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| --- | --- |
| World Frame Variables | |
| Position | Orientation |
|  |  |
|  |  |
|  |  |

|  |  |
| --- | --- |
| Body Frame Variables | |
| Position | Orientation |
| R (Roll body analog to X) |  |
| P (pitch body analog to Y) |  |
| W (Yaw body analog to Z) |  |

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| --- | --- | --- | --- |
| Directly Measured Values | | | |
| Variables | Accuracy | Sample Rate () | Source |
|  | 0.01 | 8 | Doppler Velocity Logger |
|  |  | 8 | Doppler Velocity Logger |
|  |  | 8 | Doppler Velocity Logger |
|  | 0.063 | 100 | Inertial Measurement Unit |
|  | 1.5 | 100 | Inertial Measurement Unit |

|  |  |
| --- | --- |
| Rotational Matrices, | |
| Axis | Matrix |
| Yaw |  |
| Pitch |  |
| Roll |  |
| Combined rotational matrix |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Constants | | | |
| Symbol | Value | Units | Description |
|  |  |  | Density of fresh water |
|  | est |  | Drag coefficient in the “roll” direction |
|  | est |  | Drag coefficient in the “pitch” direction |
|  | est |  | Drag coefficient in the “yaw” direction |
|  |  |  | Acceleration due to gravity |
|  | TBD |  | Volume of water displaced by the submarine |
|  | TBD |  | Mass of the submarine |
|  | TBD |  | Moment of inertia about the roll axis |
|  | TBD |  | Moment of inertia about the pitch axis |
|  | TBD |  | Moment of inertia about the yaw axis |
|  | TBD |  | Maximum cross sectional area in the P-W plane |
|  | TBD |  | Maximum cross sectional area in the R-W plane |
|  | TBD |  | Maximum cross sectional area in the R-P plane |
|  | TBD |  | Net force in the Z direction resulting from gravity and buoyancy forces |
|  | TBD | m | Distance from P axis to center of applied torque from Q1-4 |
|  | TBD | m | Distance from R axis to center of applied torque from Q1-4 |
|  | TBD | m | Distance from R axis to center of applied force from P1,P2 |
|  | TBD | m | Distance from the W axis to the center of applied force from P1, P2 |
|  | TBD | m | Distance from the W axis to the center of applied force from Q5,Q6 |

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| --- | --- |
| Standard Equations | |
| Equation | Description |
|  | Drag equation, is the density of the fluid, is the velocity, is the coefficient of drag, is the area in the direction of motion |
|  | Net force resulting from gravity and buoyancy |
|  | Force to torque equation |

Assumptions: Center of thrust for all motors will be on the R-P plane

Constraints

|  |  |
| --- | --- |
| Constraint | Justification |
|  | Accuracy of DVL drops off at higher velocities |
|  | Given 0 as the surface and –n as the bottom, the sub should not breach these for risk of disqualification |
|  | The DVL must maintain awareness of the bottom of the pool in order to not lose accuracy/awareness of position. Value TBD |
|  |  |

Variables:

: The Force exerted by the maneuvering motors

: The force exerted by the two main propulsion motors.

System takes the current state as initial values and solves for final values provided by the CPU, including and

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