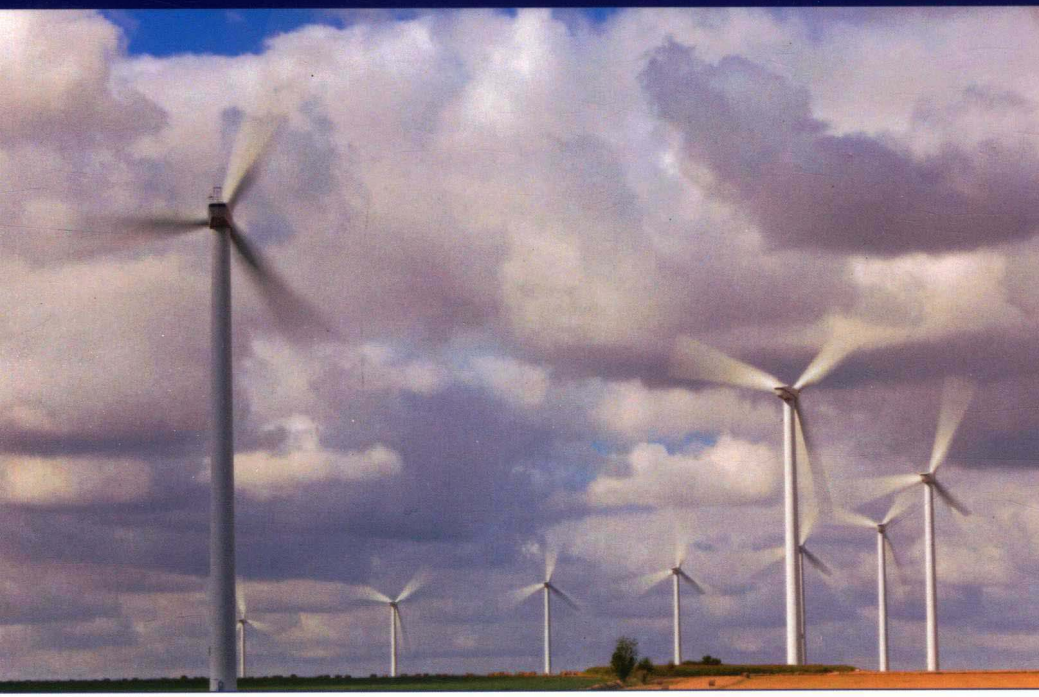

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Dedication

This book is dedicated to many students who forced to study from trial drafts of this work.

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There are a number of people that deserve mention and gratitude for their help, guidance and support during the course of this thesis project. Likewise, I would like to give thanks to my primary researchers on the submariners. Special thanks to my parents for their support and encouragement, I love them always.

Ali Razmjoo

Afshin Davarpanah

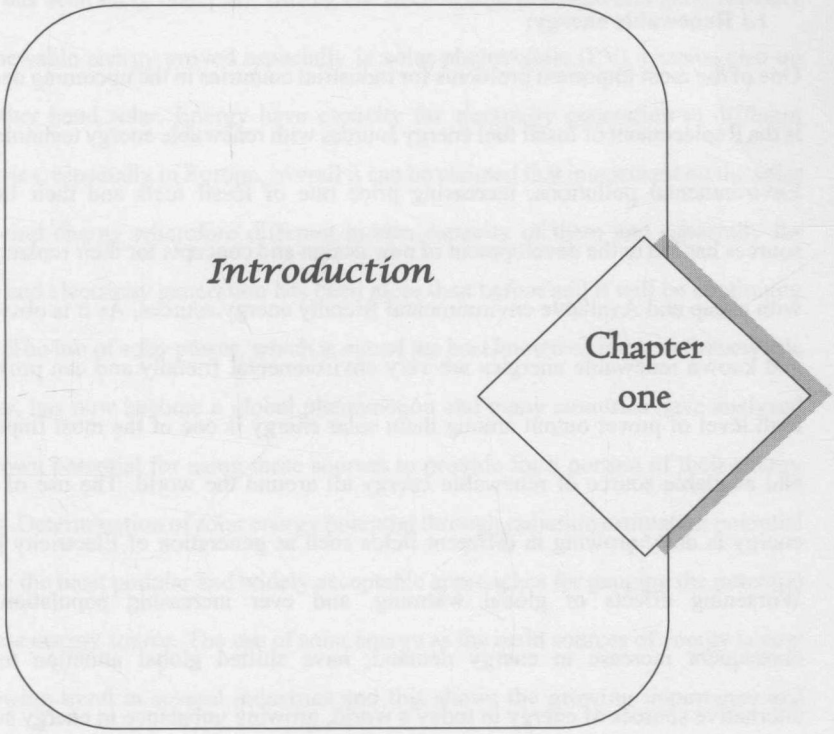
Contents:

Abstract:

Today, Global warming and climate change are two destructive factors that are threating earth temperature and environment also one of the best way to preventing it is more using of renewable energy. Using of renewable energy especially solar energy can help all kind of mankind to have a health and better life for future. In the relation one of the vehicles that can use solar panels to provide sufficient energy for movement is AUV. Actually autonomous underwater vehicle (AUV) is an unmanned underwater vehicle which is utilized to accomplish various missions autonomously. In this research book moreover of present different AUVs, building solar submarine has been considered and presented in order enhancing knowledge of researcher especially young students. It's believed that the present research could result in an underwater vehicle which is able to move under the water and provide its own required electrical energy using solar cells he Autonomous Undersea Systems Institute (AUSI) is currently working on the development of a solar powered Autonomous Underwater Vehicle (AUV) in cooperation with the Institute of Marine Technology Problems of the Russian Academy of Sciences Autonomous underwater vehicles (AUVs) are becoming increasingly popular for ocean exploration, military and industrial applications. In particular, AUVs are becoming an attractive option for underwater search and survey operations as they are inexpensive compared to manned vehicles. Previous attempts on AUV designs have

focused primarily on functional designs while very little research has been directed to identify optimum designs.

Keywords: Renewable energy, solar energy, AUVs, Submarine, Diving and Climbing, Buoyancy Force, Solar Panel



1. Introduction:

1.1 Renewable energy:

One of the most important problems for industrial countries in the upcoming decades is the Replacement of fossil fuel energy sources with renewable energy technologies. Environmental pollutions, increasing price rate of fossil fuels and their limited sources has led to the development of new design and concepts for their replacement with cheap and Available environmental friendly energy sources. As it is obviously and known renewable energies are very environmental friendly and can provide a high level of power output among them solar energy is one of the most Important and available source of renewable energy all around the world. The use of solar energy is daily growing in different fields such as generation of Electricity [1-3]. Worsening effects of global warming, and ever increasing population and consequent increase in energy demand, have shifted global attention toward alternative sources of energy in today's world, growing unbalance in energy supply and demand has caused the urgency to develop new energy sources to be felt more than ever. In the past 30 years, the global economy has had an annual growth of about 33 per cent, while electricity consumption has increased by 36% [4]. Now world needs to clean and economic energy therefore the role of the renewable energies such as solar and wind herein are undeniable and it is most important in our life. In recent years, due to global warming, cost reductions and remarkable capacity

of both mentioned energies make more investment and policy support energy of them has been more than past. During last decade high potential and good capacity in renewable energy proved especially in solar photovoltaic (PV) systems also on the other hand solar. Energy have capacity for electricity generation in different countries, especially in Europe, overall it can be claimed that investment on the solar and wind energy wherefore different hidden capacity of them and especially for clean and electricity generation has been more than before and it will be continuing [5-8]. The use of solar power, which is one of the best known examples of renewable energy, has now become a global phenomenon and many countries have analyzed their own potential for using these sources to provide for a portion of their energy needs .Determination of solar energy potential through radiation estimation potential is now the most popular and widely acceptable approaches for gauging the potential of these energy source. The use of solar energy as the main sources of energy is now a growing trend in several industries and this shows the growing importance and applicability of these power sources [9, 10].

Background of AUVs

Chapter Two

2.2 Background built of AUVs:

The first AUV was developed at the Applied Physics Laboratory at the University of Washington as early as 1957 by Stan Murphy, Bob Francois and later on, Terry Ewart. The "Special Purpose Underwater Research Vehicle", or SPURV, was used to study diffusion, acoustic transmission, and submarine wakes. Other early AUVs were developed at the Massachusetts Institute of Technology in the 1970s. One of these is on display in the Hart Nautical Gallery in MIT. At the same time, AUVs were also developed in the Soviet Union. (Although this was not commonly known until much later. Marine autonomous systems, including submarine gliders and Autonomous Underwater Vehicles, are revolution is in our ability to map and monitor the marine environment Although truly autonomous systems are typically deployed from a research vessel, they are not tethered to the vessel and do not require direct human control while collecting data . They therefore provide opportunities for data acquisition. Marine autonomous systems also have an increasing range of applications in the defense, industry and policy sectors, such as geo-hazard assessment associated with oil and gas infrastructure. In addition, recent economic drivers, such as rapidly increasing vessel fuel oil costs, are making autonomous systems a potentially attractive proposition to organizations responsible for large-scale and cost-effective marine data collection programmers .Today renewable energy has been a main part to providing energy of AUV kinds and in recent years

especially in 2012 and 2015 two solar AUVs by different groups in United states and Iran has been built [11].

2.3 General Design of an AUV

There are several aspects in AUV mechanical and electrical design that need to be looked at closely. International Submarine Engineering identifies hull design, propulsion, submerging and electric power as major design aspects [12].

2.3.1 Hull Design

An AUV must provide a pressure hull to house its components in a dry, watertight environment. The hull must allow components to be easily accessible and maintainable, as Well as allowing for modularity in case of future changes or additions. As well as being Light and strong, the hull should also be corrosion resistant as it will be subjected to a harsh saltwater environment. Spherical hulls offer the best structural integrity, however, the shape inhibits the efficient use of the space available as most components and systems are rectangular in shape. Cylindrical hulls provide the best alternative, comprising high structural integrity and a Shape conducive to the housing of electronic components [12].

2.3.2 Propulsion

Some sort of propulsion is required on all AUVs and is usually one of the main sources of Power consumption. Most AUVs use motors for propulsion due to the scarcity and cost .The location of the motors affects which degrees of freedom can

be controlled. The Positioning of the motors can also affect noise interference with onboard electronic components, as well as propeller-to-hull and propeller-to-propeller interactions. Propeller-to-hull and propeller-to-propeller interactions can have unwanted effects in the dynamics of an AUV [12].

When travelling at a constant speed, the thrust produced by the motors is equal to The friction or drag of the vehicle, that is;

$$\text{Thrust} = \text{Drag} = \frac{1}{2} l\, \rho s^2 \text{AcD} \qquad \text{eq.2.1}$$

Where ρ is the water density, s is the speed, A is the effective surface area and cD is the Drag coefficient. Power consumption for the propulsion system increases dramatically as the speed of the vehicle increases. This is because the thrust power is equal to the product of the thrust and the speed, meaning thrust power is a function of speed cubed;

$$\text{Thrust Power} = \text{Thrust} \times \text{s} = \frac{1}{2} l\, \rho s^3 \text{AcD} \qquad \text{eq.2.2}$$

Therefore, because of an AUV's limited energy supply, it must travel at a speed that does not draw too much power, but at the same time does not take too long to complete its Mission. Obtaining the ideal speed becomes an optimization problem [12].

2.3.3 General design of an AUV