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Design, Modeling and Control Architecture of an Autonomous Underwater Vehicle

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Abstract: In this paper is presented a new generation of ocean data platforms known as autonomous underwater vehicle (AUV). Autonomous underwater vehicle is an unmanned underwater vehicle that is been used to monitor the underwater thing by using of sensors. It is difficult to develop the power and communication system in order to develop control architecture. The vehicle requires autonomous guidance and control system in order to perform the underwater tasks then microcontroller based system design and embedded control system design. This vehicle consists of array of sensors which are used for camera vision, inertial measurement unit ,to measure pressure with navigation of the system the speed, acceleration positioning of system us being measured. This vehicle move with the help of fan, motor and thrusters. GPS is used to locate the vehicle. There are many challenge related to power source navigation and mission management in AUV technology so it has to overcome many obstacles. These vehicle are very useful to work related in ocean industry. Analyzing the system is being out by real time simulation.

Key words: AUV · Buoyancy and stability

INTRODUCTION

In modern technology, control engineering plays an important role. This theoretical knowledge is most significant but its practical application is also more important for the process involved in a control system which cannot be formatted easily, though it is possible to divide them into separate stage.

- Conceptual phase (formulating the target of control, defining requirements),
- Modelling [1] (developing a mathematical model, carrying out measurements and processing measurement data, on-line and off-line identification),
- Analysis of the model developed in the previous phase (its visual and controlling abilities, static and dynamic properties)
- Synthesis of the control system (defining its structure and selecting parameters),
- Validation of the control system characteristics (stability, susceptibility, reliability, modelling, computer simulation)
- Implementation of the control system (algorithms for measurement data processing, filtration, estimation of those process variables which are not measured, calculating control parameters in real time, testing, physical execution).

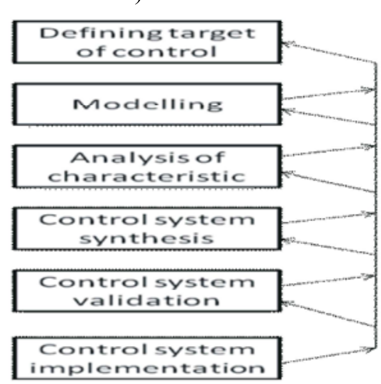

Fig. 1: Stages of Control System Design Process

Planar Motion Mechanism (PMM)[2] is used to measure the hydrodynamic derivatives of the AUV body shape. If the above mechanism is not possible then one needs to use analytical and semi-empirical methods in aerodynamics. This model enables one to simulate its.

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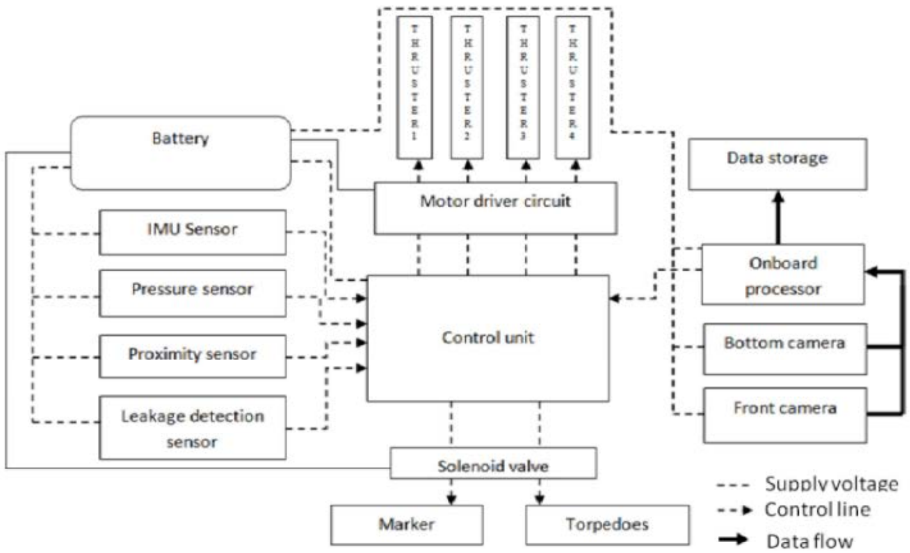

Fig. 2: Block Diagram of AUV

dynamic behaviour, and the performance of the control systems for manoeuvrings well before field tests of the vehicle at sea. System identification test is being carried out to determine the dynamic response of AUV and thereby improving the hydrodynamic model. The AUV are built with distributed architecture using networks. Electronics hardware of the AUV's comparatively occupies the minimum space. The main objective of the system is to explore the underwater using small undersea vehicle without risking people's life and to carryout various mission and measurements. Detect more number of objects by travelling long distance. To control the speed, depth and steering of the unmanned sea vehicle[3]. E.g. Batteries, sensors and vehicle payloads.

Improvement has been made in control system such that the AUV can intelligently accomplish it mission without or little attention from human supervision. Therefore, the on-board electronic controller should be good enough to implement the control system and execute the instructions at high-speed rate.

Stabilty and Buoyancy:

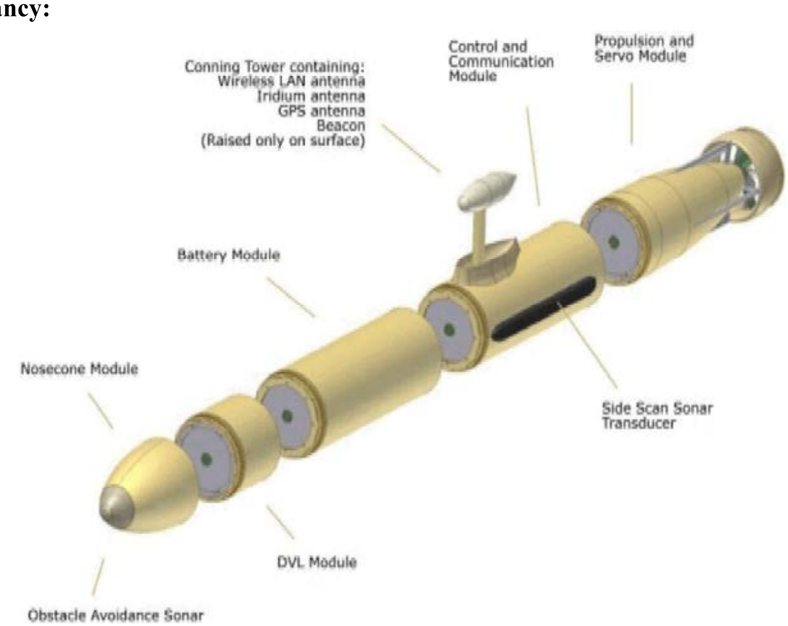

Fig. 3: AUV

The purpose of modelling the vehicle is to obtain accurate 6 DOF motion equations of the vehicles. These dynamic equations describe the velocity; the trajectory and the orientation of the vehicle after certain input are applied to the vehicles.

Gravity and Buoyancy: There will be an upward buoyancy force when a solid body submerged. In order to equivalent the weight displaced fluid thereby either the body float or it appears lighter. The object will float when the buoyancy exceeds its weight it will sink when the weight exceed the buoyancy[4]. If the buoyancy and body weight is equal then the body experience the neutral buoyancy.

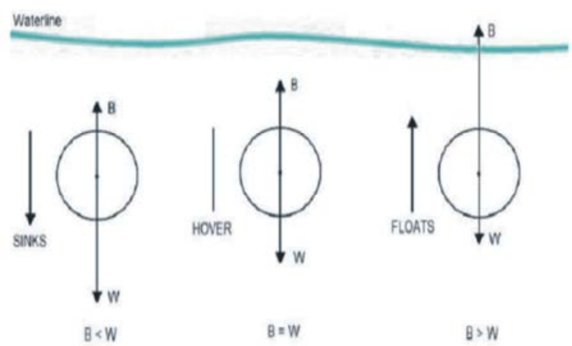

Fig. 4: Buoyancy Effect

Buoyancy Calculation:

Volume of AUV = 1.7*0.45*0.45
= 0.34425◎◎3
Volume of AUV = Volume of Water Displaced
= 0.34425◎◎3

Weight of Water Displaced = Volume of Water Displaced*density Ofwater

= (0.34425*1000)/9.81

The Weight of Auv Should Be=35kg (Approximate) to Achieve Neutral Buoyancy.

Stability: When a floating object restore itself to its balanced position after experiencing a small displacement. Then it is set to be stable. For instants, vertical stability is generally experienced in floating objects. I.e. if the object is pressed towards the downward direction it creates a higher buoyancy force. Due to this force, object is pushed up. Rotational stability[6] also plays an important. This stability depends on the force of object. When an object moves in an angular displacement along the line action then it will be stable.

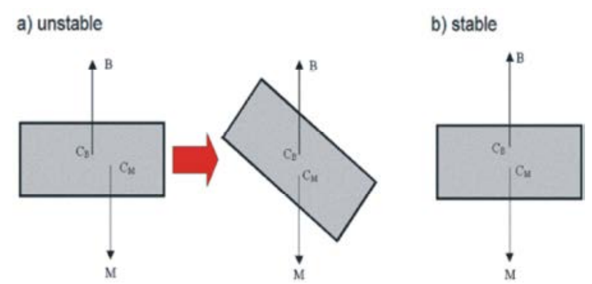

Fig. 5: The stability effect a) unstable configuration b) stable configuration

If C M and CB have the same position the vehicle will retain stability [5]. The result of this is a brightening movement RM, when the vehicle rolls or does a pitch movement this moment RM can be written as:

$$RM = 1/2[d(B + W)\ \lambda]$$

where B, W are forces of the vehicle and d distance between centres of mass and buoyancy.

Matlab Simulation and Result
Simulation Results:

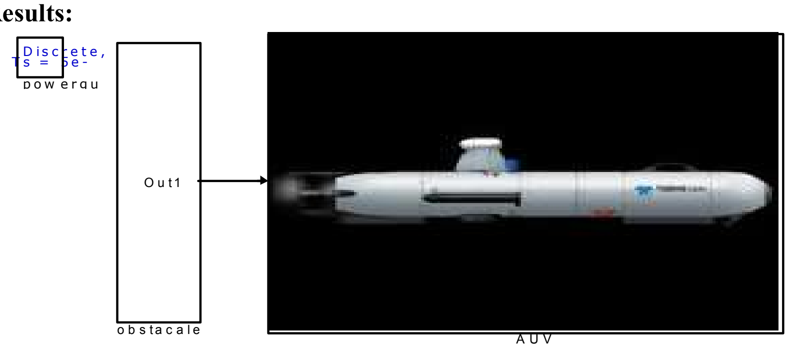

Fig. 6: Simulation AUV

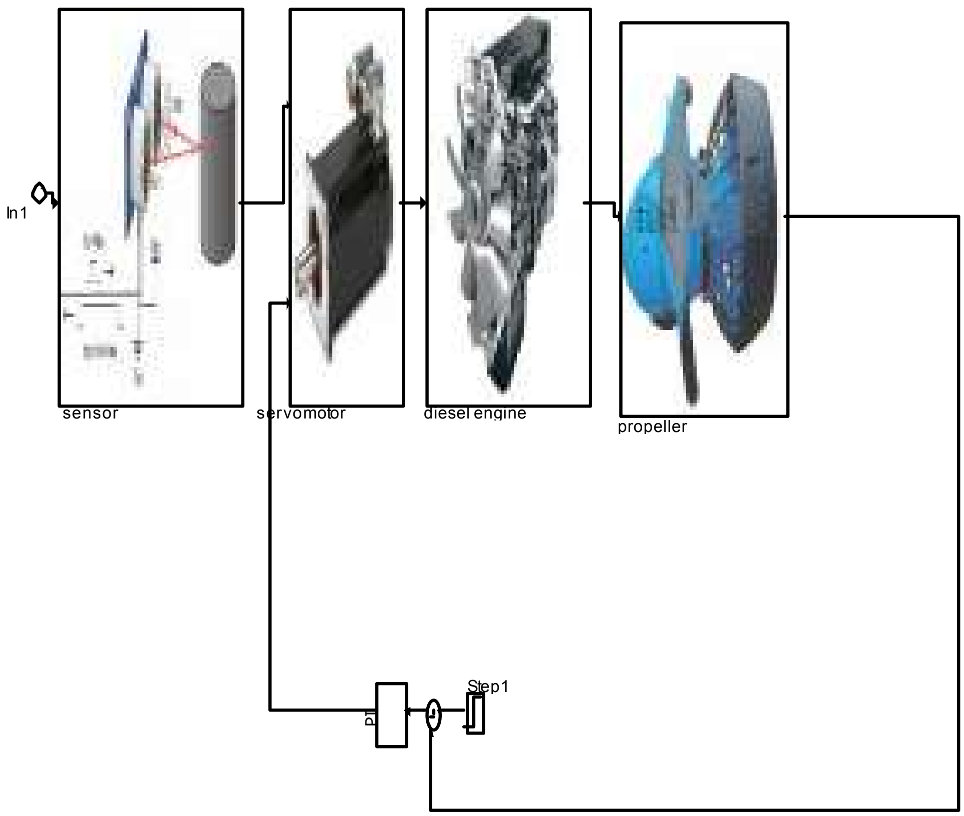

Fig. 7: Internal diagram of AUV

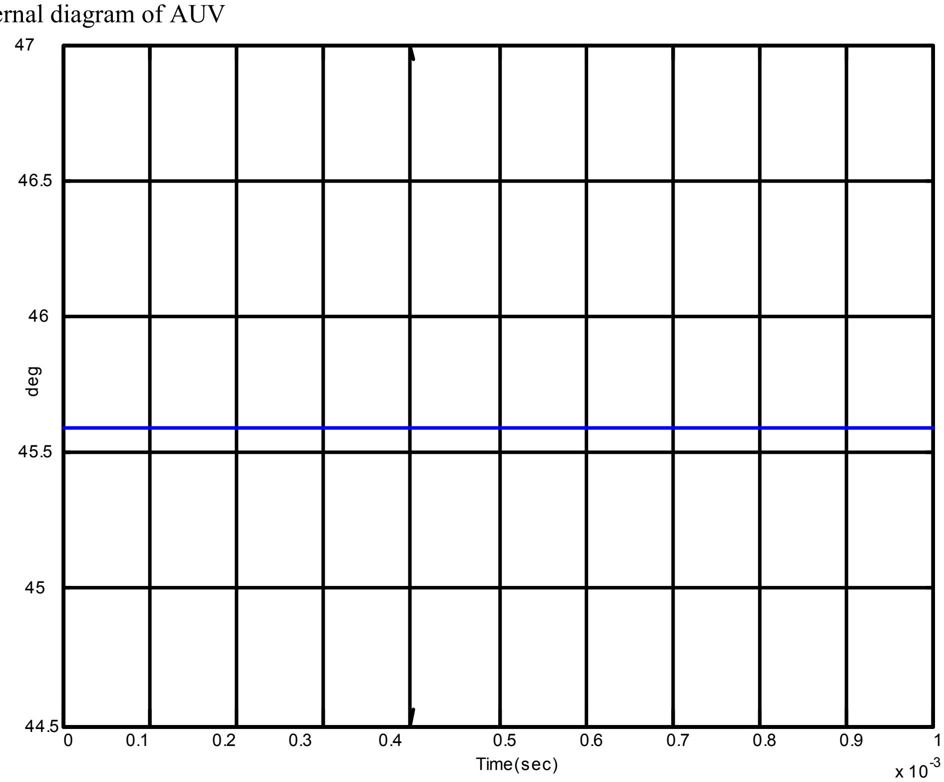

Fig. 8: When condition 0 apply, angle of the AUV in .001 sec

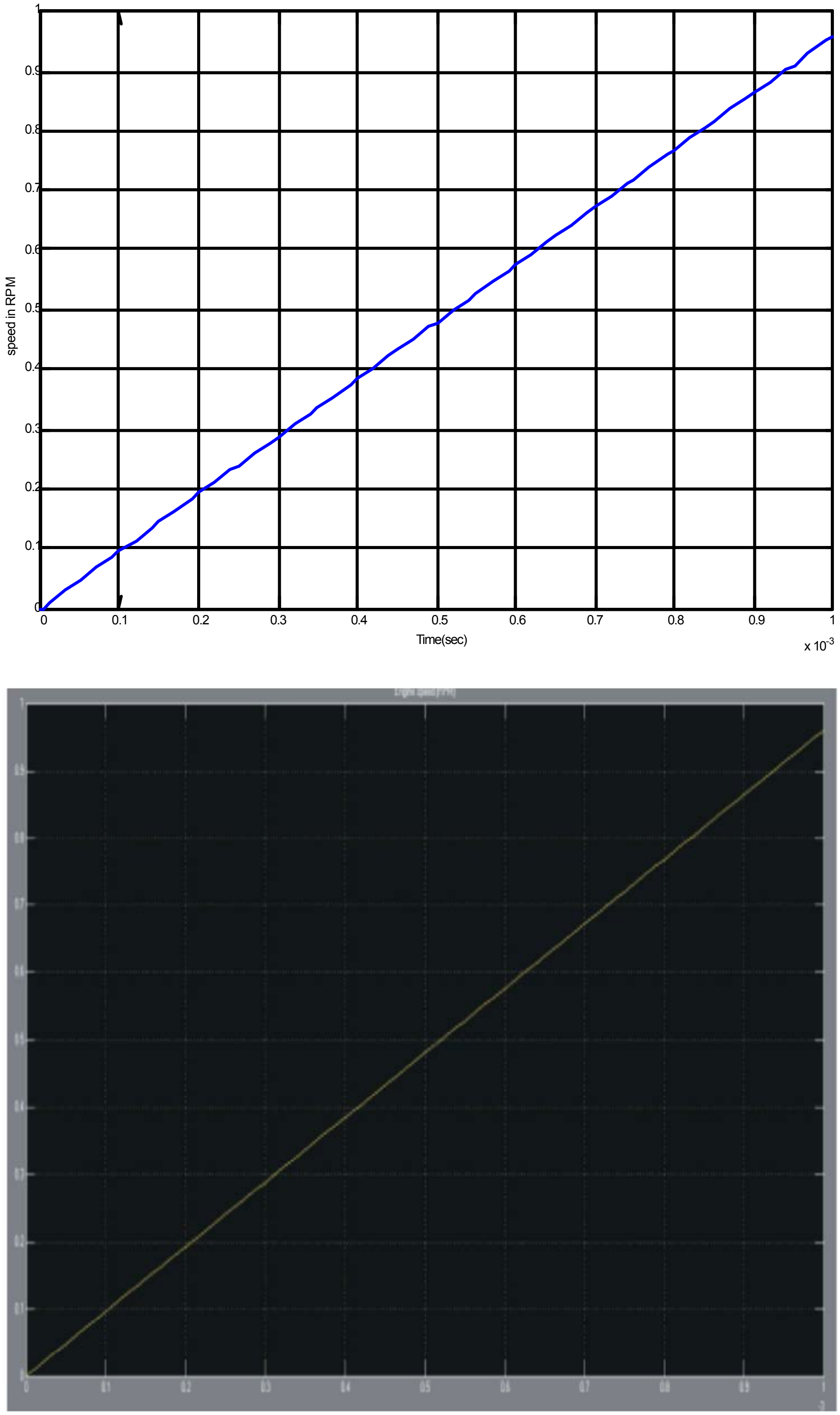

Fig. 9: When condition **0** apply, speed of the AUV in 0.01sec

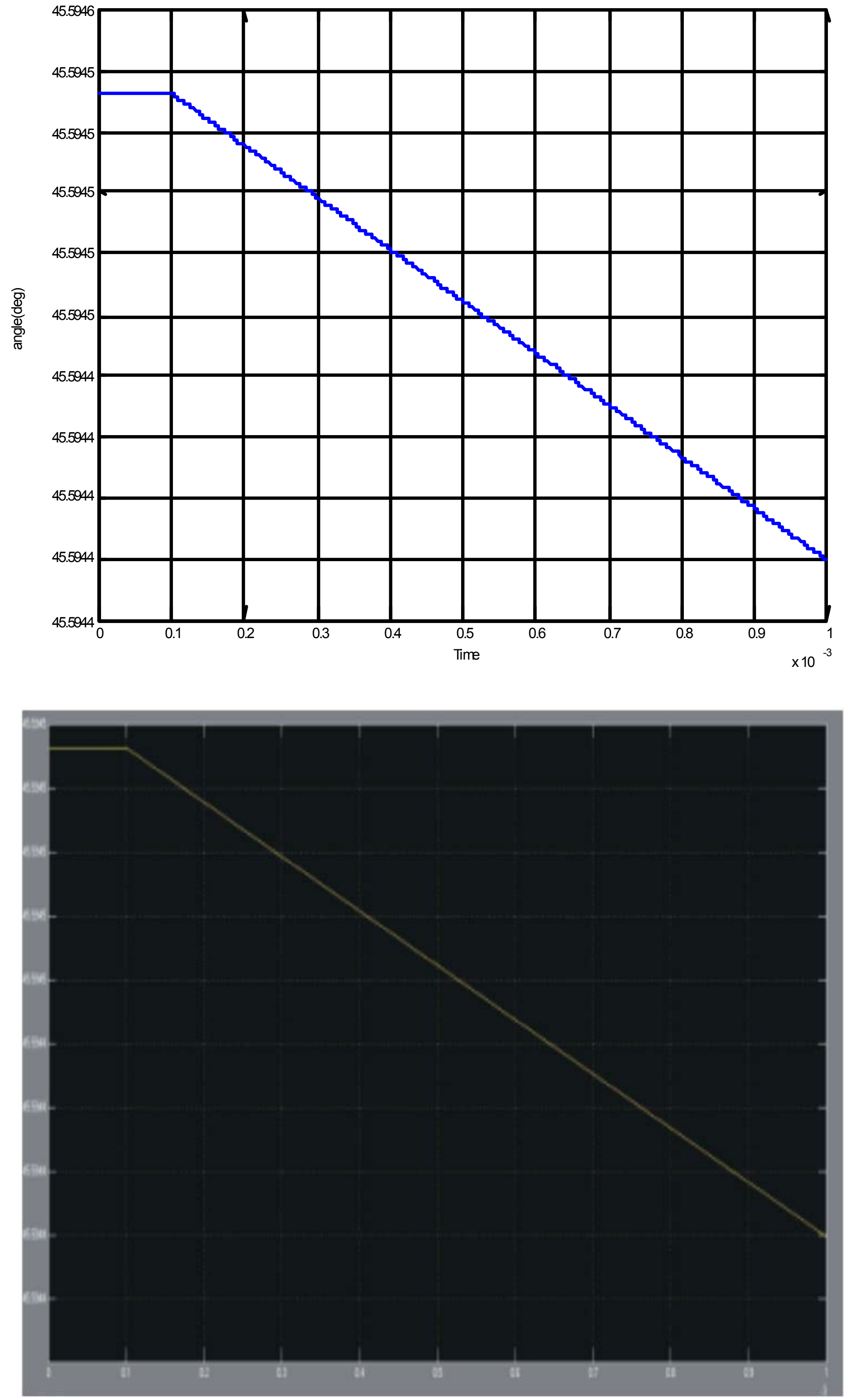

Fig. 10: When condition 1 apply, angle of the AUV in .001 sec

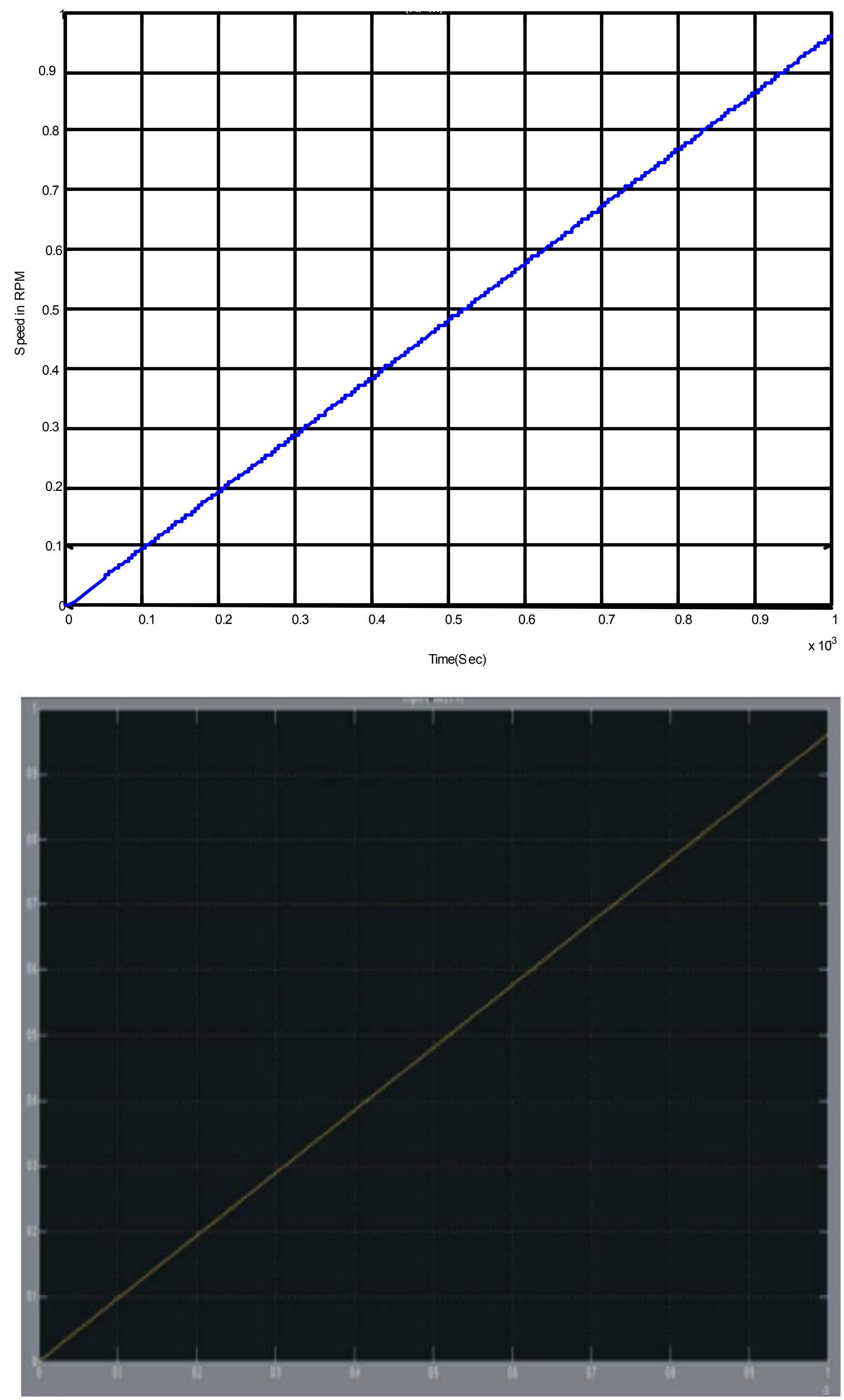

Fig. 11: When condition 1 apply, speed of the AUV in .001 sec

In this section describes the implementation of real time simulation for the designed control system by using Mat lab, Simulink [7] and Real-Time Workshop. Mat lab is a high-performance language for technical computing. The Mat lab can solve many technical-computing problems, especially those with matrix and vector formulation. Typical uses of mat lab include math and computation, Algorithm development, modelling, simulation and prototyping, data analysis, visualization, scientific and engineering graphics.

CONCLUSION

This report has given an overview about the development of the AUV. Various strategies, techniques and theories relating from basic electronic circuits up to motion, navigation and location control for autonomous underwater vehicle has been considered. It shows how different sensors work and how they can be combined to an effective navigation system. This relative small AUV was a high challenge in using space and energy on the most effective way. The following contribution was made in the thesis. Development of the electronics system of an AUV providing:

- Supply of different voltages
- Energy control and recharge possibility
- Water leakage detection and electronics protection
- Communication
- Easy and reliable design
- All controller values soft coded for easy modifications
- Efficient energy use.

REFERENCES

1. Elgar Desa, R. Madhan and P. Maurya, 2006. Potential of Autonomous Underwater Vehicles As New Generation Ocean Data Platforms, National Institute of Oceanography, , India Current Science, 90(9).
2. Morawski, L., J. Pomirski and A. Rak, 2006. Design Of the Ship Course Control System, 2006, International Design Conference - Design.
3. Wen Shinie and Shanghaishang Hai Jiao Tong, 1991. “Simulation of Hip Power Plant” University Press.
4. Li Dianpu, Wang Zongyi and Chi Haihong, 2002. Chebyshev Fitting Way and Error Analysis for Propeller Atlas across Four Quadrants. Journal of Marine Science and Application, (1): 52-59.
5. Yan Shisong, 1998. Practical Calculation Method of Ship Resistance, Ship Building of China, 16: 19-24.
6. Fan Shangyan, 1993. Ship Power Plant Simulation and Technology, Shang Hai Jiao Tong University Press.
7. Song Shi Quan, 2008. Application of Matlab In the Simulation of Electric Ship Power System, Research and Exploration in Laboratory, 27(12): 168-172.