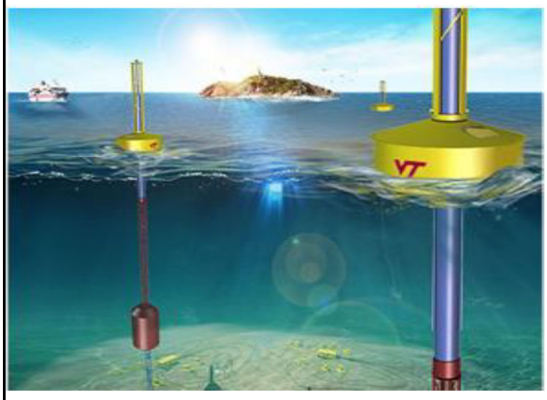
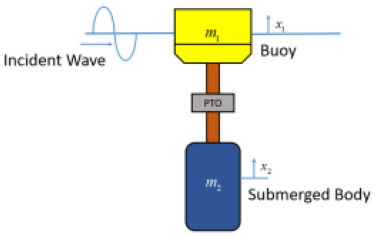
STATE OBSERVER DESIGN

CASE STUDY: WAVE ENERGY CONVERTER

WAVE ENERGY CONVERTERS (WECS) CONVERT OCEAN WAVE ENERGY INTO USABLE ENERGY





XIONG ET AL. MODELED THE WECS IN STATE SPACE

Force produced by PTO

Wave excitation force on buoy

$$\dot{x} = Ax + BF_{gen} + B_1F_{e1} + B_2F_{e2}$$
$$y = Cx$$

States: buoy position and velocity, submerged body position and velocity

Wave excitation force on submerged body

XIONG ET AL. MODELED THE WECS IN STATE SPACE

$$\dot{x} = Ax + BF_{gen} + B_1F_{e1} + B_2F_{e2}$$
$$y = Cx$$

$$A = \begin{pmatrix} 0 & 1 & 0 & 0 \\ -\frac{k_1}{m_{e1}} & -\frac{b_1}{m_{e1}} & 0 & \frac{A_{12}b_2}{m_{e1}(m_2+A_2)} \\ 0 & 0 & 0 & 1 \\ \frac{A_{21}k_1}{m_{e2}(m_1+A_1)} & \frac{A_{21}b_1}{m_{e2}(m_1+A_1)} & 0 & -\frac{b_2}{m_{e2}} \end{pmatrix}, B = \begin{pmatrix} 0 \\ \frac{1}{m_{e1}}+\frac{A_{12}}{m_{e1}(m_2+A_2)} \\ 0 \\ -\frac{1}{m_{e2}}-\frac{A_{21}}{m_{e2}(m_1+A_1)} \end{pmatrix}$$

$$B_1 = \begin{pmatrix} 0 \\ \frac{1}{m_{e1}} \\ 0 \\ -\frac{A_{21}}{m_{e2}(m_1+A_1)} \end{pmatrix}, B_2 = \begin{pmatrix} 0 \\ -\frac{A_{12}}{m_{e1}(m_2+A_2)} \\ 0 \\ \frac{1}{m_{e2}} \end{pmatrix}, C = \begin{pmatrix} 1 & 0 & -1 & 0 \\ 0 & 1 & 0 & -1 \end{pmatrix}$$

PHYSICAL PARAMETERS ARE PROVIDED IN THE PAPER

TABLE 1. PARAMETERS OF THE SYSTEM [10]

	Parameters	
m_1	Buoy mass [kg]	2625.3
	Submerged body mass [kg]	2650.4
A_1	Buoy added mass [kg]	8866.7
	Submerged body added mass [kg]	361.99
A_{12}	Buoy added mass due to submerged body [kg]	361.99
	Submerged body added mass due to buoy [kg]	361.99
b_1	Buoy radiation damping [Ns/m]	5000
	Submerged body radiation damping [Ns/m]	50000
k_1	Buoy hydrostatic stiffness [N/m]	96743
	Sampling time [s]	0.1
	Prediction step	100
	Weight on power generation	10e6
	Control input weight	10e(-6)
	Prediction horizon [s]	10
	Maximum generator force [N]	50000
	Minimum generator force [N]	-50000
	Maximum PTO damping [Ns/m]	20000
	Minimum PTO damping [Ns/m]	0
	Maximum stroke length [m]	0.75
	Minimum stroke length [m]	-0.75
	Maximum relative velocity [m/s]	1
	Minimum relative velocity [m/s]	-1
	Passive model PTO damping [Ns/m]	10000

$$\underbrace{\left(m_1 + A_1 - \frac{A_{12}A_{21}}{m_2 + A_2}\right)}_{m_{e1}}$$

$$\underbrace{\left(m_2 + A_2 - \frac{A_{21}A_{12}}{m_1 + A_1}\right)}_{m_{e2}}$$

QUESTIONS

1. Is the system state observable?
2. Design a state observer
3. Implement the state observer in Simulink