 1 to 6, characterized by the accompaniment, in real time, of the quality of products, such as vegetable and/or mineral and/or synthetic oils in function of the changes in the physical and/or chemical and/or biological properties.

37. Process according to claims 1 to 6, characterized by permitting identifications and/or predictions and/or modifications and/or adulterations of physical and/or chemical and/or biological properties within the range allowed by the system.

38. Process according to claims 1 to 4, characterized by remote measurements or by physical contact, in real time, of properties of physical and/or chemical and/or biological systems.

39. Process according to claims 1 to 6, characterized by analyzing mechanical and/or electric and/or electronic and/or optical-electronic systems of physical and/or chemical systems.
40. Process according to claims 1 to 6, characterized by analyzing properties of motors and/or automotive vehicles.

41. Process according to claims 1 to 6 used and linked in the construction of the hardware characterized by the use of a system of analogical and digital filters in order to reduce noises in electronic signals.

42. Process according to claims 1 to 6 used in the construction and use of a set, but not limited, of digital filters in order to reduce the noise and to increase the precision of the training by the intelligent system and during the measurement of signals.

43. Process according to claims 1, 2 and 3 used in the construction and utilization of a set, but not limited, of prediction algorithms for detection of situations of "risk" or "danger", in the measurement/monitoring, indicating anomalous situations.

44. Process according to claims 1 to 6 through the construction and use of a modulation system in phase and/or frequency to measure the signal from the sensor, in ultra-thin band, but not limited, to eliminate inherent noises from electronic circuits, but not limited, such as drift, i/n type noises and thermal noises and applications of "ultra" precision in measurements and/or trainings.

45. Process according to claims 1 to 6 through the construction and utilization of topologies and/or approximator algorithms in discreet time to reduce the training set and/or measurement variables, allowing, when associated with the algorithms of artificial intelligence,
the convergence of the method in situations measurement(s) signal(s) of the sensor(s) and/or bio-sensor(s) have random and/or probabilistic components.

46. Process according to claims 1 to 6 through the construction and use, but not limited, of analogical filters and/or clampers and/or signal rectifiers, limiters, clampers, multipliers for measurement/training adaptation in situations with noise, hysteresis, but not limited, in the sensor.

47. Process according to claims 1 to 6 through the construction and use of auxiliary topologies for identification and training of systems and/or sensor(s) that contain hysteresis in their behavior.

48. Process according to claims 1 to 6 through the construction of the device or equipment characterized by hardware with software linked for uses and applications in agreement with claims 1, 2, 3 and 4 for analysis of physical and/or chemical and/or biological contaminants of systems in the gaseous physical state and/or liquid state and/or solid state and/or a mixture of these, but but not limited.

49. Device according to claims 1 to 6 for detection and measurement, in real time, of alterations in chemical and/or physical and/or biological systems, characterized by the fact of the ISAC system, (10), understanding sensors and/or biosensors, (3), but not limited, an intelligent block, (1) - block and, but not limited, linked to a microcomputer or laptop computer, but not limited, (5), connected to a sensor, that supplies the response of the
detections to the block to identify alterations and/or contaminations and/or adulterations.

50. Device according to claims 1 to 6 for detection and measurement, in real time, of alterations in physical and/or chemical and/or biological systems, characterized by the use of sensors and/or bio-sensors to identify chemical and/or physics and/or biological properties of systems in gaseous, liquid and/or solid phase and/or mixtures of those phases, in real time, through tension measurements and/or measurements of electric and/or magnetic currents and/or charge transfer and/or electromagnetic and/or sound waves for input to the device that converts into digital signals.

51. Device and/or process according to claims 1 to 6, characterized by detection of physical and/or chemical and/or biological properties of systems through the use of artificial neural networks, but not limited, characterized by the input of physical and/or chemical and/or biological properties and the output of physical and/or chemical and/or biological properties.

52. Device and/or process according to claims 1 to 6, characterized by circuits, procedures and electronic components able to detect contaminations and/or adulterations and/or modifications in physical and/or chemical and/or biological systems.

53. Device and/or process according to claims 1 to 6, characterized by allowing the communication between measuring sensor(s) and/or bio-sensor(s) and the conversion into digital signal for re-conversion on a scale of
properties to be used by the software and compared with known standards.

54. Device according to claims 1 to 6, characterized by the use of a microcomputer or laptop computer, or a numeric calculation device, but not limited, which executes a software, based on techniques of Artificial Intelligence - artificial neural networks, that is connected to the module, (4), and the signals coming from the module are analyzed in real time and the system supplies a response in which the sample may or may not be deviant, then being presented on the computer screen, but not limited, and could also be presented by voice or auditory signal transmitted by telemetry.

55. Device according to claims 1 to 6, characterized by being portable, so that it can be used at different places allowing for quick analysis of physical and/or chemical and/or biological systems and/or mixtures of those in gaseous, liquid and/or solid phase and/or mixtures of those in real time and at room temperature.

56. Device and/or system according to claims 1 to 6, for analysis of contaminants in physical and/or chemical and or biological systems, characterized by possessing at the least one sensor of physical and/or chemical and/or biological properties and/or combinations of those, that passes the signal or information about those properties to the algorithm of artificial intelligence, implemented in a computer, microcontroller, memory or other medium of electronic calculation, but not limited, that determines whether the signal or set of signals and/or information are
in agreement with the standard previously defined by training or if they deviate from the defined range for the standard, giving indications if that be the case.

57. Device and/or system according to claims 1 to 6, for analysis of contaminants in physical and/or chemical and or biological systems, characterized by the signal to be previously handled, through digital and/or analogical processing of signals, for instance, transformed by Fourier, digital filters, value approximators, Kalunom filters, fuzzy logic, analogical filters, analogical signals controllers, before supplying the adequately filtered signal to the artificial intelligence algorithm.

58. Device and/or system according to claims from 1 to 6, for analysis of contaminants in physical and/or chemical and or biological systems, characterized by allowing the use of the methodology in such a way that is not linked, and in which the sensor is installed in gas pumps, but not limited, and it supplies, in real time and on site, the properties, but not limited, of temperature, resistance and capacitance of the gasoline, and the user, at the moment of filling up, when the hose of the gas pump is introduced in the tank of gasoline of the vehicle, there is in the gas hose an infrared light source, but not limited, that emits the measurements of the properties and, at the mouth of the tank, an infrared receptor, but not limited, that receives the signal, which is processed by the intelligent program, based on artificial neural networks, but not limited, that processes, in real time, the signal received, and provides, a luminous/auditory signal, which could also be
linked to a system with live-voice, or in way written together with the luminous/auditory signal in a display on the panel of the vehicle, that informs the user if the gasoline that will be used is or is not deviant.

59. Device and/or system according to claims from 1 to 6, for analysis of contaminants in physical and/or chemical and or biological systems, characterized by allowing the use of the methodology in an unlinked way in which the sensor is installed in gas pumps, but not limited, and which supplies, in real time, and on site, the properties, but not limited, of temperature, resistance and capacitance of the gasoline, and the user, at the moment of filling up, can read that information in a display linked to the gas pump or through a cellular telephone, or other device for numeric calculation that can execute the intelligent program, based on artificial neural networks, but not limited, that processes, in real time, the received signal and supplies, through the viewfinder of the cellular that will execute the intelligent program, on the viewfinder of the device for numeric calculation, the information if the gasoline that will be used is or is not deviant.

60. Device and/or system according to claims from 1 to 6, for analysis of contaminants in physical and/or chemical and or biological systems, characterized by allowing the acquisition of data from satellites linked to the present technology for monitoring of physical and/or chemical and/or biological systems in real time.

61. Device according to claims from 1 to 6, characterized by the construction of the sensor (3), made
of parallel plates, but not limited, to measure the capacitance and resistance between the plates; supplying the information of physical properties of the material, resistance and capacitance, in function of the measurement temperature, measured through the sensor (4).

62. Device and/or system according to claims from 1 to 6, to characterize contaminants in physical and/or chemical and/or biological systems, through the use of databases containing spectroscopic data, linked to the intelligent system that can allow identification of substances that alter the standard characteristics of the original system.

63. Device and/or system according to claims from 1 to 6, characterized by presenting an application of the present methodology, in which the ISAC system is installed in a car, but but not limited, and in the panel of the vehicle the output of the equipment informs the user if, for instance, the fuel, gasoline, alcohol, oil or gas is or is not deviant from the standard.

64. Device and/or system according to claims from 1 to 6, for analysis of contaminants in physical and/or chemical and or biological systems, characterized by allowing the linking of electronic circuits as RLC bridges for acquisition of electric as well as electronic signals, or even data of measurements in the form of tables that can be linked to the present technology for analysis in real time and on site of physical and/or chemical and/or biological systems.
Fig. 6
Fig. 8
Fig. 9

![Graph showing training error vs. interactions. The x-axis represents interactions ranging from 0 to 200, and the y-axis represents training error on a logarithmic scale ranging from $10^{-8}$ to $10^{2}$. The graph shows a trend of decreasing training error with increasing interactions.]
Fig. 11