# A REVERSE LOCALIZATION SCHEME FOR UNDERWATER ACOUSTIC SENSOR NETWORKS

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requirements for the award of the degree of
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*To my husband Javad, for his endless suport, love and encouragement and to my lovely son Barbod, for his patience.*

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# ABSTRACT

Underwater Wireless Sensor Networks (UWSNs) offer new opportunities to observe and predict the behavior of aquatic environments. A vital service in UWSNs is localization used in many underwater applications such as warning systems for natural disaster, ecological applications and military surveillance. In these applications, the locations of sensors need to be determined for meaningful interpretation of the sensed data. Localization for underwater is challenging as compared to terrestrial because the latter has stabilized in WSNs. In underwater networks, acoustic communication is a typical physical layer technology which has limitations and challenges. Moreover, there is a need for a large amount of sensor nodes to cover wide and deep (three dimensional) oceanographic regions. Consequently, it is essential to develop a localization protocol specifically for Underwater Acoustic Sensor Networks (UASNs). Unfortunately, many of the existing underwater localization schemes suffer limitations such as long localization time, low location accuracy, excessive messaging and limited power. Therefore, the aim of this research is to develop a faster localization scheme for UASN to reduce energy consumption and communication overhead, and to be adaptable to the mobility of water current and location changes. The proposed scheme is named Reverse Localization Scheme (RLS). The developed localization scheme is mathematically compared with seven efficient methods in terms of communication cost. Besides that, the RLS results are compared with the benchmark method Dive'N'Rise Localization using MATLAB. Simulation results showed that the developed scheme achieved faster localization time with the least possible message transfers. In addition, the scheme offers a real time localization and it is less susceptible to errors caused by mobile underwater currents. RLS has been proven to be power-efficient as all parts of the localization computations are computed at the onshore sink.

# ABSTRAK

Rangkaian Penderia Tanpa Wayar Dalam Air (RPTWDA) memberi peluang baru untuk mencerap dan meramal keadaan persekitaran akuatik. Satu perkhidmatan penting dalam RPTWDA ialah penyetempatan yang digunakan oleh banyak aplikasi dalam air seperti sistem amaran bencana alam, aplikasi ekologi dan pengawasan ketenteraan. Dalam aplikasi ini, kedudukan penderia perlu ditentukan untuk mendapat tafsiran berguna kepada data yang diperolehi. Penyetempatan dalam air adalah mencabar berbanding dengan daratan kerana penyetempatan daratan dalam RPTW telah mencapai kestabilan. Untuk rangkaian dalam air, komunikasi akustik adalah teknologi lapisan fizikal biasa yang mempunyai keterbatasan dan cabaran. Tambahan pula terdapat keperluan untuk menempatkan bilangan besar nod penderia untuk meliputi kawasan lautan yang luas dan dalam (tiga dimensi). Oleh yang demikian, adalah satu keperluan untuk membangunkan protocol penyetempatan khususnya untuk Rangkaian Penderia Akustik Dalam Air (RPADA). Malangnya kebanyakan skema penyetempatan terbatas dengan masa penyetempatan yang panjang, ketepatan kedudukan yang rendah, mesej yang berlebihan dan had kuasa penderia. Oleh itu, kajian ini bertujuan untuk membangunkan satu skema penyetempatan yang pantas untuk RPADA supaya penggunaan kuasa tenaga dan overhed komunikasi dikurangkan, serta boleh beradaptasi dengan pergerakan arus air dan perubahan kedudukan. Skema yang dicadangkan dikenali sebagai Skema Penyetempatan Balikan (SPB). Skema penyetempatan yang dicadangkan ini dibanding secara matematik dengan tujuh kaedah yang cekap dari segi kos komunikasi. Keputusan SPB dibanding juga dengan kaedah penandaarasan penyetempatan *Dive'N'Rise* menggunakan MATLAB. Hasil simulasi menunjukkan skema yang dicadangkan mencapai masa penyetempatan yang lebih pantas dengan penghantaran mesej yang kurang. Selain daripada itu, skema ini juga memberikan penyetempatan masa nyata dan kurang terdedah kepada ralat disebabkan oleh pergerakan arus air. SPB terbukti cekap-kuasa kerana pengiraan penyetempatan dilakukan di sink pantai.