Real Time Video on a deep sea trawl

INMARTECH, IMR, Norway, Oct 2016
Who are we?

CSIRO is an Australian Government funded research organisation, with about 5000 staff at around 40 sites throughout Australia. We research, marine, atmospheric, agriculture, minerals, petroleum, primary production, astronomy, IT. We invented Wifi!

Oceans and Atmosphere is a business unit which has about 300 staff. Our headquarters are in Hobart, Tasmania.
CSIRO collaborate with their industry partners and have pioneered techniques to perform biomass estimations of fish stocks such as Orange Roughy and Blue Grenadier.

We have developed platforms which contain a variety of scientific echo-sounders, digital stills and video systems. We call this our Acoustic and Optical System (AOS) and the data recovered from it is used in modelling to estimate the size of fish aggregations.
The AOS hardware consists of a frame which is mounted on a trawl headline. It houses modified Simrad GPT’s @ 12/38/120kHz, Paired GigE cameras (for sizing measurements), a host PC, sizing lasers and a PAL video camera.
The A.O.S. layout

- DSLR Camera
- 30 W LED Light
- Video Camera
- 30 W LED Light
- DSLR Camera
- NiMH Battery
- Simrad EK60 38 kHz
- Industrial Computer and Acoustics Controller
- Simrad EK60 120 kHz
- Li-Ion Battery
- Flash Unit
- 120 kHz Transducer
- Scaling Lasers
- 38 kHz Transducer
- Video Control and Capture
The techniques and methods we have developed have served the fishing industry in Australia and New Zealand well.

We have been performing these surveys annually since 2007 so we’re getting an indication of whether the fish stocks are increasing or declining.

These days industry have an increasing need to demonstrate that they are fishing sustainably and with a minimal environmental impact.
An industry need....

Having access to real time video, digital stills and echograms on the trawl headline assist the fishing masters in making decisions.

This ensures that endangered fish are not being inadvertently caught or delicate benthic fauna such as corals are not being damaged.
Some design considerations

The FO cable has a working load is less than 2 tonnes which is well below the rating of the 28mm trawl wire.

Additionally the max load occurs at the surface and a break in the middle would mean the cable would become an unusable length.

To avoid cable damage when the trawl gets hooked up, we built a remotely operated mechanical release so that we could disconnect and recover the cable before the heavy hauling on the trawl warps begin.
The real time remote release system

A old longliner winch was retrofitted with a slip ring and 3km of armoured fiber optic cable.

Typically we’re towing the trawl at about 800m and have about 1700m of wire out.

This allows a direct cable connection from the wheelhouse to the trawl headline and the AOS.
The real time remote release system

In the wheelhouse we have a deck unit. It contains the surface fiber optic media converter to provide network connectivity with a PC and an interface with the FO cable. Its also manages power, including the emergency release.
The deck unit is constantly testing cable condition. If there is an earth leakage an alarm sounds, and the status lamp turns orange. If the fault deteriorates further it reaches a threshold which automatically removes power from the cable.

The release is activated by pressing the ‘Emergency Release’ button which is always illuminated so that you can find it fast!
At the net we have the release unit. It’s a modified acoustic release which can be triggered to release a catch and detach the canister from the net.
The AOS is connected to the release canister via two inline underwater cables. We tape together two cables so that if the release separates from the net these cables pull apart. As the high voltage and fiber optics are processed in the canister, only the network connection is broken.
The Underwater Release- How it works......

Rochester cable – single mode FO + 4 electrical conductors

FO and electricals are split and re-terminated and then potted with epoxy

When the release is activated, the Cat 5 cables which are normally taped together are pulled apart. This may damage the cables but it’s a small price to pay when the alternative is main cable damage.
We attached it to the trawl using a chain bridle
Meanwhile back in the wheelhouse...
... and on the trawl 1700m behind at 800m and about 20 minutes behind what the vessel echo sounder was telling us...
Depth, pitch and roll are displayed as an overlay on the footer. The fishing masters find this really useful.
Sometimes things didn’t go well....

We underestimated the loads on the release, so we had to re-engineer our mechanical attachments at sea.
The ships engineers made a few modifications....
12mm plate, fully welded around the perimeter. The attachment lug was upgraded as well
The recovery of the AOS and the extra wire on the deck turned out to quite simple. The FO cable was used to ‘help’ the AOS up the stern ramp. It then falls back onto the top of the AOS as its hauled up the deck.
Some of the challenges......

Firstly, the system had a winch which was adapted from a long liner. The opportunities in commercial fishing to perform testing are very limited.

The cable was spooled on when alongside and therefore we had no idea how the spooling would be.

We had a few teething problems....
Some of the challenges......

Spooling was a problem which required constant attention.
The engineers modified the spooling knife to have a quick release mechanism which helped us realign the cable quickly.
We had a few disagreements with contractors. The gap at the top of the cheek plate was a concern for us. The wire could easily fall down the side and under load this could be a problem. They said it would be OK!!
Some of the challenges......

The positioning of the winch on our first trial didn’t allow enough fetch which made the block slant when the cable was at each end of the drum. We were worried that the cable would drop into the gap.
Some lessons learnt....

Our winch operated in constant tension. The tension settings needed to be constantly adjusted as the load varied with speed and the amount of cable that was paid out. The gauge displays hydraulic psi, not load on the cable.

We knew that max tension didn’t exceed the breaking strength but didn’t really know what the real tension was and how close we were to exceeding the cables specification.
Some lessons learnt....

It was difficult to know how much cable we had paid out. Was it similar to the main trawl warps or was the drag causing us to pay out significantly longer lengths which might tangle with the seabed?

We marked off some set lengths on the wire with paint to help us estimate wire out.
Some lessons learnt....

The winch was underrated and couldn’t retrieve as quickly as the main trawl warps. In a commercial world these delays are expensive. Time is money!

We need to calibrate the tension system. Next time I’d add a load cell and wire out sensor on the turning block. This would help us understand the loads and where the cable is in relation to the warps.
Other Uses.....

One of the most important tasks when using echosounders to perform biomass estimations is calibration. We suspend a calibration sphere below the transducers and record pings. This characterises the overall system performance.

It's easy on a ship because you can move the sphere in real-time and see it on the echo-sounder, and you’re doing this at a constant depth.

The AOS is autonomous and without real time feedback it’s ‘hit and miss’. Currents and sea state can mean the sphere is off axis and we have no way of knowing if we are getting valid hits.

A deployment can take around 5 hours with no guarantee that it will be successful. That’s a long time for a commercial trawler not to be fishing.
These days the AOS is lowered in its calibration mode via the FO cable. We can see in real time if we are seeing targets. We can also look at telemetry and assess pitch and roll and if necessary change the ballasting. We can also change echo-sounder settings in real-time rather than retrieve it and reconfigure.

A future project might be to build a moveable weight system which we could move and control from the surface in real-time and change the AOS attitude.
Other Uses.....

We are looking at a much simpler system with a camera and light mounted on the canister. That would give real time video and the AOS wouldn’t be needed. This would have a broader use in the fishing industry.

We are currently looking at interfacing to a multi-beam sonar as well as a cod end camera.
Before I go…

It’s important to recognise the efforts of our engineering workshops who play a big role in converting ideas and concepts into something that will work.

We would also like to thank our collaborative partners who have also invested a lot of time and effort in partnering with us to develop these instruments.
Questions?

Jeff Cordell
CSIRO Oceans and Atmosphere
Castray Esplanade
Hobart, Tasmania, Australia
+61 3 62325248

Jeff.cordell@csiro.au
Thank you

Jeff Cordell
CSIRO Oceans and Atmosphere

t  +61 3 62325248
e  Jeff.cordell@csiro.au