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MONITORING SYSTEM FOR MILITARY DIVERS

PROBLEM:

Military divers provide specialist diving capability involving the use of self-contained mixed gas equipment for duties that are characterised by long endurance, often at high intensities in the dark, and under time pressure in contested areas. There is potentially a requirement for divers to passively utilise underwater propulsion systems over a prolonged duration, resulting in challenges in maintaining core body and skin temperatures.

There may also be introduction into the subsurface domain, as is occurring in the land domain, of situational awareness tools and increased cognitive requirements that may affect the diver's ability to monitor their own health.

It is envisaged that a physiological monitoring system will allow scientists to undertake subsurface research more efficiently, support training of divers as well as in the test and evaluation of new thermal protection and other equipment. Devices are available to divers and scientists, but not as a system and do not communicate with each other. Some companies do not allow the end-user to download data that can then be analysed and interpreted.

NEED AND RELEVANCE:

Defence forces throughout the world are currently undergoing requirements shaping for future subsurface capabilities. Defence Scientists will need to support this work by undertaking experiments to investigate interventions and the utility of new equipment types.

Australia currently utilises Polar HR10 heart rate monitors, Body Cap e-Celsius core temperature pills and ibuttons to measure extremity skin temperature in research situations. The issue, in this case, is the inability to synchronise the devices together for analysis of the time-series data.

Other useful metrics that could be included in a physiological monitoring system include respiration rate, water temperature, depth, gas usage, oxygenation levels and gas toxicity. Integration with a dive computer would be a difficult, but highly desirable outcome.

Understanding what tasks the diver is undertaking throughout the dive is important. Relying on recall throughout a long dive is problematic and video capture relies on good underwater clarity and external synchronisation between devices. The addition of a sensor that automatically detects and classifies movement types (e.g. finning, hand/tool use, inactivity), as well as basic metrics (e.g. speed, body orientation), would be useful to help make sense of the other physiological time-series data.

Being able to identify when divers do something else that influences their physiology may arise, such as ingestion of cold water or passing of urine would also be beneficial.

Separate from the scientific need to collect data, dive instructors have a need to be able to better monitor divers during cold-water dives. In this use case, it would be beneficial to have near-real-time data monitoring from a surface vessel so divers can be recalled in situations, for example, where a low core temperature can be dangerous or a diver is at risk of experiencing non-freezing injuries.

RESEARCH QUESTIONS:

- Can a subsurface physiological monitoring system be designed that allows synchronising of data in a usable, ergonomic form-factor?
- Can subsurface activities be classified using an IMU(s) to allow best use of other physiological data?
- Can physiological data, such as core and skin temperature be shared with a dive instructor either in the water or on the surface?

It is expected that these questions cannot be answered entirely by one research group, and will need to be developed as a phased and collaborative approach. Further, it is anticipated that this project is not aimed at purely systems integration of different devices, and will require the research team to have an understanding of human physiology, biomechanics and/or ergonomics.

EXPECTED OUTCOMES:

A prototype of this device that can be evaluated is the expected outcome of this project. Defence is willing to facilitate user testing of the prototype to enable a device to be commercialised for acquisition through Defence Projects.

Synchronisation of core and skin temperature is the highest priority, followed by other metrics and classification of movement types, then the ability to transmit to the surface. It is not expected that all of these variables can necessarily be integrated during this initial pilot project.