Improving the Efficiency of Autonomous Underwater Vehicles (AUVs)

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Situation

Autonomous Underwater Vehicles (AUVs) (as seen in Figure 1) are robotic vehicles that function without direct human monitoring. Their main purpose is to collect data, record 3D maps of surrounding underwater environment and conduct survey missions. However, when the AUV is implemented to undertake long-duration missions it exhibits limitations in terms of safety, energy consumption, navigation and path planning accuracy.

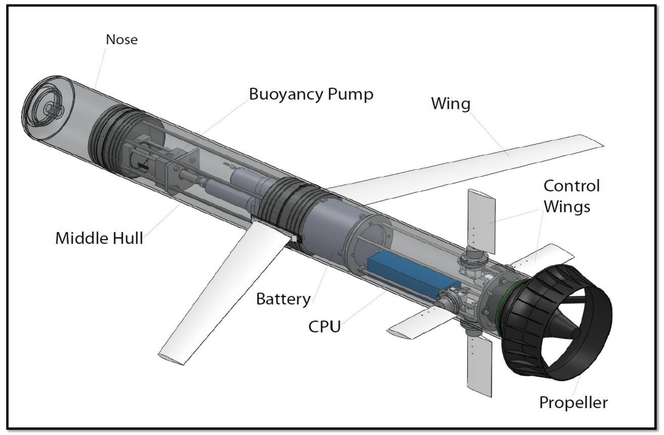

Figure1: General design of the AUV. Retrieved from http://www.aub.edu.lb on April 15th, 2014

Problems

These limitations are due to the following factors:

- The nature of the underwater environment can affect the external body of the AUV and cause it to collapse.
- The paddle-wheel propulsion system decreases the accuracy and energy efficiency of the AUV over long-duration missions.
- Conventional navigation systems have a lower precision in the underwater environment.
- Obstacle avoidance and accurate path planning becomes difficult when the AUV is exposed to unknown environments underwater.

Figure 2 illustrates how these problems relate to each other.

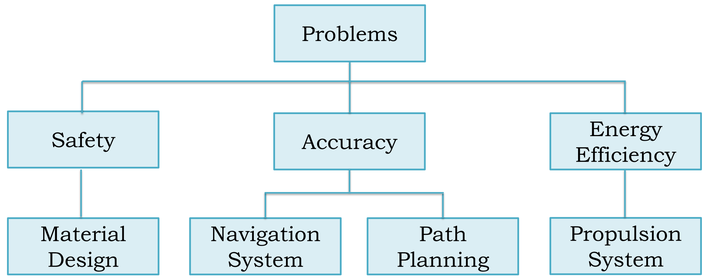

Figure 2: Illustration of the Relationship Between the Different Problems

Solutions

In order to solve these problems, we propose the following solutions to increase the overall efficiency of the AUV:

- In regards to safety, using metal/composite material (AL/CFRP) which can withstand high pressure and other surrounding media issues [1].
- With respect to energy consumption, using the three-water-jet propulsion system (see Figure 3) will increase the speed of the AUV with less power consumption [2].
- Implementing Simultaneous Localization And Mapping (SLAM) system which uses the environment to increase the navigation accuracy and minimize estimation errors [3].
- Using dynamic algorithms and graphs for re-planning and finding an accurate path that the AUV should take with respect to changes in its surroundings.

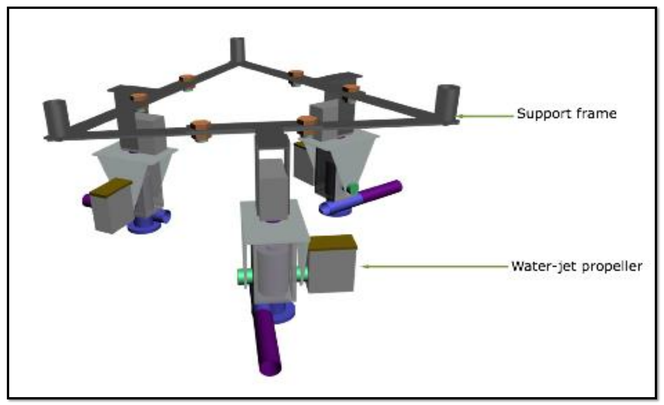

Figure 3: Design of the three water-jet propulsion system Retrieved from “Autonomous Underwater Vehicles” by Cruz

Evaluation

- Designing the body of the AUV using composite materials will increase the safety of the vehicle.
- Using the three-water-jet-propulsion system for the motion of the vehicle increases the energy efficiency of the vehicle, but the application of this system has low cost efficiency.
- Implementing the SLAM system for the navigation results in improved navigation accuracy. However the system has not been properly tested yet [4].
- Implementing dynamic algorithms and graphs for re-planning of paths increases the navigation accuracy of the vehicle. However, dynamic algorithms require a lot of processing resources, thus reducing the cost efficiency [5].

The evaluation is summarized in the following table:

Table 1: Evaluation of solution based on five different criteria

Criteria	High	Low
Safety	•	
Energy Efficiency	•	
Accuracy	•	
Cost Efficiency		•
Practicality		•

References

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