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A NOVEL SPECTRUM ANALYSIS TECHNIQUE TO IDENTIFY NOISE DUE TO VEHICLES IN MOTION

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INTRODUCTION

The importance of noise source identif..tion cannot be overemphasised. An outstanding source is noise due to v..hicles in motion. Previous research [1] have developed techniques to identify this source. Others [2,3] have shown that this noise is unsteady. An immediate result that can be postulated is that the frequency spectrum of a moving vehicle is dependent upon its position relative to a sensing point. This result is used by this research to show that the rate of change of frequency eminated by a moving vehicle, a selected band of with suitable weighting, is clearly indicative of its motion.

A spectrum analysis based system is developed to fully evaluate this technique and proved its effectiveness. A real time and on line oriented application utilizing Large Scale Integration (LSI) is also outlined.

MOVING VEHICLE SPECTRUM ANALYSIS

From a number of several specific runs of a medium size saloon car for three different speeds 20 Km/hr, 60 Km/hr and 80 Km/hr, data of noise levels was recorded. An extensive analysis of this data was performed using the set up of the instruments shown in fig.1. The data was arranged to be sampled at 1/2 seconds intervals and spectra were obtained for averaging periods of 1/32 seconds. Four prominent octave bands 63 Hz, 500 Hz, 1 kHz and 2 kHz were selected and recorded for each run as shown in fig.2. A representative spectrum for each speed is also shown at the cross-over point which corresponds to the observation point perpendicular to the flow of traffic.

Several useful points can be derived from these curves. For example, sound pressure level is proportional to speed and maximum gain is obtained at about 1 kHz. The rate of change of spectra can also be seen to be proportional to speed. In fact the band 700 Hz upwards exhibit a sharp change in level at vehicle arrival but slightly less sharp in decay rate at departure. The rate of change of high frequencies precede an analogous rate of increase of lower frequencies. This is particularly noticeable at the two octave bands 63 Hz and 1 kHz. It is also valuable to note the compression phenomena of the spectra as the speed increases. This is apparent at both the individual spectra (a,b and c) and the time spread spectra (A,B and C).

These phenomena can be attributed mainly to the so-called Doppler effect. This effect however, is now spread over the whole spectrum under investigation rather than a single frquency.

The hardware system developed relies heavily on these phenomena.

CIRCUIT DESCRIPTION

Two frequencies have been selected, 63 Hz and 1 kHz because they proved to be adequately indicative of the phenomena described above as well as rendering the resultant circuit extremely simple.

The block diagram of the circuit is shown in fig.3. It contains a single microphone unit feeding two seperate buffers. The output of these buffers are fed into two filters generating the two selected frequencies. These frequencies are converted into two levels the widths of which are made dependent on the amplitudes of the two frequencies. This is achieved via the frequency to level converters FLC 1 & FLC 2. The next stage compares these two intervals with a fixed reference in order to ascertain the limits of occurrence of these two frequencies. This is achieved by the two units LIC 1 & LIC 2 for the two octave bands 63 Hz and 1 kHz respectively. The decision circuit raises the alarm when both signals satisfy the assigned conditions.

CONCLUSIONS

A spectrum analysis based technique has been described which is used to identify noise due to moving vehicles. Several useful phenomena were discovered from extensive analysis of a number of spectra of vehicles moving at different speeds. Some of these phenomena were utilized and yielded a simple hardware circuit. The circuit should prove potentially viable; requiring a single microphone unit with non critical characteristics and easily available and cheap components. The features of the circuit invites LSI fabrication as most of the constituent components can be realized by monolithic IC technologies.

REFERENCES

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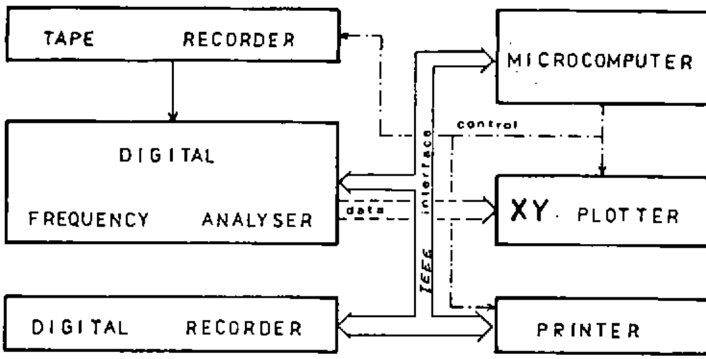

Figure 1. EXPERIMENTAL SET UP

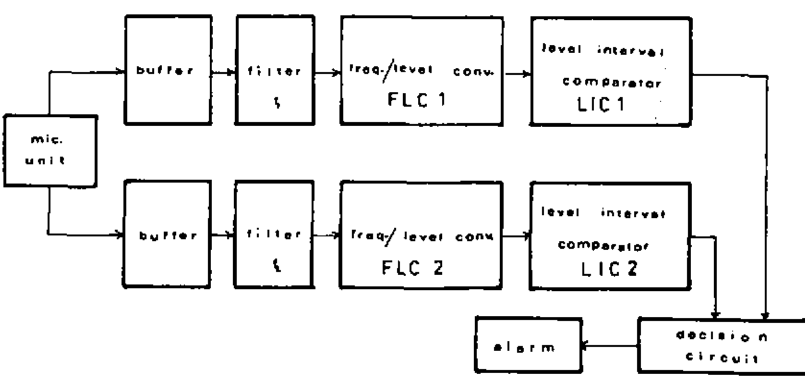

Figure 3. VEHICLE SPEED MONITORING CIRCUIT

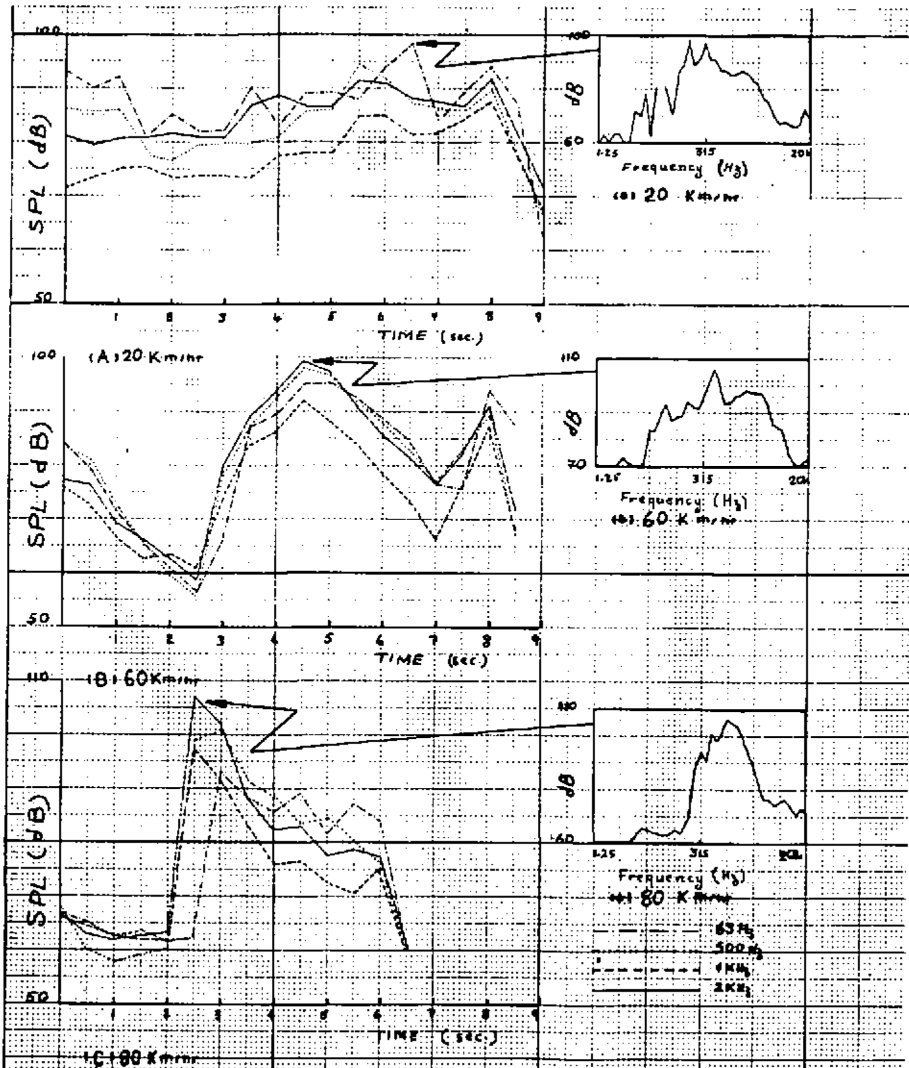

Figure 2. Vehicle Time Spread Spectra (A,B,C) & Cross Over Points Spectra (a,b,c)