ShipIR/NTCS Update

Version 3.5 of ShipIR/NTCS - Improved accuracy of detection prediction in a cluttered environment:

- Improved long-range target scene rendering (sub-pixel target image rendering now accounts for pixel-aliasing between sensor image and target sub-image so that target contrast radiance is conserved in the raw seeker image);

- Improvements to allow the user to process an even larger number of scenarios and environments, eliminate any need to analyse the results for false detections (on the background), and distinguish between noise-limited and clutter-limited infrared detections of the platform:

  - The seeker now includes a model which auto-calculates a line-by-line clutter value;
  - Improved seeker parameter input, so that user only specifies the noise-limited threshold (global) for the entire seeker FOV (e.g., NETD). The effects of background clutter are now handled automatically and are dynamic (a function of elevation and range/azimuth); and
  - The signature metrics associated with each seeker image have been reformulated to eliminate any contrast radiance below (clutter) detection threshold, and also include a new signal-to-clutter ratio (SCR).

- A more efficient polar lock-on analysis with additional statistics indicating strength of detection; and

- Analysis outputs are now available to the user for analysis using an expanded API (user Application Programming Interface).

Recent Events:

- SPIE Defence, Security, and Sensing, Orlando, Florida, USA, 25-29 April, 2012: "Improved signature prediction through coupling of ShipIR and CFD" was presented by David Vaitekunas, highlighting the efforts at Davis and Pointwise (a meshing tool provider) to help solve some more complex thermal signature problems involving radiation and complex thermal boundary layer flow.

- 8th International IR Target and Background Modeling & Simulation Workshop (2012): David Vaitekunas made two presentations, "Climatic data analysis for input to ShipIR" and "Measurement and modeling of no-skid deck surfaces".

- 5th International Conference on Signature Management Systems, Oct 2012: David Vaitekunas presented our latest technology and analysis methods in “Infrared ship signature management for the modern navy".

Upcoming Events:

- SPIE Defence, Security, and Sensing, Baltimore, Maryland, USA, 29 April - 3 May 2013: Our recent efforts to analyse historical marine climatic data and use these results to better assess the effectiveness of infrared stealth technology using the latest version of ShipIR/NTCS.

- 9th International IR Target and Background Modeling & Simulation Workshop (10-13 June, 2013): Hosted by ONERA in Toulouse, France. Davis will participate both as a Corporate Sponsor and presenter. David Vaitekunas and Chris Sideroff (formerly of Pointwise Inc) will be hosting a 1-day ShipIR tutorial to demonstrate the latest version of ShipIR/NTCS and our best practices.

Davis

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Davis Develops Compact IR Suppressor Technology for Modern Warships

A common constraint in the design of exhaust stacks for warships is the space in the exhaust funnel. Passive IR suppressors require length over which to mix cool ambient air with the hot exhaust gas, and width to have effective metal cooling.

In order to address these needs, Davis has invested in research and development to make the IR suppressors both more compact, and more space efficient.

We have developed and tested a new ejector technology called hyper-mixing. This new nozzle and mixing tube system achieves mixing over about half the length required for more traditional cloverleaf nozzle based ejector technology. The hyper mixing technology also features no decrease in engine power versus the standard ejector. The system has been tested at our facility on our hot gas wind tunnel, and has also been proven at full scale on a GE LM2500 during a warship sea trial. The hyper mixing device is in operation on the ROKN FFX-I frigate, and has been designed and fabricated for the ROKN LST-II, and the Chevron Bigfoot exhaust cooling device.

To address horizontal space constraints, a race-track or oval cross-sectional shape allows for devices to be packed closer together. These odd shaped devices pose a more difficult design challenge. Davis has leveraged the experience gained from the design of IR suppressors for aircraft, which tend to have very complex flow paths, to build more compact naval devices. Race-track shaped devices have been designed and are operational on the USN LHD-8 and ROKN FFX-I.

ROKN FFX-I

Improving Technology: Sea Water Injection

Passive engine exhaust IR suppressors can reduce the temperature of a gas turbine exhaust plume to just below 250°C, and so provide a significant reduction in IR seeker detection range. By reducing plume signature, the seeker eventually detects another heat source on the ship, or it may still lock on to the plume, only at a closer range. In the latter case, it pays to reduce the plume temperature further.

Plume signature reduction can be achieved by splitting the exhaust flow into multiple parts, or by reducing the gas temperature.

Splitting the plume is problematic because it is complex, requires a lot of stack space, and only provides signature reduction in some but not all directions. Reducing the plume temperature by passive means is possible, but also requires a larger device, or more backpressure – both scarce resources. A larger device also has the disadvantage that the flow velocity at the exit of the device is lower, potentially causing exhaust recirculation or impingement problems.

Our experience and research has lead us to conclude that the most practical method through which to

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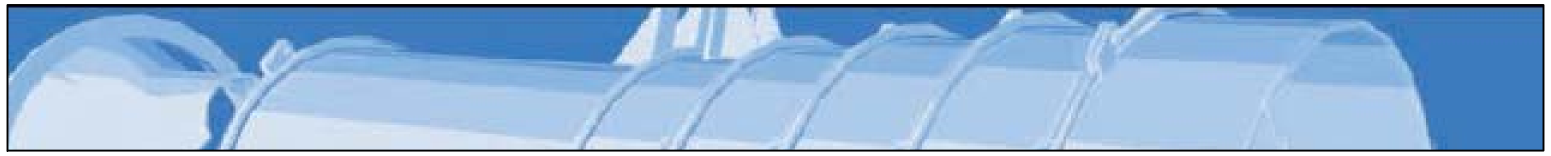
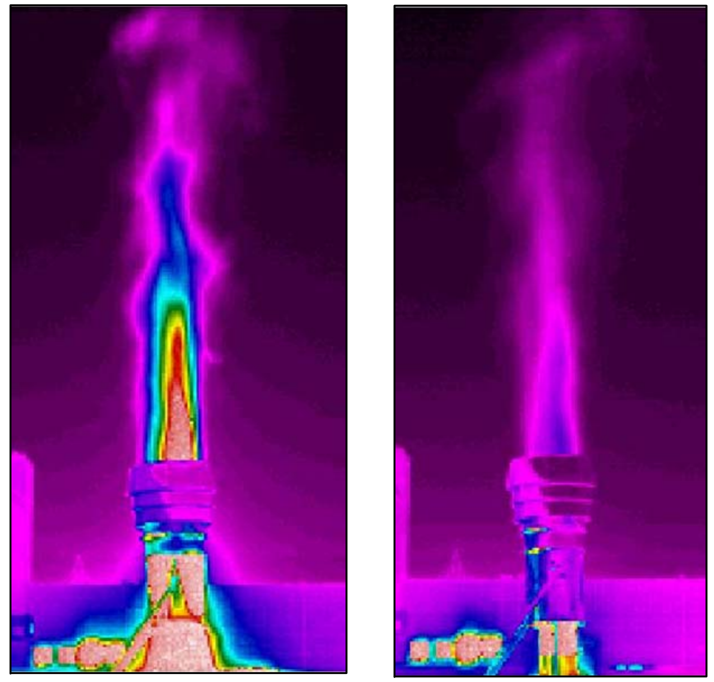


reduce plume signature below that of a standard sized passive device is through sea water injection (SWI).

Davis has determined that it is critical to inject an optimal amount of water for the engine operating state. Stray a little from the optimum point and the signature is not as good as it can be, but stray a lot and it can either make the signature worse (if there is too much injection), or cause salt deposition problems (if there is too little).

Davis has developed an algorithm for determining the optimal sea water injection rate as a function of ambient conditions and engine operating state.

Finally, there are practical aspects to an SWI system that must be considered. Salt water in a hot environment is corrosive, and attention must be paid to material selection and proper sea water drainage after shutdown.



Dry Gas   Water Injected

Real-time Platform IR Signature

The IR detectability of a ship is very dependent on its current operational and environmental states. By knowing current IR detectability, an operator can better perform mission planning, or in the case of an imminent threat, how best to launch countermeasures.

Fast Assault Boat

Davis was contracted to build a real-time signature prediction module that would return a contrast effective temperature for all view angles around a small assault boat when supplied with the environmental conditions and the position of the boat relative to an IR sensor. ShipIR was used to generate a large set of results from the combinations of input variables, and an Artificial Learning Network (ALN) was utilized to create a function which would quickly translate the eleven environmental variables into the needed contrast temperature.

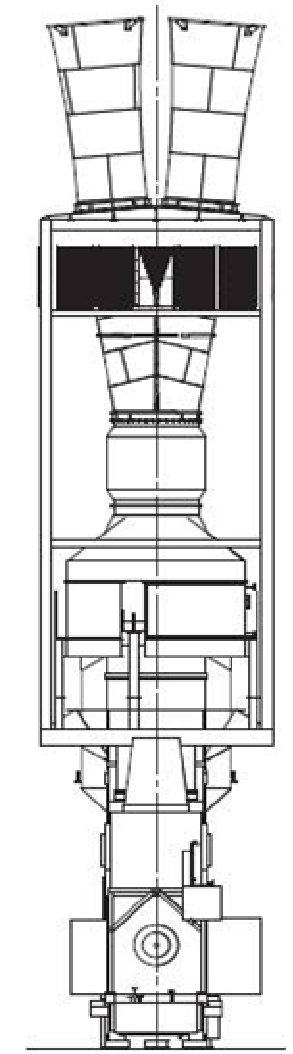
Center for Ship Signature Management (CSSM)

ShipIR has been selected as the core IR signature prediction tool for integration within an IR component of the onboard real-time Ship Signature Management System (SSMS) being developed by Fraunhofer IOSB, Germany for the CSSM. The IR-SSMS will predict IR signature and IR detectability for the ship's current state and a number of possible reduction measures (hull cooling, SWI, course, speed, etc) to serve as a sub-system in the overall SSMS and also provide data directly to the ship's weapon and decoy control systems. In 2013, a preliminary version of the IR-SSMS will be deployed on a German naval research vessel and operated for a 6 month period. By the end of 2014, IR-SSMS will be released as a basic experimental system for the same platform. Further development will then be directed toward specific functional and technical requirements of the overall SSMS.

Davis Supplies Chevron Bigfoot Rig with Exhaust Gas Cooling Equipment

Modern offshore oil production platforms utilize large marine gas turbine engines for both drilling and pumping operations. The platforms are compact and so the engine exhaust stacks tend to be located in close proximity to sensitive drilling equipment and populated areas like the helipad. Varying wind conditions makes it necessary to cool the exhaust gasses to ensure proper operation of the equipment and crew safety.

In January, 2012, Davis was contracted by Chevron to analyse the extent of the exhaust gas impingement problem, recommend solutions, and design and deliver exhaust gas cooling hardware. We employed a two phase approach to the analysis. In the first phase, we used empirical models to assess the exhaust plume trajectories



for a wide range of wind velocities, engine power levels, and gas temperatures for all the areas of interest on the platform. The results identified requirements for the cooling device and the wind conditions of greatest concern.

In the second phase, computational fluid dynamics (CFD) was employed to model the exhaust plume trajectory in more detail for a small set of wind conditions. The CFD simulation modeled multiple exhaust stacks and the complete geometry of the drilling platform. The CFD phase provides a high degree of confidence that the specified exhaust cooling device will meet the requirements for the rig.

Davis has been designing and fabricating air-to-air ejectors for naval exhaust gas cooling systems and IR suppression systems for over 25 years. That expertise has been directly applicable to the offshore oil platform market.

Otahuhu: Exhaust Plume Dispersion

In Auckland, New Zealand, Contact Energy is upgrading its Otahuhu electricity generation plant to utilize a 600 MW gas turbine generator. The Otahuhu plant is located close to the airport and it is a regulatory requirement that the updraft due to the plant exhaust plume must be controlled so as to not disrupt aircraft taking off or landing at the airport. With the introduction of the gas turbine and its high temperature exhaust, calculations showed that under some wind conditions, the updraft may be a concern.

Contact approached Davis for ideas on how to reduce the updraft. Adapting plume trajectory models to accurately predict the performance of buoyant plumes, Davis devised a novel exhaust plume diverting device which substantially increases the rate at which the exhaust plume disperses into ambient and slows its ascent. The device performance meets the requirements for updraft for all wind conditions and can be designed and fabricated at our facility in Ottawa, Canada.