Development of Video Exploration and Mapping Capability, Tools and Methods

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Final Report

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Abstract:
The project was designed to build upon work previously funded by the Northeast Consortium to further development of underwater video observation capability for research on bycatch and/or other research uses. We constructed and field-tested five inexpensive, easy-to-build video/lighting arrays to be loaned to fishermen, with which they could experiment, and from which to develop their own designs. Over a three-year period we met individually and with groups of fishermen, and other interested people, to demonstrate the gear, and/or to provide the loaner-arrays for use. Though many people where initially curious, few people went the next step of taking the opportunity to use the gear for their own experimentation. Two research endeavors successfully employed video technology supplied by this project; two fishermen succeeded in building their own designs after experimenting with gear loaned from this project. Several potential users complained that the inexpensive designs that we were providing did not function in sufficient depths of water (>150 feet) for their purposes. The invitation to experimentation with no specific experimental objective may have discouraged involvement as well. The project was terminated short of its original goals but the five video arrays remain available for use in other research partnerships.

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Introduction:

In the terrestrial sphere, land-use management is a well-developed field. As terrestrial "animals" we take for granted the role that daily personal observation of our man-made and natural environments play in understanding and management of resources. Not so in the marine sphere which is relatively obscure in comparison. Except for what we can see at the surface or bring to the surface in nets, our ability to understand the ocean environment is largely dependant on remote sensing technologies.

Though sonar-based technologies do provide high-resolution imagery, it is not the same quality of information as direct visual observation. On-the-other hand, typical underwater video technology used in science and marine exploration (ROV) is very expensive. Ship-time and the specialized equipment required means that underwater video work is reserved for targeted research tasks.

This project has sought to fill an entirely different niche. In recent years, quality video technology, cameras and lenses, has become available off-the-shelf making it possible to fabricate low-cost video/lighting arrays for underwater research under a range of conditions.

Though commercial fishermen spend much time at sea, not all their time is spent fishing. Successful fishermen invest time in observation and exploration. This project has made available to fishermen another tool for observation, to challenge their innovative curiosity. We have designed and demonstrated underwater video gear that can be easily fabricated by the average fisherman. The potential uses are two fold:

1. Gear that can be routinely used onboard to observe both normal, daily conditions and/or unusual events when they occur; and
2. Gear that can be used for future collaborative research projects investigating marine habitat and ecology, archeology, geology, and for environmental monitoring.

The premise of this project is that resident video observation capability (i.e., a "pool" of fishermen knowledgeable in building and using video gear) will open up avenues of science endeavor and better knowledge of the marine environment.

Project Objectives

- To build capacity for underwater exploration and mapping.
- To develop low cost, robust underwater video gear that can be easily deployed from fishing vessels.
- To acquaint fishermen with the technology and provide them designs that they can easily duplicate for future research endeavors.

- Encourage scientists from fields of marine ecology, geology and archeology to participate in collaborative research partnerships by making readily available tools for low-cost studies, exploration and mapping.
- Provide a reservoir of underwater video technology available to "seed" new marine research opportunities with institutions and agencies.

Key Participants

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Two workshops, two formal presentations and many dockside presentations introduced about 180 individuals to the video gear. Of these, four fishermen took advantage of the opportunity to experiment with the gear made available to them. And a high school robotics class used a project video array.

Statement of Work Completed

Gear Design, Construction and Testing

Captains Lee and Williamson designed and assembled five "kits" to be loaned to and used by fishermen.

These five kits all included the same elements:

- A video camera mounted inside a waterproof stainless steel housing with a sealed lexan faceplate
- An umbilical cord with transmission cable, rope tether and waterproof couplings
- A compact 12-volt battery
- A battery charger
- A video monitor
- A digital video recorder
- Appropriate patch cords and connections
- Two waterproof LED flashlights
- A toolbox-sized carrying case.

The five video cameras were all low-lux for low light conditions. Cameras differed in characteristics; three were black and white, two were color; three employed wide-angle lenses. Cameras, which were purchased on-line through mail order, were inexpensive "security cameras" typically found monitoring retail and home security applications. Off-the-shelf prices averaged $105 apiece.

Five waterproof housings were fabricated from scrap stainless steel pipe and plate. Cost of material, cutting, welding and assembly totaled about $66 apiece. Waterproof connectors sealed to the housing, and plug-in from the umbilical added $107 apiece.

All other parts were purchased at Home Depot or Target stores as inexpensive, off-the-shelf items. All the parts (video monitor, recorder, battery and charger) other than the camera and umbilical were made to fit in a cheap handyman's toolbox for easy storage and portability. In total, each loaner kit (camera and housing, umbilical, parts and accessories) cost about $800 apiece in materials and consumed about 15 man-hours each in fabrication and assembly.

In other words, based on this design, any fisherman with a modicum of skills could construct his own functional underwater video system for about $800 and a couple of days spent in his workshop.

For field testing and demonstrations we built several different designs of sleds and tripods to hold the cameras and flashlights in a "submersible array". These arrays were meant to be slowly towed or bounced along the sea bed. They were built from aluminum scrap, aluminum rod and PVC pipe, and weighted with sash weights. These were light enough to be hand-hauled over the side of a drifting vessel.

The five kits were each field-tested in various submersible arrays by Lee and Williamson. When possible we enlisted the assistance of local fishermen in the testing to encourage curiosity.

Outreach

The project was introduced to the fishing public at the 2006 Maine Fishermen's Forum in March 2006 through a workshop entitled *Low Cost Video Designs for Fishermen.* The workshop was well received with more than 60 people attending in two sessions, one in the morning and a second in the afternoon. Bill Lee demonstrated a range of underwater video designs and explained various purposes. 30 people signed up to receive additional information and were subsequently contacted.

Subsequently, we were invited to lead a similar workshop at the 2007 Maine Fishermen's Forum entitled *Underwater Video Systems for Fishermen*. In this workshop, Bill showed in detail how fishermen can build their own systems from available off-the-shelf materials and equipment. Project sample equipment available for loan to interested fishermen (complete video packages with monitor, umbilical and camera with housing) were on display for inspection. 26 people signed up for additional information and were contacted.

Captains Lee and Williamson have offered on-site demonstrations to fishermen. John has met with Captains Bob Liston, Satch McMahon and Michael Perkins to demonstrate the gear, and make it available for loan. In these three cases, these charter boat operators were interested in viewing the habitats associated with favorite fishing locations. The 150 foot umbilical has proven to be a limitation for their purposes. John has also demonstrated video gear for Sea Grant researcher Peter Nelson.

Working with Boston University researcher Les Kaufman and Provincetown fisherman Phillip Michaud, Bill Lee used the project video arrays to observe fishing performance of a beam trawl used to sample sand lance populations on Stellwagen Bank. The video information allowed the sand lance research team to perfect the performance of the beam trawl for a more consistent catch rate and an estimate of catch per swept area. Captain Michaud subsequently used video arrays on loan to observe and experiment with small-scale scallop dredge performance and reduced habitat impacts.

Bill has accompanied Captain Bob Fisher on the F/V Marina Rose to observe his bait net and doors in operation. Bill has also demonstrated the equipment to Captains Bob and Allen Smith who have subsequently used the design to fabricate their own underwater system; Bill will continue to work with these men to perfect their design.

In July 2008, Bill Lee addressed a group of 65 at the Sandy Bay Yacht Club; Rockport, MA entitled *Ocean Odyssey ~ Cape Ann* showing underwater footage of marine habitats filmed specially for the presentation (using project equipment). Program notes: *"Bill Lee will offer a whole new video taken underwater exploring the ocean floor and everything else in Thatcher Bay, Sandy Bay and Ipswich Bay.*

He will offer insights on ecological changes he has observed over time and his activities with major marine research institutes and organizations. Don't miss this fascinating presentation of riveting images unavailable anywhere else and Bill's totally informative, perceptive and of course, fun information."

In October 2008, Bill and John addressed a class in robotics at Manchester-Essex High School, Manchester-by-the-Sea, MA, taught by Physics teacher Mr. John Chiffer. These high school seniors are building submersible ROVs as a class assignment. Bill demonstrated various underwater camera designs and fabrication techniques. A project video system has been loaned to this class to observe their ROV prototypes in actual conditions.

Results and Conclusions

Despite considerable curiosity in submersible video, evidenced by large attendance at Fishermen's Forum workshops in two different years, and numerous dockside and phone conversations, the project failed to elicit the response or level of experimentation that we had anticipated. There were several reasons that contributed to this:

1. Many fishermen who investigated the technology in workshops, had very specific research ideas in mind. In follow up interviews, they expressed more interest in obtaining the funding to pursue their ideas than in using the project video gear as the first step in testing feasibility.

2. Some fishermen and other marine users (e.g., aquaculturists), though attracted by the low cost of the project video gear, were more interested in purchasing ready-made, higher-quality systems than in constructing their own designs at low-cost.

3. The open-ended nature of this project's experimental approach (i.e., to play around with underwater video to see what you can do with it), did not appeal to working fishermen. Several fishermen, when pressed to take a kit with which to experiment, declined explaining that they did not have time in their work day for random observation. Fishermen and others, who did take advantage of the opportunity provided by this project, used the gear for specific objectives.

4. The low-cost design of the systems, which could be built at home for less than a thousand dollars, ended up being a significant limitation. Inexpensive transmission cable used in the umbilical, unamplified signal strength, and voltage loss, all combined to limit the project video systems to operating in <150 feet water depth (or in the case of a towed array to 150 feet extension from the vessel). A system designed for video quality at much greater depth would have doubled or tripled the cost per kit, and increased the entry-level skills needed to construct one at home. Most fishermen interviewed expressed desire to investigate fish habitat at 150 feet depth and deeper; or to observe trawl gear performance typically towed several hundred feet behind the vessel.

In hind sight, this project could have been better structured if it had:

- Identified a small group of fishermen with specific ideas for investigation to act as a study group;
- Have brought these individuals together with the project investigators to design, field-test and perfect two or three system designs for specific purposes; and
- Targeted systems designed to cost up to $3000 apiece, rather than to have limited costs to under $1000.

The project was originally funded for $24,000 under a Northeast Consortium Project Development Grant. Because of lack of response to the experimental design, only 57% of the funding was used. The five video system kits developed in this project are in use by the two project investigators and are available on request to other NEC investigators.