BIRD STRIKE COMMITTEE EUROPE

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SUPERVISION OF AIRPORT AREAS BY TECNIQUES OF ACOUSTIC SURVEY AND ANALYSIS

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ABSTRACT

The Paper contains an experimental monitoring at Leonardo da Vinci Airport, to survey birds presence in airport areas by acoustic methodology.

The Paper is divided into four sections:

Introduction
Methods
Discuss and results
Conclusions

1 . INTRODUCTION

The problem of the birds' presence in the airports' areas has been studied in deepned way since many years (BSCE 1992 and precedents). An international publication, relative to different systems of control and removal of the birds from the airport's areas, is made and continuously updated .

An experimental project is actually studied to the "Leonardo da Vinci" airport by the University of Roma "Tor Vergata", the Second University of Rome "La Sapienza" and the company "Isatel" for the realization of a new methodology for the control of the birds' presences in the airport's areas, that could be integrated with the systems of removal actually in use.

The system, based on the modern acoustic technology, permits a supervision and a general control of environment by sensors located in the airport's areas.

The choice of this new system of control emphasize aspects particularly interesting, because this new system can be not expensive whether for the material or for installation or for keeping. It's possible to use this new techincue also for others aims relative to the security (moviment of the airplanes or service's vehicles, individuation in case of absence of visibility, measurement of the speed's wind, etc..).

2 METHODS

2.1 . Methodologys for Acoustic Monitorage

The measurable sizes of reference, usually utilizec to make an acoustic analysis, are constituted by pressure, frequency and audio intensity. Set before that for sound we mean any signal that propagates itself by pressure's waves in any fluid means (air, water, etc.), it's clear that the observation of these sizes depends on source that gives out the soundwaves, on means in which they propagate themselves and on type of trasductor used to measure.

Usually the trasductor is made by a microphone: it's known that the characteristics that can differentiate the microphones between them are many but here it's interesting to remind only few : directivity, curve of frequency reponse, precision and invariableness of the characteristics of gain by time, cost and resistance to the atmospheric factors concerning the type of the systems that we will study.

With a view to have informations of position it's possible to measure the audio intensity by a feeler makes of two microphones mounted face to face and slightly distant between them.

It's possible in this way to measure the component, on the feeler's axis, of the audio intensity's vector and consequently to obtain informations of the source's position.

The active elements that have an important role in some applications of acoustic analysis are those that generate audio signals, with known parameters,that comparate with emitted signal, give the charateristics of this one [1][2].

2.2 Techniques for the Noises Identifications

The techniques that we want follow to do the noises' identification are based on two type of automatic analysis that will be used in integrated complementary or alternative way favourably of the functions of identification that we want activate.

The first type of methodology . method knowledge based . is based on the analysis of the sounds that we want recognize fixing that an acoustic signal belongs to a certain noise or not if it's characterized by some parameters that satisfy the limits previously determined by the analysis of the same signals.

The second type is that in which the same system in automatic way, in front of the analysis of many signals identifyting the same noise, defines the limits that any parameters must satisfy so that they belong to a noise or to another one. At this second methodology belong the systems that utilize the neural networks or the Markoff's chains that have been developed for the identification of the vocal signals [3][4][5][6].

It's interesting to observe that all of two the methodologies above mentioned analyze the signal basing on some their fondamental parameters and consequently all of two forecast a first manual analysis of the signals for to fix the same parameters that normally are the amplitude of some band of frequency's specter of the signal unseemly in little intervals of prefixed duration. The definition of the temporal duration of the little intervals like as their eventual temporal superposition, and the limits of the bands in which are decomposed the frequency's specters of the single little intervals, influence greatly the probability to make a correct identification for all of two the methodologies above mentioned.

It's possible to obtain others useful informations on the sound signals comparing the amplitudes and the temporal evolution of the outlets of many sensors rightly positioned.

3 . DISCUSS AND RESULTS

3.1 Structures and Examples of utilization of Systems of Control in the Airport areas

The application of the above mentioned technics of acoustic analysis in sector of the airports' check lets to see the implementation of several systems of big interest between which we mention the following examples.

3.2 . Wind Speed

In the hypothesis of the presence of several acoustic sensors connected to an informatic network in a certain area, it's possible to suppose the utilization of one or more emissive sources of known localization to give out fixed acoustic.

From the analysis of the delay's time in the reception of the sensors it's possible to know the detailed map of the air's speeds [7].

The relieved speed is relative to the plane on what are installed the big part of the sensors, but by the disponibility of meteorological observations and eventually by the presence of a few number sensors/generators in high positions, it's possible to know something about the ascensional moves, so important for the aerial traffic.

It's interesting to note that the variations of the specter of the acoustic signal could allow the individualization of particles in the air like fog, fouling, etc....

3.3 . Position Vehicles

If we make an hypotesis to have at one's disposal a sensors' network arranged in the airport's area, it's possible to think providing the service's vehicles with "acoustic number plates" [8], that are acoustic sources, eventually by ultrasounds for does not disturb the personnel, with sequences and different frequencies of emission for each number plates.

In this way it's possible to distinguish the vehicles (or the pedestrians) between them, and to know thier position by the temporal differences during the survey of the signal makes by the sensors, known the map of the wind's speeds at the level above the ground.

This methodology is not applaying to the airplanes, because it's impossible to provide all the airplanes of the earth with the acoustic number plates.

For these last it's thinkable to use the same sounds from them emitted, whether for them localization, or for them identification, by techniques similar to previous, but more sophisticated because the own characteristics of each sound are not known.

It's interesting to regard that these noises could be used to have a smattering of working of the motors during the mouvements of the airplanes in the airport's area.

3.4 . Presence of Birds

The birds, that can be present in an airport's area, are of different species, and their presence is in some cases function of the season in what is made the survey.

The principal charateristic, that permits the identification by an acoustic system, is the emission of notes of different type, often equipped by modulations.

Generally the emission of the notes from the birds is constant and spontaneus.

The acoustic techniques can be utilized whether for the relevation of the notes and consequently for the identification of the species, or for the birds' removal for the areas in which they can be a danger for the airplanes, as actually is made in many airports.

For this object it's possible to utilize peculiar notes of birds of prey, or sounds very disliked to the species held in consideration. These sounds can be of fixed type . simple sounds before recordered . or of variable type . adding, for example, elaborations of the notes received to the sounds before recordered . ; the sounds of the first type have the handicap to permit at the birds to accustom themselves to the same sounds.

In case in what we utilize the sounds it's very important the quality of the sounds given out,to make not possible, for the birds, to understand the differences between the real sound of danger and the artificial sounds made by a recorder.

3.5 . Survey Intruders

The presence in the airport's areas of a acoustic sensors' network can permit also to give a support to the systems of survey intruders, normally used, because it's thinkable the identification of typical noises of disliked people as human voices, broken glasses, etc..

3.6 Hypothesis of acoustic system for integrated control of airport areas

From the ideas above mentioned, it's possible to deduct that a network made by sensors and acoustic generators, can permit the control of important parameters for the management of many airport's problems.

A system, so made, could be of support for the others traditional techniques, whether giving, in some cases, more informations, or giving, in the others cases, the same information with less costs, or simply confirming the informations obtained by traditional systems.

4. CONCLUSIONS

4.1 Tests in phase of realization - Preface.

On the basis of the ideas above mentioned, we have taked the decision to involve resources coming from the sectors of university research, of airport's control and of industry prearranging a programme of joint work that permits the tests and the carrying out of the proper techniques in the sphere of interest for the creation of systems similar for the typologies to the examples above mentioned. H

The work until this moment has been planned and taken ahead on four different levels:

1 . realization of the instruments for the search and analysis:

2 . research of the methodologies and techniques recognition (these thematic are been treated in the relative chapter):

3 . acquisition and characteristics' study of acoustic signals of interest;

4 . development of sensors and microphones (in phase of realization).

In the next chapter we want to deepen the third argument above mentioned.

4.2 Acquisition and charateristics study of acoustic signals of interest

The work has been developed by the recordings of sounds and noises of two fundamental types:

. recordings contained in publication of scientific or movie type;

. recordings made in the areas of Fiumicino aircort during different days or hours on basis of informations given by airport's personnel.

All the sounds so obtained have been analyzed in a calculator by mathematical algorithmics based principally on FFT (Fast Fourier Transform) and have been taken in object the following arguments:

1 . analysis of temporal segments of half second sampled with a speed of 44100 samples/second to establish the limits in frequency;

2 . analysis in frequency of sounds and noises long five seconds sampled by aspeed of 11025 samples/second whether complete or made for temporal intervals of 200 ms with displacement of the initial instant to the next one of H

3 . analysis in frequency of the tangle of sounds and noises complete above mentioned;

4 . analysis in frequency of the tangle of sounds and noises above mentioned previously filtered by a filter pass.band centred on the frequencies resulted more significant from the previous analysis.

The study of the subject contained in the first point has permitted the analysis of the sounds considered until the frequency of 22050 Hz and this has permitted to affirm that the sounds and the noises considered do not surpass significantly the frequency of 5000 Hz [fig. 1 and 2].

The result of this first study has been that to reduce the analysis considering a higher limit of frequency of 5512 Hz and the utilization of recordings of temporal duration until five seconds. This interval has permitted the analysis of the tangle of the signal, that has been utylized for the reconstruction of the motulated present in the notes of birds, and particularly of sea gulls.

The principal result of the study of the sea gulls' notes, already present in the complet sound and confirmed by the analysis for intervals, is the presence of a fundamental component near to 1000 Hz and of its first, second and third harmonics, endowed with a great power, generally bigger than that fundamental and than the fourth, that is not ever present [fig. 3, 4 and 5].

The noises of airplanes have shown the presence of only component well sketched, of good power, located near 3000 Hz in function of the type of airplane, and of remarkable noise of ground shown by distribution of the power in equivalent way on the different components of the frequencies [fig. 6 and 7].

The characteristics above mentioned are own of the sounds considered, because the others sounds recorded in the airport's area show different characteristics of frequencies.

The course of the frequencies in the time, relieved by the analysis for intervals, has shown the presence of a modulation of the frequencies of the birds' notes obtained by the acoustic case represented by the beak and the others physical cavities.

This modulation has been studied by the analysis in frequency, until 30 Hz, of the signals' tangles previously filtered near the above mentioned frequencies, and shows the presence of a component of a remarkable amplitude near 3 or 4 Hz in case of sea gulls and the absence of modulation in case of airplanes, with a distribution of the power almost completely on the continuous frequency [fig. 8, 9 and 10].

Also in case of airplanes in taxiing's phase it has been shown the presence of specter of signal with different and well defined frequencies and slowly variable in the time as during the phases of landing and take off.

On the basis of these observations we are developing H

5. NEXT DEVELOPMENTS

On the basis of the observations made we are trying to value the opportunity to introduce, in a gradual way, the above mentioned technics of acoustic survey in the sphere of airport's security. The hypothesis of evolution of this project pass through a first phase calibration of the singol recognizers able to operate with the "TECHNICS OF RECOGNITION OF THE SOUND'S TYPE" that permits to submit to a verification of screening of noises champions taken from the field; after positive completion of this first phase it's possible to make an hypothesis of pilot experimentation in a sphere limited to the application of the identification of birds' presence; the third phase could broaden the control to others elements; the next phases could study many sensors systems, made by active elements and control's centralized station, looking at a complet configuration able to manage the recognition and the removal of the birds, the recognition and the setting of the service's vehicles or men, the recognition of meteorological situations, the recognition and setting of the airplanes on the runways, etc..

We can observe that the development of these technologies allows a bigger collection of sounds to use for the identification of of the acoustic signals whether off.line by recognizers based on known rules or by techniques of automatic learning (chains of markoff, neurals networks,etc...).

6. REFERENCES

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[5] Rabiner L. R., Juang B. H. IEEE ASSP Magazine "Anintroduction to hidden Markov models" January 86
[6]- "Apparato acustico ed elettrico integrato per il controllometeorologico".
[7]- "Apparato acustico per il controllo del traffico ferroviario e/oautomobilistico e/o aeroportuale".
[8]- J.C. Roche "Tous les oiseaux d' Europe" 4CD Citelle 1990 France

Figures

Fig. 1 . Specter of frequency (amplitude and power) until 21 kHz of a sea gull's note.

Fig. 2 . Specter of frequency (amplitude and power) until 21 kHz of an airplane's noise.

Fig. 3 . Specter of frequency (amplitude and power) of the sea gull's note long six seconds.

Fig. 4 . Specter of frequency for intervals of 200 msec of the same signal of fig. 3.

Fig. 5 . specter of frequency for intervals of 200 msec of the same signal of fig. 3.

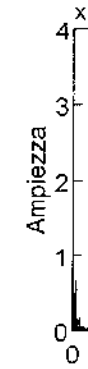
Fig. 6 . Specter of frequency (amplitude) of the airplane's noise long six second.

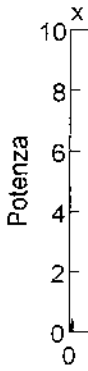
Fig. 7 . Specter of frequency for intervals long 200 msec of the same signal of fig. 6.

fig. 8 . Specter until 30 hz of the tangle of the frequency of 1018 Hz belonging to the same signal of fig. 3.

Fig. 9 . Specter until 30 Hz of the tangle of the frequency of 2037 Hz belonging to the same signal of fig. 3.

Fig.10 . Specter until 30 hz of the tangle of the frequency of 3131 hz belonging to the same signal of fig. 6.





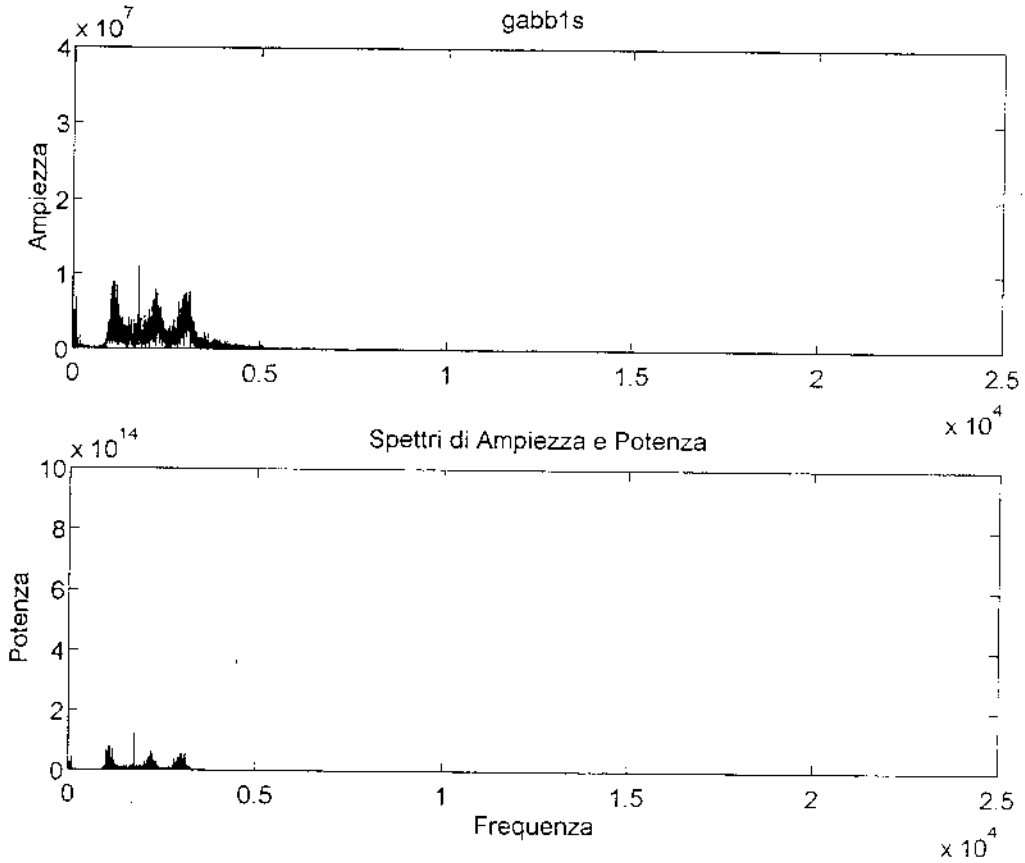

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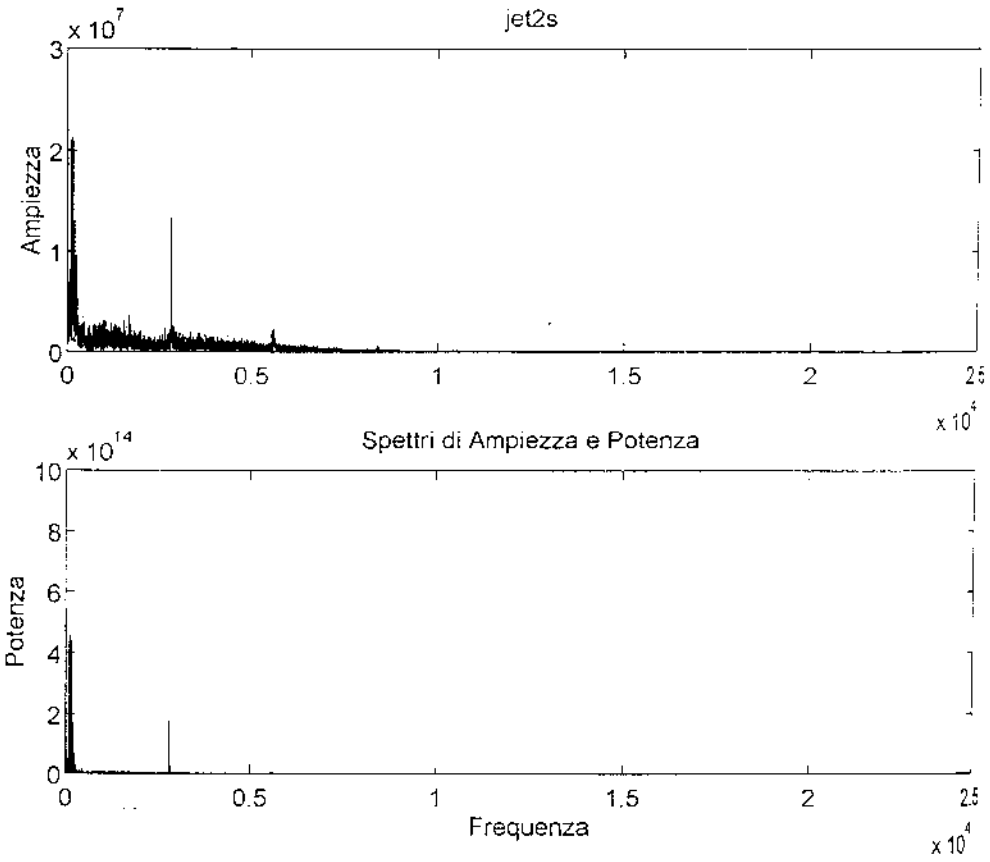
fig 1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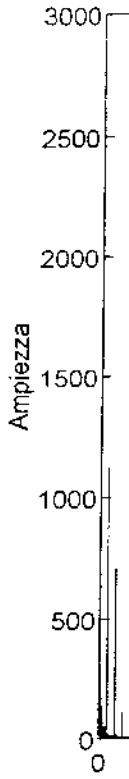
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Fig 2

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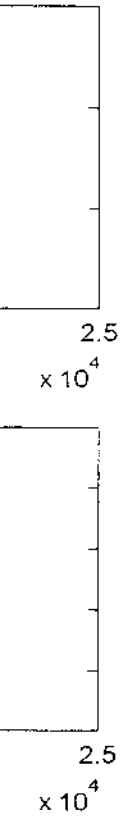

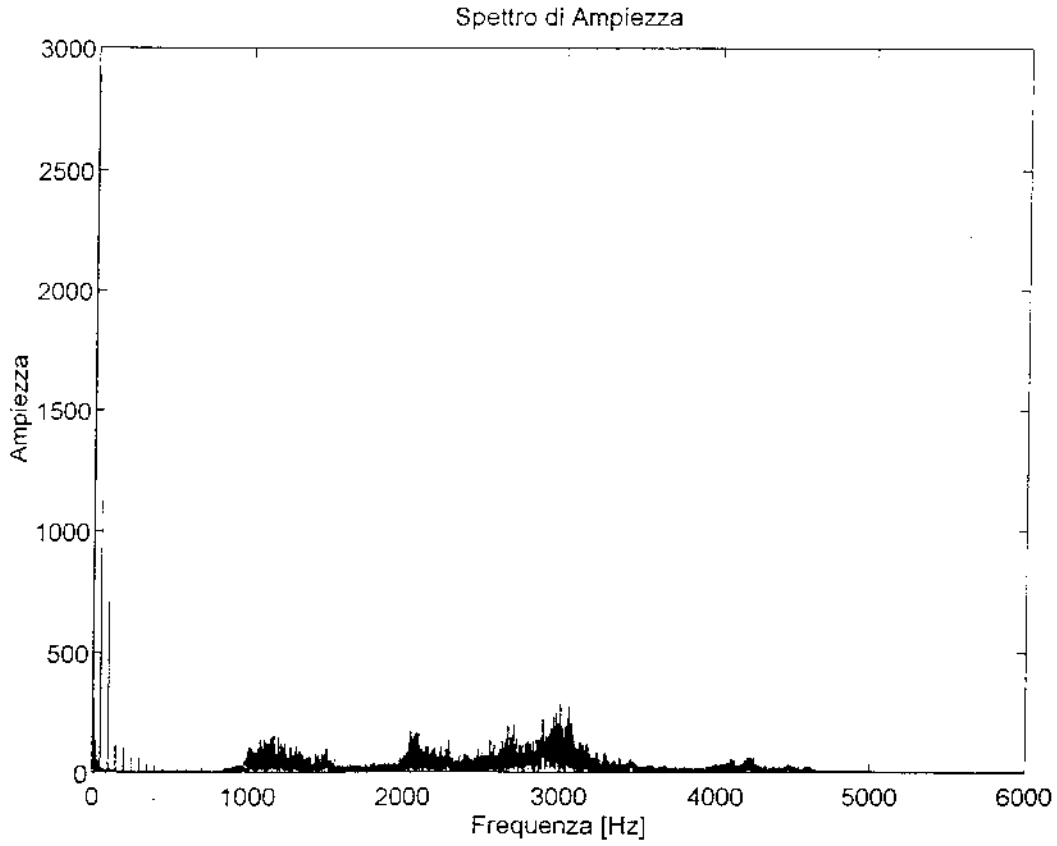

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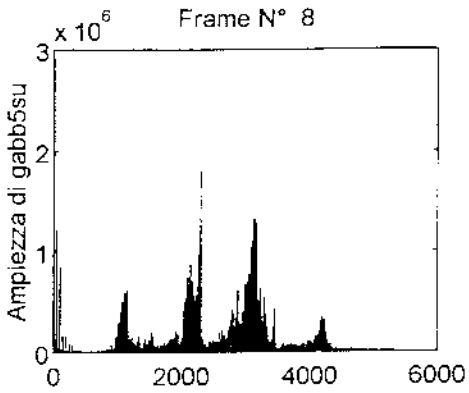
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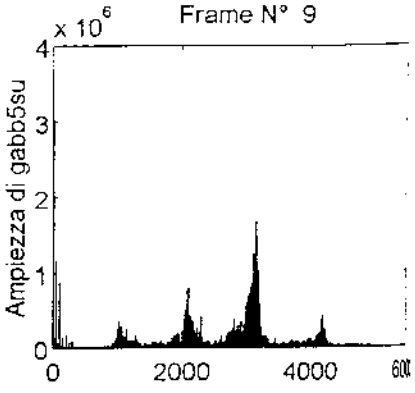
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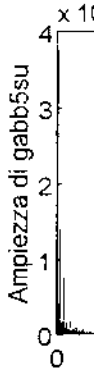
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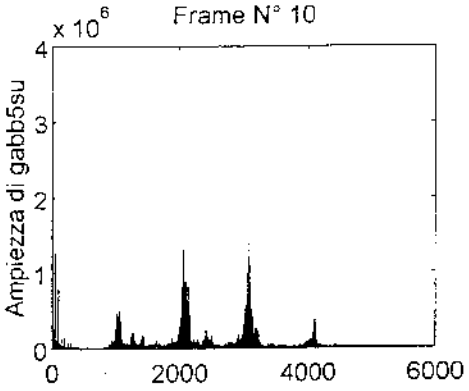
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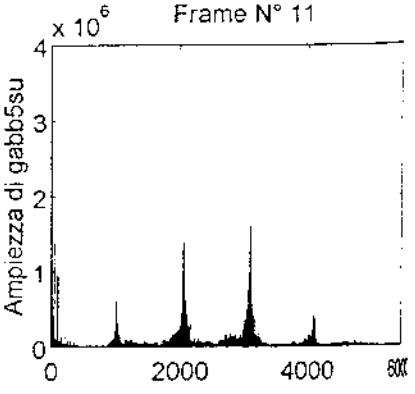
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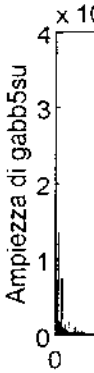
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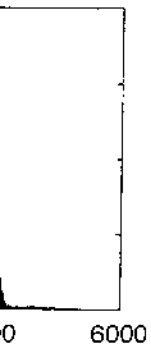
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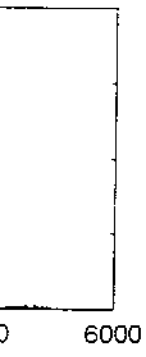
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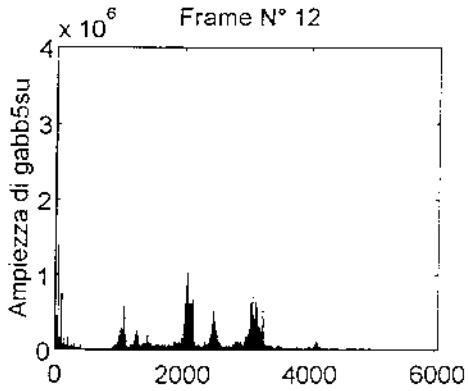
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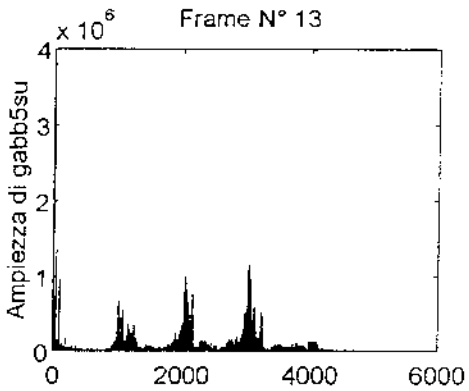
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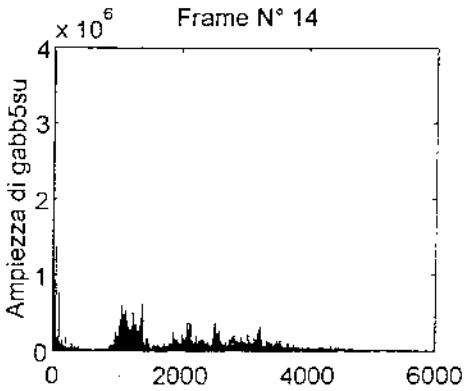
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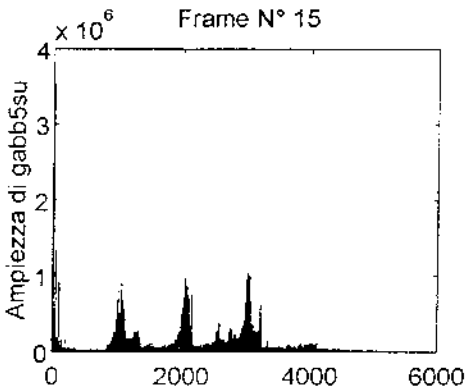
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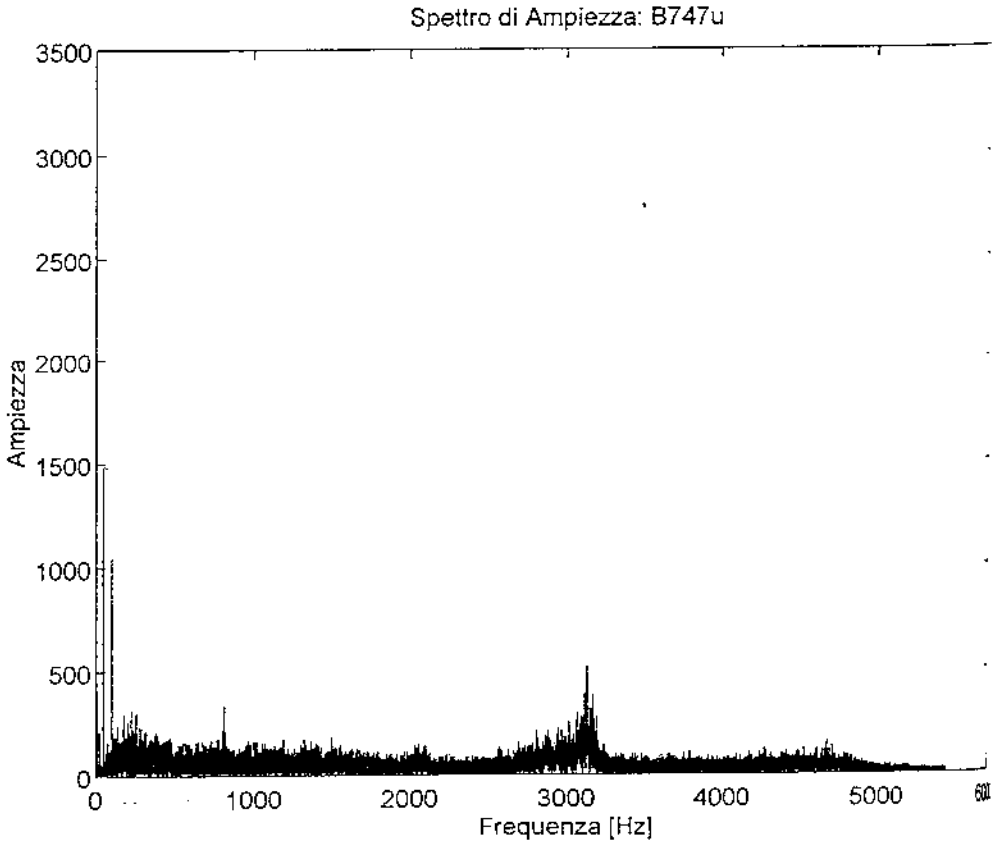
Fig 5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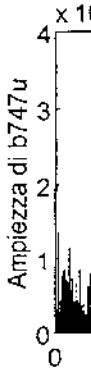
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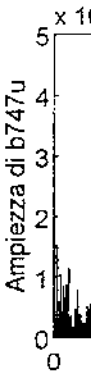
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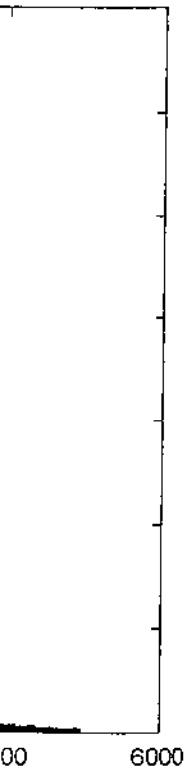
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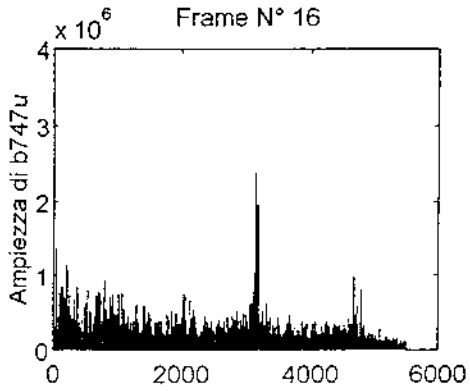
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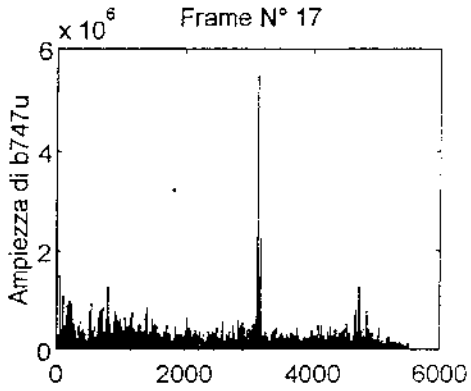
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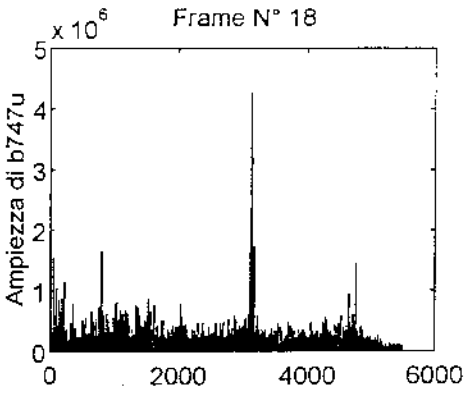
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Ampiezza di b747u
0
1
2
3
4
5
0
2000
4000
6000

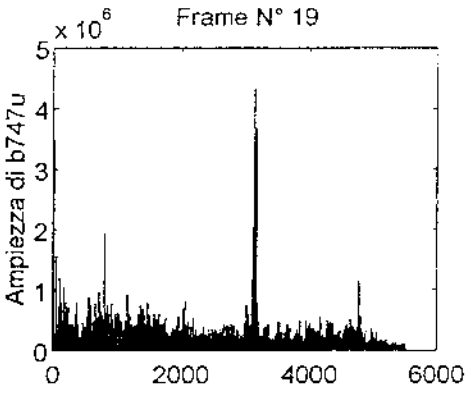

Frame N° 19
x 10^6
Ampiezza di b747u
0
1
2
3
4
5
0
2000
4000
6000

Fig 7

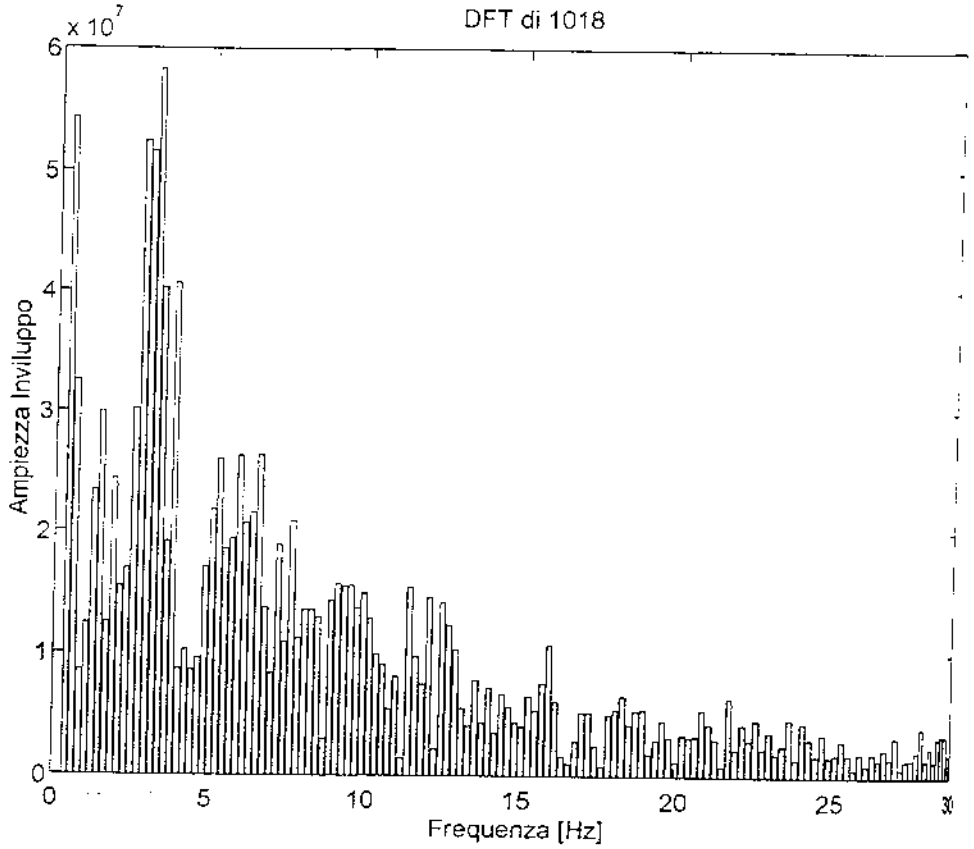
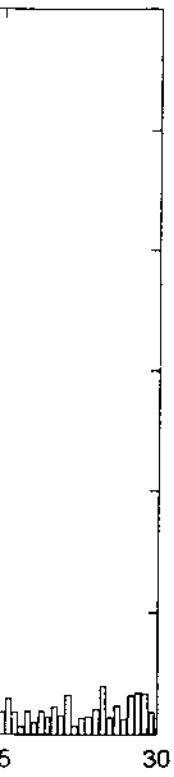

x 10^7
DFT di 1018
Ampiezza Inviluppo
Frequenza [Hz]
0
1
2
3
4
5
6
0
5
10
15
20
25
30

fig 2

GABBSM

GABBSM



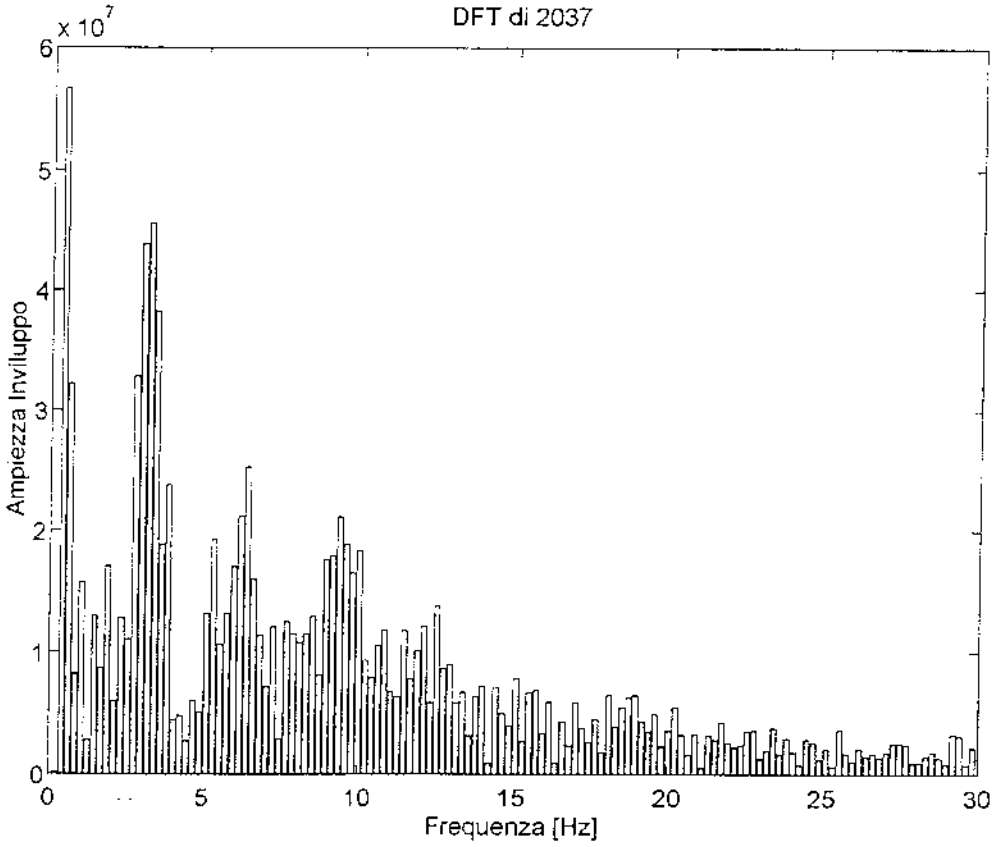


fig 8

B747 U

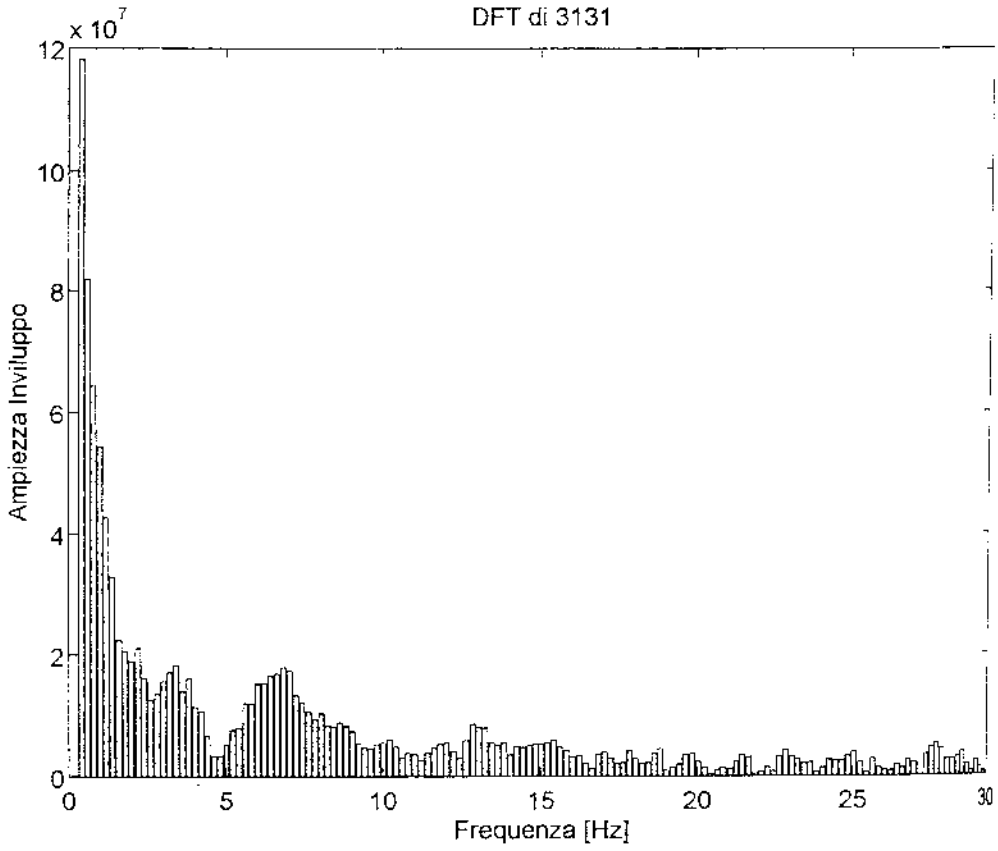


Fig 10

The paper gives
93. There have
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(Keywords: Bir