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An experiment for genarating $\cos^2$-type of apodisation filters

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An experiment for the generation of $\cos^2$-type of apodisation filters has been described. It has been found that fairly good results can be obtained by this method.

1. INTRODUCTION

The application of consinusoidal apodisation filters in digital communication systems has been discussed by Arsenault (1966). The first method for producing these filters by rotating a Wollaston prism while taking the photograph of a rectangular bar pattern was produced by Clair *et al* (1970) including one of us. In a previous communication (Sarma & Mondal 1974), we had proposed an optical homodyne system based on the principle of the division of amplitude for the generation of these filters. In continuation of that work, the principle of the method, experimental set-up and the results obtained therefrom have been presented.

2. PRINCIPLE OF THE METHOD

The principle of the method is based on the well-known Malus law for polarised light. When a plane polarised beam of light having intensity I_0 is incident on a polaroid, the intensity I_θ of the transmitted beam is given by $I_\theta = I_0 \cos^2 \theta$, where θ is the angle between the plane of polarisation and the polaroid axis for maximum transmission. Hence, as the polaroid is rotated with a uniform angular velocity, the intensity of the emergent beam varies as $\cos^2 \theta$. Now, when this emergent light is collected on to a film moving with a constant linear speed, the film gets exposed proportional to the light incident on it and along the direction of film transport. A positive transparency of the processed film gives the required $\cos^2$-filter. A variable frequency filter over a wide range of frequencies can be generated by varying the speed of the photographic film as also the speed of rotation of the polaroid. It is to be borne in mind, however, that the non-linear response of the film may produce some distortion in the pattern. To obtain a distortion-free filter, the photographic film must be exposed within the linear response region.

3. Experimental Set-Up

Figure 1 shows the schematic arrangement of the experimental set-up. Plane polarised light from a He–Ne laser is devided into two parts by the beam splitter B_1. As the moving photographic film has to be exposed over a short interval of time and one needs a perfectly polarised beam, the use of lasers is highly advantageous. The attenuators A_1 and A_2 are polaroids whose orientations are so selected as to provide the required intensity for operation within the linear region of the characteristic curve. M_1 and M_2 are two plane mirrors whose functions are evident. Thus, one part of the incident light intensity is made to mix up with the variable intensity output from the rotating polaroid P resulting in an amplitude modulated overall output whose maxima and minima can be made to lie within the linear region by adjusting the polarising components. A limiting aperture is placed between B_2 and the photographic film F and a V-shaped slit is used just in front of the film to properly restrict the width of the light beam in the direction of translation of the film and avoiding the effects of diffraction due to the slit simultaneously.

4. Results

A collimated beam of plane polarised light from a 15 mW. He–Ne spectra physics laser was used for this experiment. We chose two beam splitters such that B_1 and B_2 were having 90 per cent—10 per cent and 50 per cent—50 per cent transmission respectively. We made preliminary experiments to determine the range of exposures to be given in this experiment. The attenuators A_1 and A_2 were then kept fixed in a suitable position. The polaroid P was mounted on a frame which was coupled to an electrically-driven motor The speed of rotation of the polaroid could be varied continuously. We used a Philips-Carl Zeiss Model PP 1021 camera in which automatic arrangement for a continuous linear translation of the photographic film is provided. Trials were conducted with a V-shaped slit which tapered to zero width from a maximum width of 0.38 cms and this was placed just in front of and in contact with the film to eliminate the diffraction effects. The patterns corresponding to different widths were scanned along the length of the film and this enabled us to select the appropriate width of the slit. We took ORWO 35 mm. photographic films and used Kodak 163 developer for processing.

It may be mentioned here that a large number of variable parameters are involved in this experiment, *viz.*, the speed of rotation of the polaroid, the speed of translation of the film, the width of the slit, etc.. We, therefore, performed a large number of experiments to have a proper match of all these parameters. In figure 2, we have presented the photograph of the exposed film which gave us the best results. The recorded output obtained from a Hilger microdensitometer by scanning the exposed negative has been shown in figure 3 on an aibitrary scale. The various parameters chosen to obtain this results are as follows

The angular speed of rotation of the polaroid = 50 rev./minute.

The linear speed of the photographic film $F = 3.06$ cm/sec.

The width of the slit $V = 0.04$ cm.

Acknowledgment

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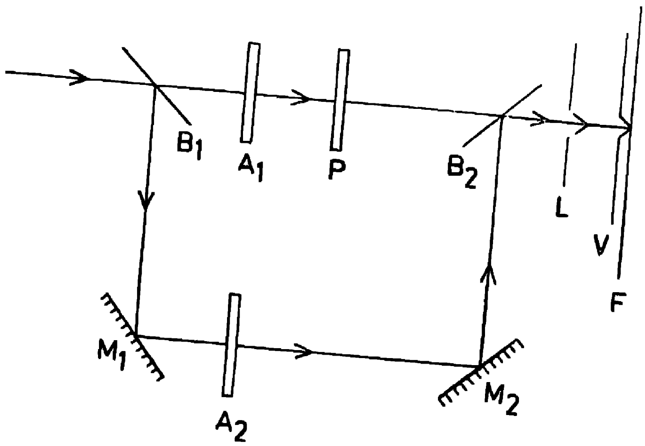

Fig 1 Schematic representation of the experimental set-up.

Fig 2 Photograph of the exposed film.

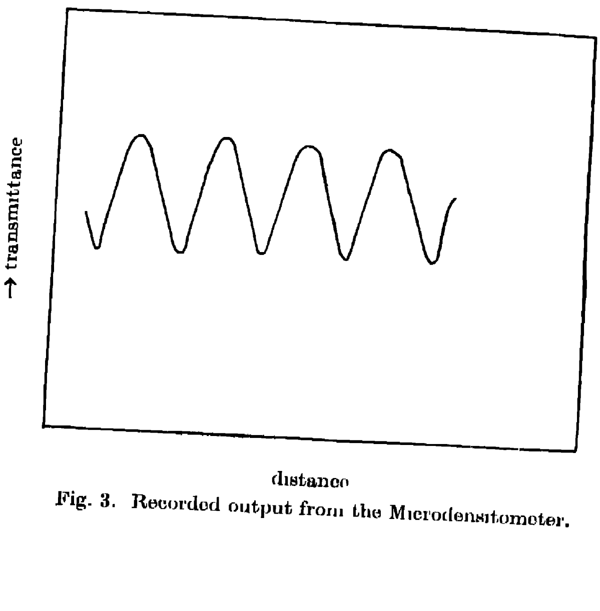

Fig. 3. Recorded output from the Microdensitometer.