Regarding Toxin Detection Mechanisms for Harmful Algae Blooms and Current Device Apparatuses or Development

May 30th, 2021
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Abstract

Current toxin detection mechanisms are insufficient in comparison to a software defined networking system with P2P compatibility in regards to real time detection. In regards to current mechanisms, this involves both wet chemical as well as physical devices and/or buoys. The introduction of new technologies in regards to network latency in relation to novel detection methods is what will be the cornerstone of this research. The importance of this field is to draw conclusions in regards to technological implementations in relation to detection, time, network latency and quality of the data.

***Keywords*:** *Toxin Detection, Chemical Sensors, Wet Sensors, Physical Sensors, Peripherals, Environmental Engineering, Oceanic Studies, P2P, Distributed Computing, Software Defined Networking, Network Latency*

Problem Statements

Beach water testings that rely on chemical wet or wet sensory mechanisms typically take 24 to 72 hours. Even EPA-tested methods have a sample incubation period of at least 24 hours, according to *Beachapedia*. There is also a series of recreational water quality testing material, according to the *EPA*. Time allocation problems and the need for rapid testing is what have led to different rapidly tested indicators as a new field of water monitoring solutions. These include numerous devices centered around optical sensory mechanisms and various forms of mass spectrometry. Many new methods are also physical buoys that are actively developed utilizing various architectures and communication protocols. There however needs to be better software defined networking protocols in regards to telemetry monitoring and massively scaled rapid testing solutions. Therefore, new research is being conducted and introduced in regards to these protocols and the improvement in regards to efficiency and reliability.

Current Research

There is emerging research within the field of underwater communication and telecommunication protocols in relation to the rapid testing problem. The rapid testing problem is notably the need for quicker and efficient testing mechanisms as opposed to 24 to 48 hour results. Most of this research does revolve around different software defined networking protocols and structures, especially given that researchers can't get signals underwater the traditional way. Given the doppler effect in waves, underwater wireless communication needs to have some sort of signal conversion process in order to improve latency. One such device centered around latency improvement, is a project noted on my website *Oceanic Colonization*. I have introduced before a project known as *Reinvent the Internet*, centered around signal conversion methods. It utilized a digital to analog converter along with sonar to convert signals underwater. It was also part of the same project that I submitted to *GigabitDCx*, that was centered around collecting data about our oceans utilizing noiseless signals. This research shows the importance of signal conversion in regards to latency.

It is worth noting that the project has been taken further with *hydroelectric wirelessly charged grid* proposals. However, the main impact revolves around the difference in detection time and better signal latency. The ability to collect data underwater while seamlessly connected to a signal is a plus. It also means that both rapid and real time data collection is feasible. The secondary part of such a network in relation to toxin detection, is how to speed up data collection through a series of networked modules. The novel method has revolved around a novel communications protocol that utilizes a variation of a P2P mesh network architecture. This is in part due to the non-reliability of 4G connectivity, and the need to offload data in parallel. Traditionally, buoys might connect to EC2 instances or various Amazon Cloud or Microsoft Azure services in regards to their data monitoring. Some solutions also may have their own server and a data synchronization and monitoring station. However, with hefty servers or even multi-cloud architectures, there is a heavy reliance on the latency from the data processing, to signal conversion, to signal processing, to collecting and syncing that data. Given the many extra steps required through that infrastructure, likely the efficiency in regards to cost and data collection may not match the communication protocols I am working on.

Past Research

It is worth noting that many past research mechanisms in regards to chemical testing, are generally very time consuming. The primary focus is in regards to physical buoys and devices. The *IOOS*, which is the *Integrated Ocean Observing System*, has many regional directories in regards to physical buoy deployments. This is important because it is worth noting their own *data standards*. They utilize something known as an ERDDAP server, which utilizes a restful API in regards to oceanic datasets and tabular data. This has less to do with latency, given that you can utilize a restful API in regards to translating offline data if you wanted to contribute data to their directory. This is an important note because many researchers may make the mistake of creating a software defined networking protocol centered around the data publishing process when the focus should be on synchronization and processing. It is also worth noting that many ecological researchers heavily rely on a communications method known as Underwater Acoustic Modems. However, though many of those methods revolve around a variation of sonar conversion, there are still problems in regards to latency and energy density. My experience in solving these, is in regards to distributed data offloading and various power-up methods and modules such as microcontroller-controlled energy generation modules. This means methods of controlling powerup and usage computationally instead of a full threshold. The data offloading process is in regards to the mesh networking systems mentioned prior.

Experimental Protocols

The experimental protocols in regards to rapid and real time testing as mentioned, revolves around a variety of things. The first is signal transmission and processing. This has been implemented in regards to the sonar conversion method done in prior phase research. The secondary phases, which are my newer methods, include the conversion as well as the offloading processes. Instead of implementing device by device communication and data-offloading, one can build a mesh layer on top of the underwater telemetry devices. This layer is an offline-centered P2P distributed network w/ various data sharding and parallel processing capabilities. This is in contrast to devices connected to a 4G network and just collecting data and garnishing signal strength. The contrast is a non-reliance on 4G compatibility, less reliance on ham radio signal compatibility, and more reliance on the actual data syndication process in sync. The more buoys deployed, the faster the latency and better the data extraction process is (which is already realtime). Lastly, the third integration is experimentation in regards to physical hardware and firmware implementations for limiting energy consumption and usage. There have been various implementations of protocols that limit energy consumption. This includes *deep sleep* protocols, and a colleague of mine has implemented a variation of DSP for different battery modules. This is different from my method.

General Discussion

It is generally well known that many protocols exist within physical buoys. The focus by many researchers is what rapid testing method works best. In regards to metrics, there are certain metrics in relation to network latency, signal strength, data collection, data quality and ways of quantifying that data. There is also a heavy reliance on energy density and research within that side of the field as well. The point of this paper is to introduce these methodologies in a generic and general sense so that one has a better understanding of this emerging field. Underwater telemetry and communication protocols have been around for a while, including in submarines, and various forms of military technology as well. However, this has been re-emerging within the field of rapid testing for beaches or various forms of oceanic toxins. The need for effective and quick water quality testing and monitoring is there.

Conclusion

It is important to note that much of my research relies on networking and data transferring capabilities. The importance is not novel detection in terms of what to detect, as there are various cost-effective methods in regards to detection already. However, for further discussions and developmental research, it may be worth going over the debate on what is more important to detect and various mechanisms in relation to that. For sake of simplicity regarding the core of this paper, a focus is on the actual protocols regarding the network latency, data transmission and telemetry methods. A secondary focus such as energy density is heavily related to sensory mechanisms and mechanisms within actual communication protocols for these sensors. I believe given the data offloading capabilities my system and its design has, it is more efficient than other physical buoys relying on different communication protocols. Among these buoys include my previous attempts, which also converted sonar but then wirelessly routed back that data through a 4G network instead of the offline network implementation I am proposing.

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