LASER RADAR FOR VISIBILITY MEASUREMENT

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ABSTRACT

There are two types of visibility meters; the one is the
transmission type meter to measure the light attenuation between
a transmitter and a receiver that are separately arranged, and
the other is the reflection type to collect back-scattered com-
ponents of light radiated from a transmitter.

We have developed a reflection type horizontal visibility
meter for marine services under the direction of the Electronic
Navigation Aids Division of the Maritime Safety Agency, Japan.
This equipment consists of a pulsed laser radar transmitter/re-
ceiver unit and a data processing unit.

The power source is a Q-switched ruby laser with 1 MW output
and 30 ns pulse-width. Back-scattered laser light components
from Rayleigh or Mie scattering particles in the atmosphere are
collected by a receiving telescope aligned close to a transmit-
ting telescope. Electrical signals from a photomultiplier are
amplified by a log amplifier and sequentially A/D-converted at
the sampling interval of 10 ns and with the resolution of 8 bits.
Digital data are stored in a buffer memory and then processed by
a mini-computer.

The algorism for data processing is represented by the radar
equation and the definition of visibility:

$$P_r = K P_o \beta \pi(x_1) \frac{\int_o^{x_1} \sigma(x)\, dx}{x^2} \tag{1}$$

$$\int_0^{R_v} \alpha(x)\, dx = 0.02 \tag{2}$$

where K is a constant, P_r the receiver input power, P_o the laser
output power, $\beta \mathcal{Z}(x_1)$ the back-scattering coefficient at the dis-
tance of x_1, $\mathcal{O}(x)$ the attenuation coefficient and R_v the meteo-
rological range, that is, visibility. These equations (1) and
(2) are used under the assumption that the back-scattering co-
efficient, which is obtained only from omni-directional scatter-
ing, is constant at any and all distances.

Experiments were made in July 1973 at Kushiro, Hokkaido.
By sampling signals at a level of power as wide as possible, it
was obtained that the variance between the results of measure-
ments by means of this equipment and with the eye was 0.1.