Handover Priority Deduction Based On Machine Learning in Under Water WirelessSensor Networks

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Abstract— **In Underwater Wireless Sensor Network(UWSN), there are nodes moving by themselves like AUVs(Autonomous Underwater Vehicles), or nodes moving passively by currents and other environmental effects. For the passive nodes, normally there exists difficulties in estimating the nodes' locations. Herein, handover technologies for the nodes are necessary but the researches for handover technologies in UWSN are barely being processed. Because of the environmental characteristics, it is difficult to realize underwater handover. This paper presents the model which predicts the ocean current in specific timelines through the practical data learned in various machine-learning methodologies at the southeastern sea of the Korean peninsula. By assessing the performance, the appropriate model would be selected for predicting current directions. Assume that unfixed underwater sensor nodes are moved by currents, and handover priorities will be decided by the predicted current directions. The result of deciding handover priorities suggested with dividing sectors by stations, DTC(Decision Tree Classifier) had the highest prediction performance which is Rank 1 accuracy 55.79% and Rank 3 accuracy 85.60%.**

Index Terms— **Ocean current, Machine learning, UWSN, Handover priority.**

I. INTRODUCTION

Over the past years, the wireless communications system has been used in many areas. Because of its advantages that it can be deployed in the areas difficult to install wires and it is cheaper than wired communications, wireless communications system is vastly used. Especially in oceans, there is a huge difficulty that communications system entity needs to be installed in wide and deep water level. Therefore, mostly underwater communications systems should be wireless. Various kinds of underwater communications researches are reported with increasing demands in fishing, marine disaster, national defenses, and searching for resources. In underwater sensor networks, there are active nodes like AUV or passive nodes moved by environmental reasons such as the currents. Since location tracking devices like GPS are not available for underwater sensor nodes, it is difficult to track their locations. However, a efficient handover technology is needed for underwater nodes to communicate continuously. In underwater circumstances, the existing handover technologies used on the land are not suitable because of their characteristics such as energy restriction, long propagation time, or low transmission speeds. Moreover, the underwater sensors are difficult to know their locations and to manage. Therefore, to solve the problems, machine learning models will be helpful. To apply machine learning technologies, practical data collected at the southeastern coasts of the Korean peninsula are used for training. Machine learning models in many different ways can predict flowing directions of sensor nodes spread sea surfaces layer. Assuming that sensor nodes are moving in the current directions predicted by the models, this work will suggest an efficient way to decide handover priority when the sensor node is moving outside of its corresponding range.

II. EXISTING SYSTEM

Over the past years, the wireless communications system has been used in many areas. Because of its advantages that it can be deployed in the areas difficult to install wires and it is cheaper than wired communications, wireless communications system is vastly used. Especially in oceans, there is a huge difficulty that communications system entity needs to be installed in wide and deep-water level.

Therefore, mostly under water communications systems should be wireless. Various kinds of underwater communications researches are reported with increasing demands in fishing, marine disaster, national defences, and searching for resources. In underwater sensor networks, there are active nodes like AUV or passive nodes moved by environmental reasons such as the currents. Since location tracking devices like GPS are not available for underwater sensor nodes, it is difficult to track their locations. However, a efficient handover technology is needed for underwater nodes to communicate continuously. In underwater circumstances, the existing handover technologies used on the land are not suitable because of their characteristics such as energy restriction, long propagation time, or low transmission speeds. Moreover, the underwater sensors are difficult to know their locations and to manage.

III. PROPOSED SYSTEM

Predictive analytical algorithms and statistical models to analyse large datasets to assess the likelihood of a set of potential outcomes. These models draw upon current, contextual, and historical data to predict the probability of future events. As new information is made available, the system incorporates more data into the statistical model and updates its predictions accordingly. Throughout this process of machine learning (ML), the model gets "smarter" and predictions become increasingly accurate.

A. Design

The degree of interest in each concept has varied over the year, each has stood the test of time. Each provides the software designer with a foundation from which more sophisticated design methods can be applied. Fundamental design concepts provide the necessary framework for "getting it right".

During the design process the software requirements model is transformed into design models that describe the details of the data structures, system architecture, interface, and components. Each design product is reviewed for quality before moving to the next phase of software development.

1) Input Design:

The design of input focus on controlling the amount of dataset as input required, avoiding delay and keeping the process simple. The input is designed in such a way to provide security. Inputdesign will consider the following steps:

The dataset should be given as input.The dataset should be arranged.

Methods for preparing input validations.

2) Output Design:

A quality output is one, which meets the requirement of the user and presents the information clearly. In output design, it is determined how the information is to be displayed for immediate need.

Designing computer output should proceed in an organized, well thought out manner; the right output must be developed while ensuring that each output element is designed so that the user will find the system can be used easily and effectively.

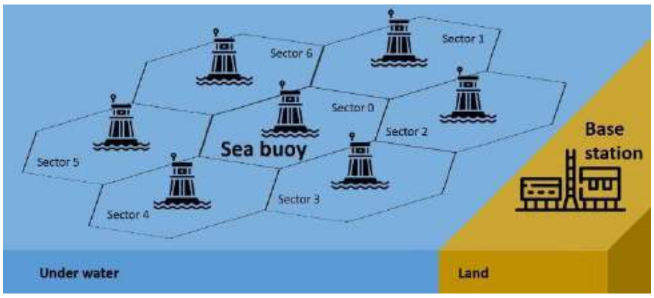
3) *System Design:*

This phase contains the attributes of the dataset which are maintained in the database table. The datasetcollection can be of two types namely train dataset and test dataset.

IV. BACKGROUND AND RELATED WORK

Underwater Wireless Sensor Network

The UWSN communicates using acoustic wave unlike with the networks on the land. This makes it possible to communicate under restricted circumstances with energy restriction, and high bit error rates, long propagation delay time and using batteries.



UWSN Handover Scenario

Fig. 1. Underwater Wireless Sensor Network diagram.

Handover is a technology helping natural cell conversion in the case the nodes move between the base stations. Normally on the land, each base station has its own communication range like Fig. 2. If the sensor node goes outside of this range, the communication will be stopped. For example, if Node 1 connected to Base Station A to the location of Node 2, it is necessary to change the connection to Base station B.

Cell conversion is normally decided by signal strength.

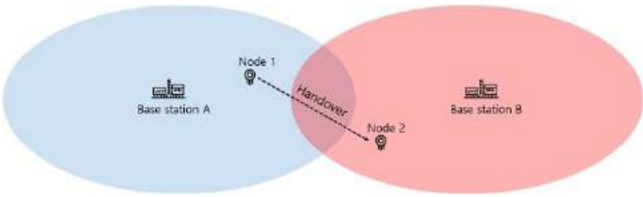


Fig. 2. Underwater Wireless Sensor Network Handover.

System Structure

V. SYSTEM STRUCTURE AND DATA

The underwater wireless sensor network structure is the same as Fig. 1 in ocean areas. Each sector is constructed in the form of hexagonal cells, and there is a buoy in the centre of each cell. And the range of the cell is each buoy’s communications range and the sensor nodes and the buoy transmits data in between. If a sensor node moves to another sector, the connection to the buoy at the former sector will be lost. Handover connecting sensor nodes to a new buoy is required. But in UWSN, it is hardly possible to deploy location verification devices like GPS, and to calculate locations by communications between

nodes and buoys, or between nodes and other nodes because it needs many data transmissions and calculations. Moreover, this way makes UWSN which has restricted energy and long propagation time more complicated. In this paper, nodes' movements will be predicted with a prediction model made with practical data, to connect moving nodes to new buoys without losing them.

Based on predicted current directions, the buoy sends decided handover priorities and the address values to sensor nodes. If there is no response from the buoy after the sensor node transmits the data, it can be considered that it went out of the communications range of the buoy connected to itself. After this, based on the most recent information about handover priority, the sensor node transmits the data to the target buoy. Through this procedure, sensor nodes can immediately perform handover to buoy with the highest possibility, even if the communication fails, and this can reduce the energy consumption of the sensor nodes significantly.

VI. SYSTEM IMPLEMENTATION

Implementation of a modified application to replace an existing one. This type of conversation is relatively easy to handle, provide there are no major changes in the system.

Each program is tested individually at the time of development using the data and has verified that this program linked together in the way specified in the programs specification, the computer system and its environment is tested to the satisfaction of the user. The system that has been developed is accepted and proved to be satisfactory for the user. A simple operating procedure is included so that the user can understand the different functions clearly and quickly.

The processed data is used for predictive modelling so that appropriate results can be generated from it. This predictive modelling is done using a technique called Machine Learning. It is defined as a "computer's ability to learn without being explicitly programmed". Machine learning uses programmed algorithms that receive and analyse input data to predict output values within an acceptable range.

Machine learning algorithms are programs (math and logic) that adjust themselves to perform better as they are exposed to more data. The "learning" part of machine learning means that those programs change how they process data over time, much as humans change how they process data by learning. So, a machine-learning algorithm is a program with a specific way to adjusting its own parameters, given feedback on its previous performance making predictions about a dataset.

ALGORITHMS

LINEAR REGRESSION

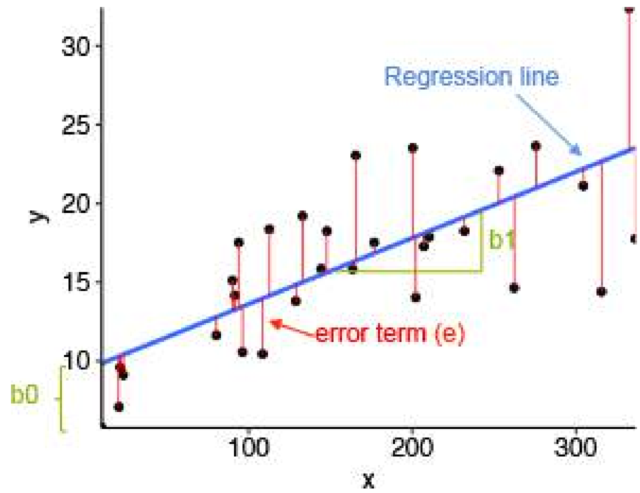


Fig. 3. Regression Line

GRADIENT BOOSTING REGRESSOR

A. *1. Gradient Boosting Machine (GBM)*

A Gradient Boosting Machine or GBM combines the predictions from multiple decision trees to generate the final predictions. Keep in mind that all the weak learners in a gradient boosting machine are decisiontrees.

But if we are using the same algorithm, then how is using a hundred decision trees better than using a single decision tree? How do different decision trees capture different signals/information from the data?

Here is the trick – the nodes in every decision tree take a different subset of features for selecting the best split. This means that the individual trees aren't all the same and hence they are able to capture differentsignals from the data.

Additionally, each new tree takes into account the errors or mistakes made by the previous trees. So, every successive decision tree is built on the errors of the previous trees. This is how the trees in a gradient boosting machine algorithm are built sequentially.

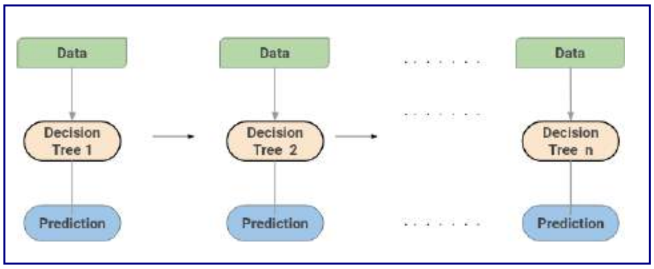


Fig. 3. Decision Tree Classifier

When we try to predict the target variable using any machine learning technique, the main causes of difference in actual and predicted values are noise, variance, and bias. Ensemble helps to reduce these factors (except noise, which is irreducible error)

VIII. CONCLUSION

In this paper, machine learning based prediction models to minimize loss of sensor nodes by applying the predicted current direction for underwater handover in UWSN circumstances are suggested. The measured data at the south-eastern sea of the Korean peninsula is used for training. By studying and comparing 5 different types of machine learning models, it is confirmed that the DTC model has the highest performance for the dataset. A efficient handover process can be suggested on the basis of the results. The advantage of the proposed prediction method is that each buoy can continuously use collecting data and adapt to situation around it. Without the prediction model, it would be difficult to decide the handover priority of the sensor nodes. As aforementioned, the handover target could be specified by predicted moving route by using the proposed method.

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