Modelling In The Marine Environment

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Numerical modelling is applied broadly to solve complex marine problems. These models are used to create a simulation of the marine scenarios. This model uses mathematics to define the physical conditions of the selected marine scenario. This technique has been used to gather data and provide solutions for several marine incidents, which include marine life present in that area, level of oxygen, biodiversity maintenance and conservation. Before numerical modelling, all the marine problems were solved through the use of analogue modelling; however, for complex problems, there was a need for a method that could provide precise answers, so numerical modelling was employed. This model is especially useful for marine ecosystem locations that cannot be observed physically, like the Mariana Trench, due to dangerous consequences or lack of proper technology. Numerical modelling has helped geologists to develop a better understanding of the Earth's marine ecosystems and their processes (Petrovskii, 2011).

Impact Of Measurement On Numerical Modeling

Every numerical model roughly follows a few steps in its calculation. These steps include the mathematical model, discretization methods, numerical methods, algorithms and interpretation. Each step provides the basis for the subsequent step. These steps present the broader scenario of the problem; however, a more detailed analysis is obtained through the measurements applied in the numerical method. Numerical measurements provide precise calculations based on which the geological scenarios can be understood at a deeper level. These measurements include mean, median, range, mode, percentile and standard deviation. Measurement provides quantitative data in the numeric model and aids in eliminating variables that may come up during the modelling process.

Mean is the average of similar values, the median is the measurement of a central location, and the mode is a measure of central tendencies. Percentiles represent the data from smaller to the largest value, while the range is the opposite of it, providing values from largest to smallest. Range helps in measuring the simplest variables in the data. The measurement of all the variables and data is done through standard deviation. With the help of these measurements, numeric modelling can construct precise marine scenarios (Zhang et al., 2021).

Principal Component Analysis

In most cases, the datasets can be extremely large and intricate, making them complex. Understanding these datasets can pose difficulty for designers who require simple data representation for their tasks. For this reason, Principal component analysis is used as it can reduce the dimensionality of these datasets, which allows for easier interpretation. This does not mean that the information is lost; on the contrary, it maximizes variance by using uncorrelated variables. This preserves the integrity of the data (Jolliffe and Cadima, 2016).

The principal component analysis is highly adaptable and can be moulded according to the needs of the study being conducted. This analysis can be used with different modelling systems, including numeric modelling. It allows pattern identification, which can be simplified enough to obtain important information. It makes the data manageable and efficient by giving the most valuable variables and dimensions that can be utilized by people who do not require complex data. Precise measurements become difficult to achieve when there is a lot of distance and variables at play. This causes an increase in unknown points in the data, resulting in an increase in independent variables, which is not ideal. To eliminate this problem, it is important to reduce the dimensionality of the datasets. With a large amount of data, selecting the right variables for elimination can be difficult; however, principal component analysis (PCA) helps in finding meaningful variables while eliminating redundant data. PCA is a transformation method that utilizes the combination of weighted linear measurements to eliminate redundancy. It then creates a set of new variables that represent the concise data.

Modelling Tidal Stream Energy Extraction

One of the renewable energy sources is in-stream tidal wave energy, as it is very predictable; however, to efficiently utilize this energy, it is important to carefully observe and assess the resources. To successfully implement this technology, it is important to design a project that will allow for simulation of the technology before it is applied in reality. For this purpose, numeric modelling was employed to create a geological scenario that will allow the assessment of the maximum potential of this energy. It is very important to use a 3D numeric model so that a high-quality simulation can be developed that would give accurate field measurements. This was done through the hydrodynamic model that created tidal simulations. This model represented the statistics that showed that it was capable of reproducing tidal hydrodynamics. Calculation and analysis of mean power densities were done, which showed the best places for high tide performance. Further, calculations were done to determine the best place for tidal extraction using two different methods: the undisturbed flow model and the FVCOM-MHK model. The results obtained from both methods were similar in smaller samples; however, the undisturbed flow model provided a better performance on a larger scale. This study provided a controlled environment to study the tidal stream energy; however, the results obtained may vary from place to place due to environmental factors, so further research is required (Yang et al., 2020).

Ocean Wave Modeling

In ocean wave modelling, the main components are the motion and elevation of the wave from the surface of the sea or the ocean; however, the atmosphere is also considered because it affects the ocean as well. By combining all these, major weather forecasts can be predicted. The computational fluid dynamics (CFD) model is utilized to calculate the ocean waves, as it provides a precise simulation of the ocean waves. It also helps calculate the turbulence created by the wind that may increase the wave's surface. This model gives a precise forecast of the ocean waves. Although this model helps predict the forecast in certain locations, when the area increases, it can be a little uncertain and requires a coupled approach with other models. This is done to increase the efficiency of the calculations of the CFD model (Cavaleri et al., 2019).

Comparison And Contrast

The two models are vastly different as both calculate different values. The tidal stream model is focused on finding the location in streams that would have high tidal activity. This is so that these areas can be used to extract the renewable energy created by the tidal waves. Only one of the two models selected for this purpose provided the required results. On the contrary, ocean wave modelling is used to calculate the elevation of the wave. This is done to forecast the weather and foresee any disaster, such as a tsunami, before it hits the land. This is being done using the CFD method, and for more precise calculations, this method is paired with other methods. The only similarity between these models is that both try to simulate geological scenarios to solve certain problems. These simulations help calculate and analyze the data, which is then used to make assumptions about these scenarios. These assumptions are then analyzed further to produce concrete evidence that will allow the geologists or scientists to come up with the best solution.

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