Optical Range Gating to Extend Visibility in the Fog. (*)

Milano, February, 14-1969

Background radiance coming from the first layers of fog is the main reason for loss of contrast and consequent reduction of visibility [1]. *Optical range gating is a technique to strongly reduce this contribution — so allowing to extend the visibility in the fog. It consists of a pulsed light source used in connection with a gated observation device, which can be switched on with a suitable delay in order to cut down the first layers back-scattering.*

An experiment has been performed at CISE Labs to test the effectiveness of a range gating system, of which we report some results. These are by no means complete, but are however sufficient to confirm the predicted visibility improvement [1]. *As the pulsed light source a Q-switched ruby laser has been used, which supplies a* 20 *ns optical pulse with a* 20 *MW peak power.*

The light beam from the laser is spread by a negative lens over an angular aperture of 11° *so as to illuminate the field of view. The observation system is placed close to the laser* (1.5 *meters apart) and consists in a RCA C73435U image converter tube* (*shorthand ICT in the following*) *with an S-20 photocathode and a P-11 phosphor screen. The ICT can be switched on applying to the control grid a* 250 *V pulse which we have obtained by means of an avalanche transistors circuit providing a rise time of less of* 4 *ns and a fall time of less of* 10 *ns.*

A fast photodiode (*SGD* 100) *provides the start signal synchronized to the laser optical pulse, which actuates with an adjustable delay the shutter grid of the ICT.*

The photocathode of the ICT is matched to an f/0.87, 75 *mm Super Farron objective lens covering a field of angular aperture of* 11°; *the phosphor screen of the ICT may be observed through an eyepiece or photographed by a standard camera.*

The scene shown in the photographs consists in a sequence of pairs of square targets bearing a number equal to the distance in meter from the observation/illumination point. The targets cover the range 20÷45 *m whilst a further target with a square frame and a central dot is placed at a distance of* 100 *m. Photographs were taken in the night to minimize the effect of spurious light. The vertical dark lines visibile in all the pictures are due to the objectionable shadows that the grid wires of the converter tube produce.*

Photo n. 1 *illustrates how the scene looks like, and was taken in claer air without fog.*

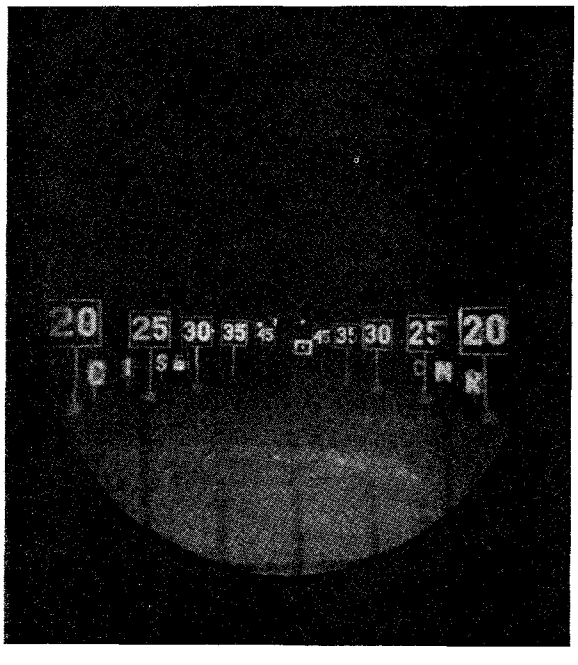

Fig. 1.

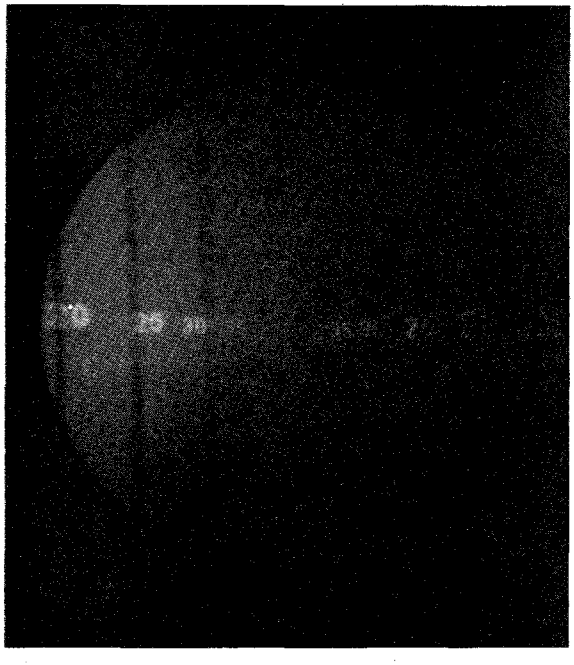

Fig. 2.

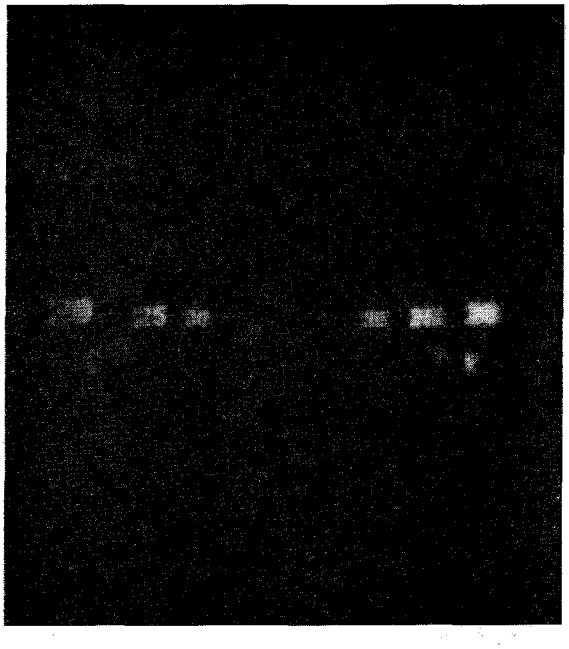

Fig. 3.

Photos n. 2÷6 *are a sequence taken in a fairly stable, natural fog on* 8th *Febraury* 1970. *Without range gating, the scene appeared to the naked eye as depicted in photo n.* 2, *which was taken using the laser as the light source; note that visibility range is about* 35 *m.*

Photos n. 3, 4, 5 *and* 6 *are illustrative of the improvement in visibility achievable with the range gating system.*

(*) Work supported by the Contract CISE-CNR n. 17, 8, 3, 1, for the Technology and Electronic Instrumentation.

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TABLE I.

N. of photo	ICT gate delay (*ns*)	ICT gate length (*ns*)	Range covered (*m*)	Objective stop *f*/	Camera stop *f*/	Number of pulse laser superposed	Remarks
1	no gate			5.6	2	a 500 W filament lamp used	
2	no gate			4	2.8	1	
3	120	80	18÷30	2.8	1.9	1	
4	280	80	42÷54	2.8	1.9	1	
5	260	80	39÷51	0.87	1.9	1	negative lens in front of laser removed
	620	80	93÷105	0.87	1.9	5	
6	620	80	93÷105	0.87	1.9	8	Idem

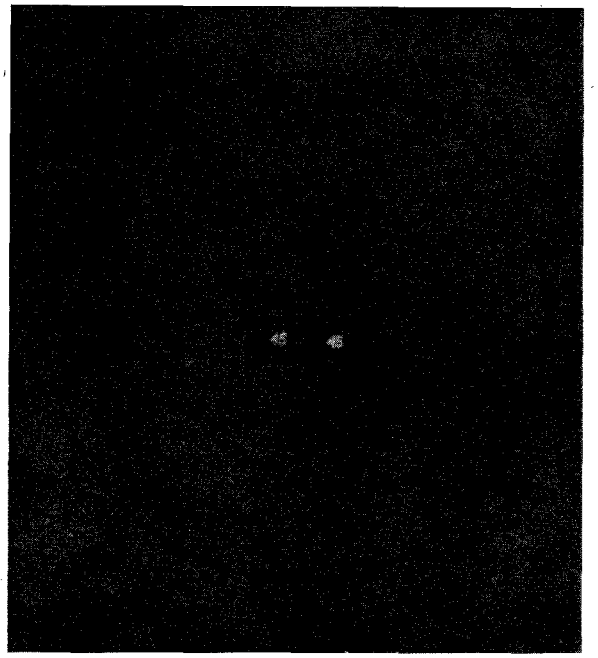

Fig. 4.

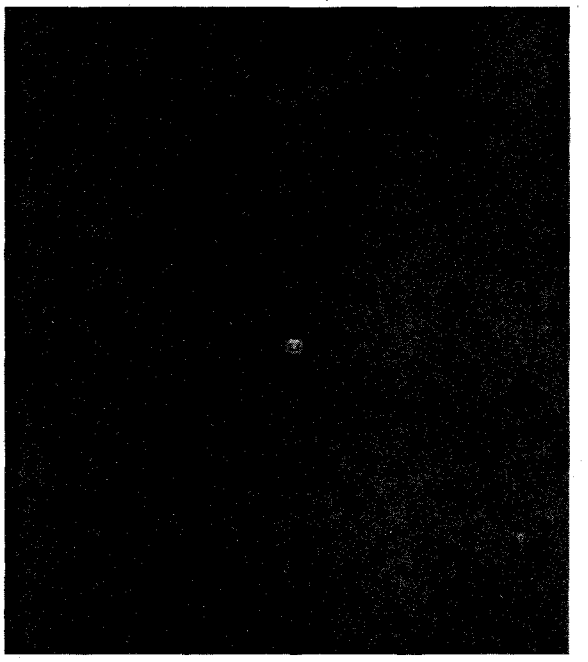

Fig. 6.

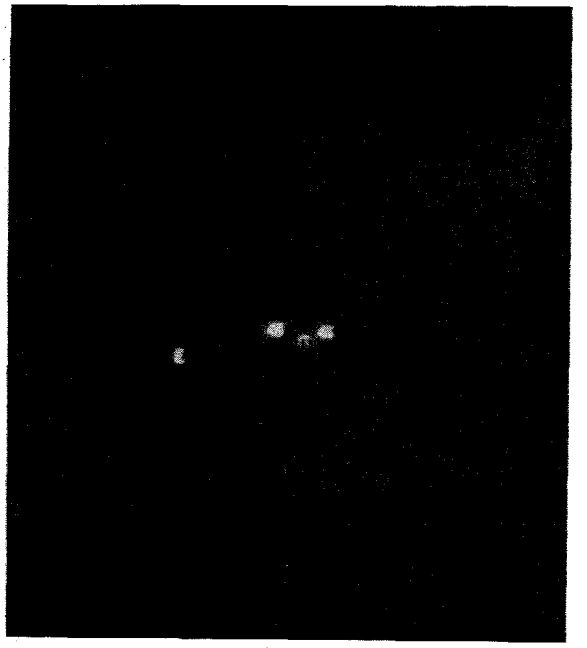

Fig. 5.

The delay in the ICT switching-on time for these photos is reported in Table I *together with the range covered and optical data about stops of objective lens and camera lens.*

By a comparison of photos 2÷6 *it can be appreciated that the visibility range has been extended over a factor about of* 3 (100 *m devided by* 35 *m) and nevertheless the angular resolution is still good. The lack of detail of pictures n.* 3 *and* 4 *is due to the uneven distribution of radiance in the laser beam which did not allow a correct exposure of the Polaroid film* (3000 *Asa*) *all over the scene.*

We are planning to test the range gating system over increased distances; this was not possible at present for space limitations.

AKNOWLEDGMENTS.

We are indebted to prof. E. Gatti and prof. V. Svelto for their critical suggestions. The skillness of Mr. Lucchini, who made most of the experimental work,is also aknowledged.

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REFERENCE

[1] S. DONATI, A. SONA: *Evaluation of the visibility improvement in the fog by the range gating technique.* - « Optoelectronics », vol. 1, p. 89 (1969).