The City College of New York
Office of Research

CCNY College-wide Research Vision (CRV) Initiative Concept White Paper

A Next-Generation Modeling-Monitoring System to Study Offshore Wind Energy Problems

Project Team:

Principal Investigator: Hansong Tang, Associate Professor
Department: CE, SOE, The City College of New York
Other Key Personnel: Vasil Diyamandoglu (CE), Naresh Devineni (CE), Alexandar Tzanov (CUNY, HPC), Branko Glisic (Princeton U, Eng.), a marine ecologist (TBD)

Project Concept Description: (Maximum 2 pages)

Keywords: Sea-Level Rise, Offshore Wind Energy, Modeling, Machine Learning, Water Quality Analysis, Sensing and Monitoring, Environmental Impact, Resilience.

Objective: In order to address the consequences of climate change and increasing activities of human beings in coastal ocean waters, this project develops a next generation modeling-monitoring system, and it studies coastal ocean flow in offshore wind energy development. The following facts manifest that this project is timely and significant:

- In October, 2021, the Biden administration announced that it plans 7 offshore wind farms on the East and West coasts on the United States and in the Gulf of Mexico by 2025, towards the deployment of 30 GW of offshore wind energy by 2030 (Associated Press, 2021).
- The NYS is well on the way to developing 9,000 megawatts of offshore wind energy by 2035, enough to power up to 6 million homes. Now there are a few ongoing projects in NYS' coastal waters (NYSERDA, Nov. 2021).

Our long-term goal is to grow the proposed system into an operation platform to conduct scientific research and industry application (e.g., real-time prediction and monitoring).

Approach: The system will be an integration of the team expertise in six distinct areas of study (Note: although four are from engineering, they are in four distinct academic disciplines):

Area #1 ---model development and ocean flow simulation, Hansong Tang
Area #2 ---data analysis and machine learning, Naresh Devineni
Area #3 ---water quality analysis and evaluation, Vasil Diyamandoglu
Area #4 --- sensor and monitoring of ocean impact, collaborator: Branko Glisic
Area #5 --- marine biologist, to be identified
Area #6 --- high-performance computing, collaborator: AlexandarTzanov

The modeling-monitoring system will be built around the unique capabilities of the team members in model development, study of data, water quality analysis, wave impact on structures, and high-performance computing in their past projects (NSF, NOAA, etc.).

As a measure to develop the modeling system and also a scientific study, joint efforts from the four areas will be made on the following aspects:

- Hydrodynamics in the presence of offshore wind farms and effects of their design (e.g., location, foundation configuration, etc.) on hydrodynamics
- Evaluation of impact of offshore wind farms on ocean water (e.g., change in water parameters relevant to ecosystems and their habitat in ocean waters).

- Impact of extreme waves (e.g., water loads on farms' foundation) during hurricanes and possible mitigation measures, in future sea-level and hurricane conditions.

Outcomes: Area # 1: computational methods, their validations, and showcasesmodeling.
Area # 2: machine learning models for prediction of water motion and quality.
Area # 3: a database for flow and water quality information.
Area # 4: kits of monitoring and acquisition of data (including those from field).
Area # 5: a model to evaluate the change of marine ecosystem.
Area # 6: a software package and a website that implement all above.

The outcomes of the above six areas all converge to the modeling-monitoring system, plus an innovative study on ocean waters in development of offshore wind energy.

Expected Products: The final products will be the following:

- A modeling-monitoring system, a software package, for ocean flow problems at offshore wind farms.
- A website showing its prediction, monitoring, and analysis.
- A set of publications to disseminate the results.

Merits: The modeling-monitoring system of this project will be the first of its kinds, and it is highly desired in offshore wind energy development. It will have the capability to provide key parameters and deal with issues in offshore wind energy development that cannot be handled by existing systems and software. It will serve as a platform in developing offshore wind farms providing energy for tens of millions of homes and other applications.

The system will not only allow to further our understanding in scientific, engineering, and design issues in offshore wind energy development but also will set up an unprecedented platform for other researchers across CCNY and beyond to study their problems, including, ocean biology, structure design, risk management, and many more.

Impact: The proposed modeling system will advance our understanding and predicting capabilities of offshore wind energy, and it will directly impact the related industries by providing an unparalleled platform for engineering design, risk mitigation, and operational management.

The modeling system to be developed in this project has a much broader impact; in addition to offshore wind energy, equally it is applicable, unique, and highly desired in many other areas, e.g., oil pipeline deployment, seawall construction, water quality of wastewater plants, and submarine maneuvers.

Milestones:

Year 1: a. Development in computational methods. b. Data collection and analysis methods
c. Software development
Year 2: a. Validation and test of the methods. b. Software development
Year 3: a. Showcase study. b. Outreach to industry and communities. c. Dissemination of the results

Budget (Maximum Budget $200K):

Personnel Costs: (please list key positions and estimate budget required)

- Key Personnel: Hansong Tang, Vasil Diyamandoglu, Naresh Devineni, and a marine biologist/ecologist.
- Admin/research staff:a person to outreachto industry and seek external funding, TBD
- Students: Posdoc 1; PhD 1; Undergrad, MS 3

$600k, three years, pay to participants, measurement of data from field, supplies, and travel.