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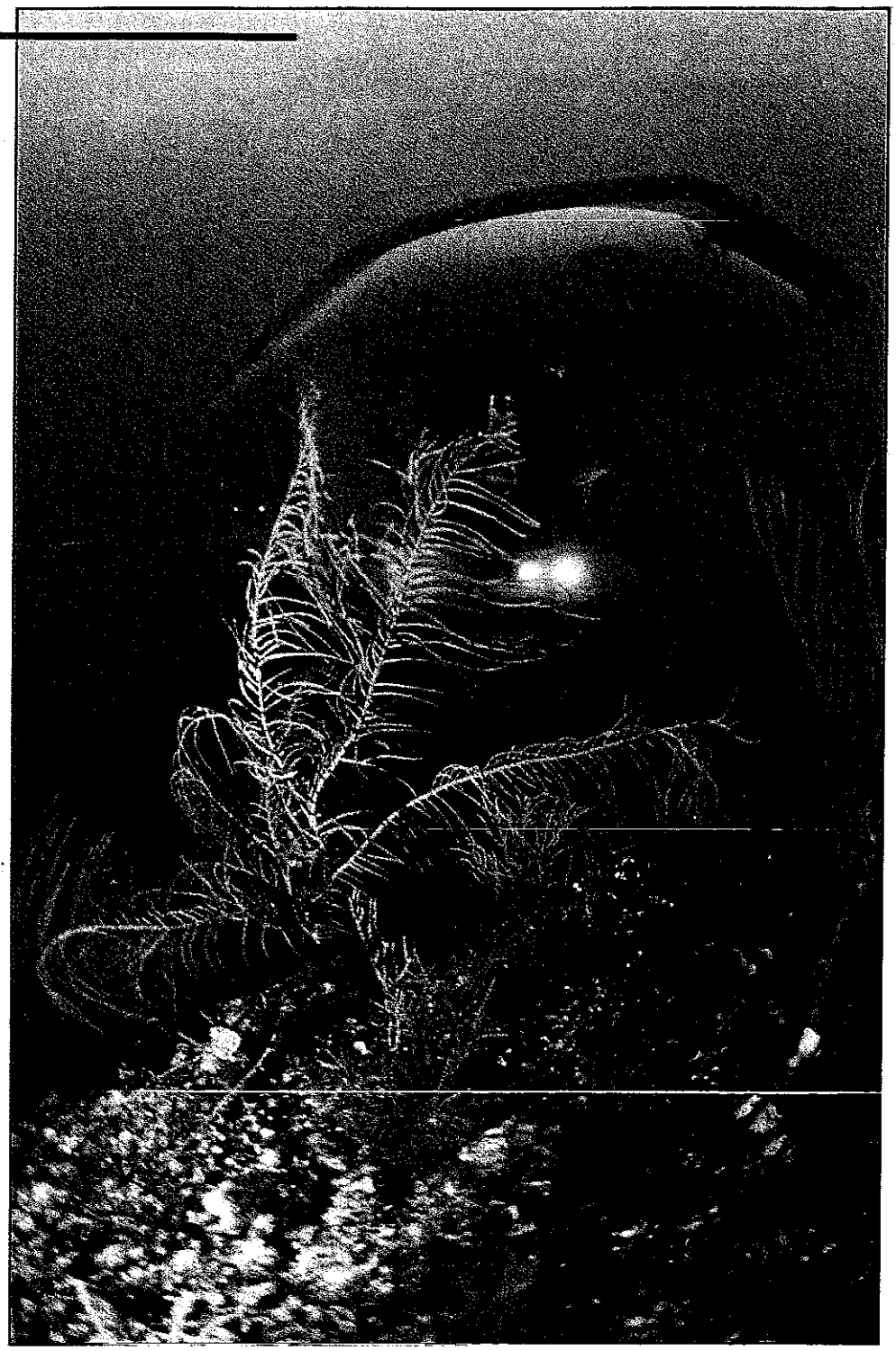

PAPER

A System for Stereo-Video Measurement of Sub-Tidal Organisms

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ABSTRACT

The in situ *estimation of the length of marine biological specimens or features by Scuba divers is complicated by the magnifying properties of water and the underwater environment. In this paper we describe the development and preliminary testing of an underwater stereo-video system designed to make accurate and precise measurements of the lengths of underwater fauna and flora. The results of 640 measurements of sixteen plastic silhouettes of fish are presented. The initial results demonstrate the ability of the system to make accurate and repeatable measurements of length when the orientation of the subject to the stereo-video cameras is less than 75 degrees.*

INTRODUCTION

In situ visual estimates of the size or length of marine organisms are frequently made by ecologists aided by self contained underwater breathing apparatus (SCUBA). Size or length data have been collected in this manner particularly for reef fish (Jones and Chase 1975; Harmelin-Vivien and Bouchon-Navaro 1981; Russ 1985; McCormick and Choat 1987; Bellwood and Alcala 1988; Kulibicki 1989; Samoilys 1989; Francour 1994). These estimates of size or length may be used to assess the biomass or population size structure of selected species, to detect seasonal changes in these variables or for detecting environmental impacts. Visual estimates have advantages over other sampling techniques in that they are rapid and non-destructive.

However, making accurate and precise visual estimates of the length of objects underwater is extremely difficult and requires the observers to be well trained and experienced (English et al. 1994). The estimation of the length of an object underwater is complicated by the magnification of water. In water objects are magnified by a factor of 1.3 and objects appear to be closer to the observer than the actual range. Researchers using SCUBA are not efficient workers when performance underwater is compared to similar activities in the air (Hollien and Rothman 1975). Additionally, the sampling bias and errors resulting from the detrimental physiological effects related to SCUBA diving (Baddeley 1965; Baddeley et al. 1968) must be of concern.

Where data from visual size or length estimates have been published few authors attempt to state the precision or accuracy of their data. Problems with long-term studies occur when different observers may be involved in making estimates of size or length of marine organisms at different spatial and time scales. Even though calibration procedures are used by some researchers (GBRMPA 1979; Bell et al. 1985) inter-observer variability still poses a major bias. If the data collected are to be used to compare the size estimates recorded for different times, places, or species then it is important that the level of precision and accuracy is stated to allow realistic interpretation of the comparisons.

These visual estimates, particularly of the length of reef fish, often lack precision and accuracy. Due to observer error and biases it is probable that many studies lack statistical power to detect small changes in the length of the organisms being studied (English et al. 1994; Fairweather 1991). To overcome the problem of subjectivity in visual estimates and enhance accuracy and precision, an impersonal system of measurement is needed. Clearly, any impersonal system of measurement must be technology based, but within the limits imposed by the underwater environment and finite resources of research organizations.

Klimley and Brown (1983) described the use of stereophotography for estimating the size and dispersion of free swimming sharks. The system was viable underwater, convenient to use for measurement, and could be developed or purchased at a reasonable cost. Since this project in 1983 there have been rapid technological improvements in video cameras which improves the potential of such a system. The objective of this research is the development of a stereo-video system which can accurately and precisely determine the size or length of underwater flora and fauna.

WHAT IS PHOTOGRAMMETRY?

Principles

Photogrammetry is essentially the science of quantitative analysis of measurements from photographs. Photogrammetry pre-dates photography, as da Vinci and Desargues developed the principles of perspective and projective geometry in the 14th and 16th centuries. The first actual applications of photogrammetry for qualitative mapping occurred with the early photographic processes, but, production line mapping systems were not introduced until the 1930s (Slama 1980).