SEGMENT CLASSIFICATION OF ANALOGUE MODULATION

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ABSTRACTS

Automatic modulation recognition is a rapidly elvolving signal analysis are. In recent years much iterest by academic and military research institutes has focused around the research and development of modulation recognition algorithms. The aim of this paper is to discuss some of the avaible analogue modulation recognisers and to introduce quick and fast algorithms for well known modulation types.

1 INTRODUCTION

The current trend in modern communication is the use of digital modulation types rather than analogue ones. However, the analogue modulations are still in use especially in the third world countries. The analogue modulation types that can be classified with the developed algorithm, introduced in this paper, are: AM (with different modulation depths - 30% and 80%), DSB, VSB, LSB, USB, FM. Generelly, any automatic modulation recogniser, based on the decision-theoretic approach, comprises three main stages: 1) pre-processing, 2) key feature extraction and 3) modulation classification.

2 CLASSIFICATION OF AECH SEGMENT

From every available segment, the suggested procedure to discriminate between the different of analogue modulation comprises two steps: 1) key features extraction and 2) modulation classification. In the proposed analogue modulation recognition algorithm, four key features are used to discriminate betweeen the modulation types of interest and they are derived from the instantaneous amplitude and the instantaneous phase as well as the radio signal spectrum. The four key features are used for the analogue modulation recognition algorithms.

They are:

- γ_{max} - represents the maximum value of the spectral power density of the normalized-centered instantaneous amplitude of the intercepted signal. γ_{max} is used to discriminate betweeen FM signals as a subset and DSB, and combined (AM-FM) signals as the second subset. As the FM signals have constant instantaneous amplitude, their normalized-centered instantaneous amplitude is zero.
- σ_{ap} - is the standard deviation of the absolute value of the centred non-linear component of the instantaneous phase, evaluated over the non-weak intervals of a signals segment. σ_{ap} is used to discriminate between DSB signals as a subset and Combined (AM-FM) signals as the second subset.
- σ_{dp} - is the standard deviation of the centred non-linear component of the direct instantaneous phase, evaluated over the non-weak intervals of a signals segment. So, σ_{dp} can be used to discriminate between the types that have direct phase information (DSB, LSB, USB, FM, and Combined) and that have no direct phase information (AM and VSB).
- The fourth key feature P is used for measuring the spectrum symmetry around the carrier frequency, and it is based on the spectral powers for the lower and upper sidebands of the signal. The ratio P is used to discriminate between the VSB and AM signals as well as to discriminate between the SSB (LSB and USB) as a subset and the DSB, FM and combined modulated signals as the second subset.

A detailed pictorial representation of the proposed analogue modulations recognition procedure is shown in Fig. 1 in the form of a flowchart.

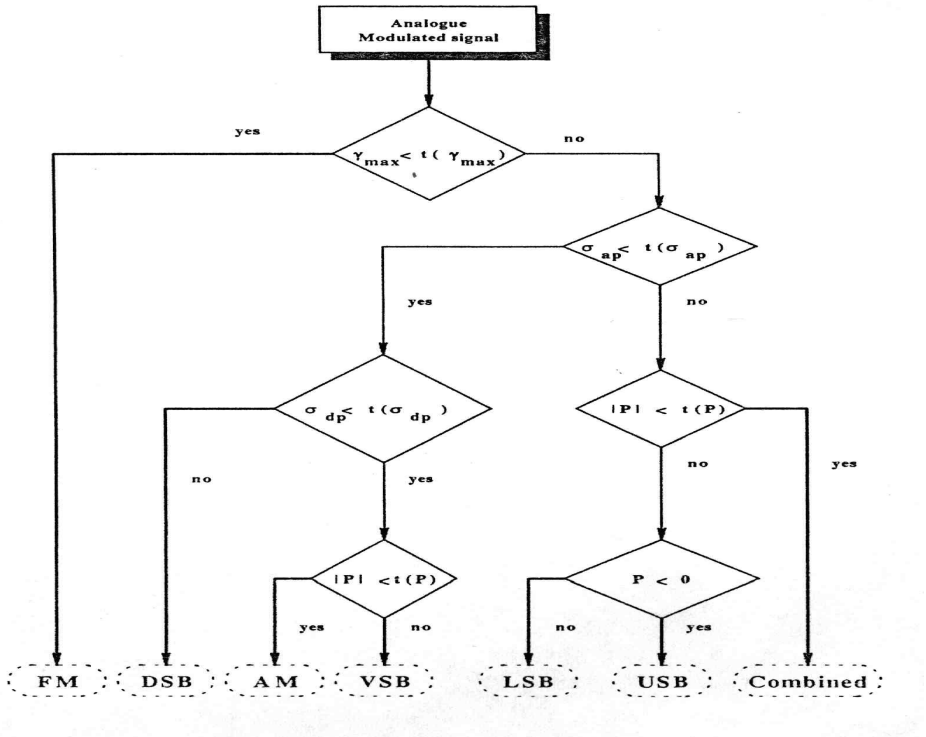

Fig. 1: *Functional flowchart for the Analogue Modulation Recognition Algorithm*

3 CONCLUSIONS

There are three motivations for using the proposed algorithms in the on-line analysis. These are: 1) simplicity of the key feature extraction, 2) determination of the optimum threshold value for each key feature should be finished beforehand, 3) the simplicity of the decision rules used in the decision about the modulation type and it is clear that each decision rule used in these algorithms comprises only one logic function (IF ... THEN ... ELSE IF ... END) and none of them comprises a combination of more than one function.

The proposed analogue modulations recognition procedure have been tested and simulated for real signals. The results of simulation of the Analogue Modulation Recognition Algorithm for real signals are presented in the table 1.

Simulated Modulation Type	Deduced Modulation Type					
	AM	DSB	VSB	LSB	USB	FM
AM	94%		6%			
DSB	12%	88%				
VSB		8%	92%			
LSB				70%	30%	
USB				22%	78%	
FM						100%

Tab. 1: *Confusion matrix of the Analogue Modulation Recognition Algorithm (based on 1000 realizations for the real signals)*

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