Using DotNetNuke in Development and implementation of Marine Robotics Research at University of Limerick

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Declaration

*Using DotNetNuke in Development and Implementation of Marine Robotics Research at University of Limerick*

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This thesis is presented in partial fulfillment of the requirements for the degree of Master of Engineer in Computer and Communications Systems. It is entirely my own work and has not been submitted to any other university or higher education institution, or for any other academic award in this university. Where use has been made of the work of other people it has been fully acknowledged and fully referenced.

__________________________
Jing Zeng

August 20th 2013
I dedicate this work to my supervisors, my family and friends at home and aboard, for their continued encouragement, instruction and support.
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Abstract

This thesis explores using the open source content management system DotNetNuke (DNN) for the design and implementation of a portal website for the Mobile & Marine Robotic Research Centre (MMRRC) at University of Limerick. This was done in collaboration with the research team in university research centre. Based on plenty of research material accumulated during years of studies, the MMRRC website would be a platform for visitors or interested researchers to learn about the research activities and projects undertaken by MMRRC team at University of Limerick and keep the latest news updated on the website all the time. During this project, there was an exercise in Shannon Estuary which explored a ship undersea and simulate oil leak from the ship. The MMRRC team played significant role in planning and executing the exercise. Video, pictures, as well as real-time data obtained from this exercise were updated on the website. In contrast to traditional websites, this portal website developed with DNN can be easily and conveniently managed by administrators using role-based approach.
Chapter 1: Introduction

1.0 Introduction

Websites designers used only Hyper Text Markup Language (HTML) to develop websites in early time, later with increasing availability of the Internet and computer technologies, varied language and technologies were used, such as XHTML, JavaScript VBScript, which involves large amount of coding and huge efforts in small tasks such as alignment of its contents. Recently, more projects are commercially developed into open-source market with business goals or totally free. Developers can use the open-source products to start and build the web features of their own.

This thesis explores the structure and features of the open-source content management system DNN, then applies it to implement a multi-portal permissions user-oriented website for Mobile & Marine Robotics Research Centre (MMRRC) at University of Limerick. The Content Management System (CMS) is an open-source system with a collection of computer-based cooperative procedures used to manage the content of a website, to manage work flow in a collaborative environment as well as allow varies people to contribute to and share design process based on user roles conveniently. As open-source system, CMSs can receive the source in order to identify bugs (Richard N., 2010) and are frequently used for storing, controlling, revising and publishing documentation. This project deeply investigates the core of the DNN technology and closely integrates with the research team in MMRRC. A dynamic portal website has been developed and designed based on software engineering development process.
1.1 Project Motivation

The motivation that sparked the initial concept for this project derives from the author’s website development experience for a web-based course. Internet and media communication techniques have changed human’s manner to learn new things. With the concise content and costless developing process, open-source CMS is the optimal choice (Wikipedia 2013). As the only research centre focused in the field of remote operated vehicles (ROVs) and payload technologies in Ireland as an island nation, MMRRC need to be known by the interested researchers around the world and conveniently visited on the Internet. In order to make web site compatible with different browser platforms, aligned with recent advances in web technologies and to make site maintenance faster and easier, it was decided to use DNN to develop new web site and replace the old one (based on static HTML pages).

1.2 Project Objectives

The aim of the project is to build a portal website to integrate the MMRRC with all its research activities, business processes, people, project information and resources based on DNN technology. The objective is to enhance the website service to different role-based users by distributing and updating exhaustive information and latest project news of MMRRC. Generally, although some applications integrated in a portal website are not directly available to the client-end users, they can be accessed from the portal website by operations of developers or by means of web service. Regarding the functionality, this portal website can provide different features for normal user and administrator. From normal user perspective, it is a common platform to visit for different sources with distinctive services. From a technical administrator perspective, it is a web service easy to manage which use unified search, harvesting, tips and other techniques in order to present unify content to users. (Catalin M
1.3 Project Structure

This project has been developed on the basis of two closely linked components, one being academic research and the other comprising of the practical design and implementation. Both of these two elements are dependent on each other. The practice should be based on research understanding and the research would become deeper and deeper during the process of development and implementation of this thesis project. The research undertaken and the technologies applied in this thesis project have been documented in the following chapters.

In this thesis, chapter 2 contains research, literature reviews and theories background that are relevant to the design and development of creating this project. Here related projects have also been documented. Chapter 3 gives detailed introduction of the chosen framework DNN and the advantages and disadvantages in developing the thesis project. Chapter 4 describes the technical design process of the project, such as the aspects of module design and the graphic real-time data. Chapter 5 includes the completed project appearance as well the work been done in Shannon Response Exercise and Chapter 6 concludes the thesis with an overall review of this thesis project and future work.

1.4 Target Users

This portal website is intended for university students, scientific researchers who are interested in the scientific field of marine robot to learn about MMRRC. For example, it will help suitable students to decide whether to study PhD in MMRRC. This project could be applied for commercial goals for interested inventors might use the robots developed by MMRRC for field research.
Chapter 2: Research

2.0 Introduction

Based on the materials coming from years of research in marine robotic field, this thesis project should introduce MMRRC in clear content exhaustively and stress on the main or important scientific inventions and experiments. Thus a complete understanding of MMRRC is necessary before starting the practice project. In addition, this chapter covers brief understanding of CMS as well as some examples. Choosing DNN to design and develop the project in based on certain design pattern. Details on present development situation of DNN and conceptual design pattern are discussed in later section. At the end of this chapter, several related projects are given for author to understand the practice application of DNN. Analyzing the features of each project can be helpful to the design and implementation of this thesis project.

2.1 Background Research about MMRRC

The MMRRC is a research centre at University of Limerick, which was founded prior to 2000, focused on the exercise and experiments in the field of unmanned remote vehicle and undersea payload technologies, both for commercial and scientific purpose.

Researches in the centre initially focused on the development of control and sensor solutions for both mobile-based and land-based, as well as industrial robotic applications. Later, the focus of the research team’s activities gradually evolved from work on land-based systems toward applications of sensor and robotics in the marine robotic domain. In the 2001, the MMRRC commenced development of two vehicles, ‘UMAR’ and ‘Tethra’, for underwater systems
testing and AUV Controller experimentation. Two year later, the centre broadened its research in control strategies for use on autonomous underwater vehicles (AUVs) to incorporate survey mission planning and survey support tools. Today, the MMRRC is the only research centre focused on robotic applications in the marine environment within Ireland as an island nation. A suite of Hydrographic Survey equipment and Unmanned Underwater Vehicles (UUVs) including ROV Latis has been created and developed by the research team in the centre, which can be deployed for commercial surveys and collaborative research and development activities. Figure 1 shows the dry lab and Figure 2 shows the wet lab of MMRRC at University of Limerick. (Mobile & Marine Robotics Research Centre 2011)
With high levels of operational flexibility, ROV Latis is a smart multi-mode vehicle, which can be applied for applications in homeland security and harbor survey, undersea archeology, marine incident response, offshore energy devices, etc. It can not only deploy from small inshore boat but also the larger vessels. The ROV Latis in MMRRC have special features, like fault-tolerant thruster control, high-frequency short range sonar and automatic control modes. Customers who use this robot will significantly reduce the cost of survey and, at the same time, improve the planning and execution.

The MMRRC has a range of laboratory and field test equipment available for research and training purposes in marine technology and industrial automation. This includes a range of mobile and industrial robots, sensor calibration and test equipment, simulators for fundamental research and hardware-in-the-loop testing, and data acquisition systems.
Large volume of pictures, video, publications research results have been collected through years of research. In this case, the MMRRC website needs to be built to publish all the materials collected through research projects over years and the real-time news about any activities in the research centre. It is also designed to disseminate research activities of the centre, enabling visitors to learn about research outcomes of MMRRC, as well as to get access to real-time research data collected from smart monitoring platforms.

2.2 Content Management System

Since 2000 content management has become an important application and development filed, it is when website, B2B and B2C went through the challenge of market. Human went back to the basic level of information technology, that is the improvements of emulate ability which can be obtained by using content management to manage all the data property for enterprise. After that, the enterprise began to realize the importance of content management.

\[ A \text{ CMS is defined as “A collection of tools designed to allow the creation, modification, organization and removal of information from a website”} \]

(Prayas 2008)

CMS, refers to Content Management System, can be used for not only dealing with document management, but also managing pictures, flash, voice video and email. Different from the original website which is unable to update amount of information in real-time and cost more time, human resource and technology to maintain, content management refers to non-technical content contributors can add and edit content through a standard web browser with no IT support. The powerful, new user interface allows users to make changes faster and easier than ever before. In this system, data can be defined as nearly anything, such as documents, movies, picture, etc. CMS controls access to data based on different user roles, aids in easy storage and
retrieval of data, reduces repetitive duplicate input and improves communication between users. Users add or upgrade web page functionality by quickly and easily installing software apps. The integrated apps marketplace makes it faster and easier than ever before to find and install new web site features. The control panel provides a wide range of editing options, allowing users to create pages, install new modules, edit content, and preview pages more quickly and easily. (Niraj et al 2010)

CMS is a software system between web server in front end and the office system or flow system in back end, aiming to make content regulation such as files of documents, audio-video, computer files and web content easily accessible through both inter-office network or via the Internet. The solution of CMS aims to collect, manage, use, deliver and increase the unstructured and half-structured data resources. Developers use CMS to submit, update, approve and distribute content, including files, tables, pictures, data from data base, video and everything needs to be posted on Internet, Intranet and Extranet websites. (Yueguang Ding et al 2008)

As a software system, the CMS is also used for information delivery, including web based system which separates the content of information from the appearance of the information already presented. Usually the information pages are in documents and are organized borders. CMS application allows manager to manage the creation and modification. Content Delivery Application compiles information to update the web site. Both of these are further divided into an outline, organizing the content and appearance template. A native format is used in storing individual content. This kind of format allows creators and maintainers to user familiar software tools for creation and maintenance. There are various subsystems that interact with each other in CMS. Collection is a subsystem to exquisite information and support syndication, workflows and integration of external sources. Management subsystem is responsible for the
management and control of information repositories, definition and controlling. Publishing subsystem in-charge of external digital publications in a semiautomatic or automatic manner through models built upon templates. Once the information needs to be retrieved, an assembly process will gather the content in accordance with the document’s outline and formats as well as the template for the documents. Automated maintenance procedure can be implemented as the data structure allows triggers to be associated with. It is also based on the activation of the triggers. (Baxter S et al 2002)

CMS is widely used in open source community and the commercial market once the communities need to reach large scale, for example, the class support communities or the websites for volunteers’ organizations. Among thousands of CMS, it is important to decide which is the most appropriate in building the websites. With the help of Web 2.0, the website allows more dynamic conversations and content contribution by end-users, like blogs, wiki and forums. Common features of normal CMS are: easy editing, preview before publishing, extendable, various user levels, automatic system updates, etc.

Most features of a CMS include web-based publishing feature which provide a set of templates approved by the organization as well as wizards to modify web content, format management feature to change legacy electronic documents and scanned paper documents into HTML or PDF, revision control feature allows update to new version or restored to a previous version of the website content. Other additional features are indexing, searching and retrieval which make users to search for data conveniently. Having a CMS saves money for the owner do not need to pay the web developer once modification need to be done, such as creating new pages, inactivating old pages without breaking the design or architecture.

A CMS can be embedded into a live website so that the owner can update its content and keep
website organized and comprehensive in case that he has bare minimum knowledge about coding. In many circumstances, whether a personal client or an enterprise needs software packet to install and deploy the system, as well as the design and encryption of the template. CMS is able to separate the workflow and process control tools from the Enterprise Document Management System. One of the most important points is that CMS provides email to detect the signature at the end of documents which are signed by the department, the department or the company. Thus, the same content can be used in different processes. The advantage of CMS is it can increase the development speed and reduce development cost. A professional website with uniform style and strong functions can be built without learning the complex website build technology and HTML language. It is easy to update a website by using CMS because of the separation of the design and the content part in the CMS. Even non-technical users can create a website with CMS. And the change of content separates from the change of design ideas. Other advantages include it allows to work on computer without installation, allows to create/delete new sections and pages on website, allows redirects to pages using the 301 standard and supports the usage of navigation bar. However, one of the most common mistakes is that many CMSs could build overly complex and modeling workflow model which is hard to update once users’ requirements change. In other words, the better choice is using a low-end system. (Myers B et al 2000) Because of the template feature of CMS, different pages cannot have different templates or cascading style sheets. It is as well not appropriate to use CMS for smaller and simple sites.

Currently on the internet, there are over 1000 CMSs available, mostly are open source. For example, Unlike using HTML or web packages, editors using different CMSs might have the similar look and feel although it can reduce the amount of coding, ease the design of user interfaces, allow only developer to customize the interface and support required functionality. (Tiansi Zou et al 2009) Take a discussion forum as an example, only the developers can create
additional functionality in the website using CMS to implement the discussion, rating or tagging. For the end-users, they will not be able to add or subscribe the feed for the discussion post. In other words, developers and end-users have different administration rights and the later are restricted in interaction with the website. Users can act as four roles in a CMS, as a developer to design the website, an owner to have special rights to edit the website as well as to call a designer to do some modification, an administrator to manage the posted content on the website and an end-user to interact with the content and function.

These four roles can overlap with each other and can simultaneously be encompassed by one user. In this case, particular end-user might be not satisfied with the interface or the functionality designed by designer. Therefore, users should be given the opportunities to customize their own interface or give feedback according to their user experience. Just like people like to live in the house which they have taken participate into the design and to arrange things in the way they want, CMS will be beneficial if it supports user customizations.

Following are the examples and brief description of each CMS, excepting DNN.

2.2.1 WordPress

First be released in May 2003, WordPress is currently the most popular used CMS. With the feature of free and open source, WordPress has a plug-in architecture and a template system. It runs on a web hosting service and is based on PGP and MySQL. Themes can be installed through the WordPress Appearance administration tool and users can switch between different themes so that the look or the functionalities can be changed. In additional, the PHP, HTML and CSS code can be added to provide advanced features. (Wikipedia 2013)

The plugin architecture of WordPress makes it extremely popular, which allows users to extend
its functionalities and also offer custom functions and features that specify their websites. Widgets in WordPress refer to small modules offering users sidebar content management and other customization options such as web forms. Multi-user means to allow multiple blogs exist within on installation while still be belonged by a centralized maintainer. WordPress is not only applied for web application, but also for mobile systems, for example, android, iOS, Windows Phone, etc.

2.2.2 Drupal

Drupal is a free open-source CMS as well as a web application framework which is written in the PHP language. Since originally be written by Dries Buytaert as a message board in 2001, now it is developed by an active community with vast users. The Drupal users range from personal blogs to corporate, political, government websites, as well as business collaboration sites. Drupal core, as the standard release of Drupal, supports account registration, menu management, page layout customization and system administration which all of these are common features of CMS. Due to the plug-in extensibility and modular design feature of Drupal, the core can be extended by contributed modules. It is convenient for developers that no programming skills are necessarily required for Drupal basic website installation and implementation although there are programming interfaces. Another feature of Drupal is that it can run on any computer platform that supports a web server is able to run PHP and a database used for storage.

Drupal core includes optional modules which help to extend the functionality of the system. The decision of choosing the specific module is based on the template applied to develop the websites. Different themes which can be used to customize the look and feel in design personal websites are provided as well. Drupal supports more than 40 languages. However, it is difficult
to learn and request frequent security upgrades.

2.2.3 PHP-Nuke

PHP-Nuke is a CMS based on PHP and MySQL used as automated news publishing website, allowing users and editors to post news items on the website and only registered users can comment on the content. Unlike other CMS, the later version of PHP-Nuke is not free. Version 8.1 is only available after pay and only the purchaser of the software is free to distribute the source code.

Modules can be added to the system through an administration interface in order to support additional features and its look and feel can be customized through themes system. Some standard modules are forums, search, and submit, advertising and web links. There are some back draws in this CMS. Security holes have been discovered in SQL injection and some issues with search engine indexes since no simple URLs or unique titles is used for individual page.

2.2.4 Joomla

Written in PHP and using object-oriented programming techniques and software design patterns, Joomla is a free CMS which publishes content on the internet and interacts with a module-view-controller. Date is stored in the database like MySQL, MS SQL or PostgreSQL. Till March 2012, there are over 30 million times download of Joomla which make it become the second common used CMS. Usually Joomla is applied to develop personal homepages, corporate web sites, and social networks. It is easy to install because many web hosts have the control panels which support automatic installation of Joomla or provide information on installing and maintaining about Joomla. Templates are used in Joomla as extension which contain components like layout, color scheme, images and effects and fonts. They are
responsible for the design and structure of the Joomla websites. By using Joonla, developer can easily develop a website for end users. Once more functionalities are requested by end users, there are thousands of function extensions available on the Joomla Extension Directory. The main disadvantage of this CMS is that the changing of layout is difficult.

In this project, a CMS website for MMRC in University of Limerick is built using DNN. Focusing on the operations about content which refers to word introduction, galleries, videos and useful links, this website includes four main models: OceanRINGS, About US, Support and Contact Us. The support technology is ASP.NET and the database is Microsoft SQL Server 2008. As an example of CMS, this website owns exhaustive function although it is simple.

2.3 Present Situation and Development of DotNetNuke

As the proliferation of World Wide Web blogs and the rapidly development of Information Communication Technology platforms, the number of users using internet has grown extremely large. As shown in Figure 3, the ordinate refers to the number of internet users in 100 inhabitants. Almost 80% of the population in developed countries surf the internet. In developing world, one in three people use the internet. (Wikipedia 2013) These kinds of multi-user websites or applications are named as online communities where users can share content, interact with each other.
DNN is a feasible and flexible open source CMS platform based on up-to-date Microsoft.ASP.Net technology. As one of the existing content management system, DNN is built using VB.Net programming languages based on Microsoft ASP.NET. Common Language Runtime(CLR) actually is a new .NET framework with OS-neutral and independent device which is a mass of classes that can be summed up as system classes, data and XML classes, windows and drawing and web classes. In addition, aspects of traditional workstation development in the .NET framework exist and combine with new incarnation of ASP.

DNN was originally initiated at Source forge in 2002 as an open source Web Portal Framework. In January 2002, Microsoft Corp published a platform named the IBuySpy Portal aim to demonstrate ASP.net 1.0. Ten month later, Shaun Walker released a modified version of the original IBuySpy. As the rapid growing of users, on February 28, 2003 it was named DNN. In September, 2006 DNN Corp was created by Shaun Walker with some associates who along
with him for a long time. It is distributed under both a Community Edition BSD-style license and a Professional Edition license with the foundation VB.NET language. (DNN Software 2013) The Community Edition allows access to the source code of framework and basic modules, and an MIT license allowing flexible rights to modify and distribute.

As the fourth generation web-based platform written in VB.net for ASP.net framework, DNN can support and produce complete technical website or system through administration and configuration without necessary traditional programming skills outcome. With the functionality of aspects such as menu and security management, the DNN platform takes the responsibility of host environment which is highly adaptable for developing custom applications with different pieces of management functionality and small readymade components. In this case, it is convenient and quick to implement a feature in the website portal. (Walker S et al 2005)

DNN is always applied to the construction of virtual communities which support human interaction, communication and exchange ideas through internet for social, professional, educational and other aims. Instead of face-to-face meeting which might leads to problem or mistakes, the virtual community provides new opportunities for interpersonal relationships and contributes to the development of knowledge. At the same time, face-to-face meeting depending on the virtual work group can develop new capacities, as well as bring best practices, save time and avoiding mistakes. (Rheingold H 2000)

Basic framework and API is provided for website design and development, including the functionalities of rights and content management. Some modules supported by it can be applied directly. Others are self-definitive which can make it easy for developers to design personal website with extended functionalities. The upload function has successfully separated the content and form so that the art editor and developer can cooperate better as well as increase the
efficiency and quality of the developing process when the designers can more focus on the logic and circuit. With the strong framework in DNN, some modules can be implemented more easily. For in traditional way of designing website, it will take a long time to develop the basic functionalities. One of the most important features of DNN is the totally separation between Data Layer, Data Access Layer, Business Logic Layer and Presentation Layer. Another is the feature of skin in DNN which implements the dynamic outward appearance of individual layers of portal, tab and module. What you see in the tab and module is exactly what you get.

2.4 Design Pattern

Originally design pattern was applied in architecture and first appeared in the book written by Christopher Alexander about the city planning and building design. This idea expressed in the book can be applied in all fields of engineering design, including the software development and design. Later according to the idea of Alexander, a book named Design Patterns: Elements of Reusable Object-Oriented Software was written by Erich Gamma, Richard Helm, Ralph Johnson and John Vlissides. These four writers were known as GoF and their book was regards as the milestone in pattern research. The design pattern can help solve the difficult in designing the reusable object-oriented software for it needs to focus on the problem at present as well as consider the issues and requirements in future, what refers to full versatility. (Christopher A 1979)

In the book of GoF, the definition of design pattern is as follow:

Design Pattern is the description of the class and objects which are used to solve general design problems and communicate with each other under the specific scenarios as well as the abstract solution for the specific issues which repeatedly appear under certain
In other words, design pattern gives a common design for the repeated problems during the design process and the system. It describes the problem, solution, the circumstance to use the solution and the result by giving main points and examples. There are four elements in design pattern. (Erieh G et al 1994)

- Pattern name: Several words to give a brief generalization about the problems, solutions and results. By using the pattern name, the software engineer can discuss the pattern with colleagues and conveniently write the document. It also can help designer to think and the idea and result communications between designers.

- Questions: Description of the situation to use the pattern. It gives an explanation of the certain question to be solved as well as the impacts leading to inflexible design.

- Solution: Explanation about the method to solve the problem and the responsibility, relationship and collaboration of separate part in design pattern. The design pattern acts as a template to solve specific problems in the way of providing issues’ abstract description and how to use common elements combination to solve the problems.

- Result: Description the result after using the design pattern. The result can be the standard to judge the good or bad of pattern been chosen, also the effect on the cost, the benefits, the flexibility and the extensibility. (Pher A 1997)

Software pattern came into appearance as the application of design pattern in software implementation. During the long time practical exercises in software design and organized software management, design pattern provides a thinking template by which can achieve concise and flexible design. In additional, a series of universal, simple and professional words
are created in design, implementation and organization that highly convenient the communication between designers. (Zhiying Zhou 2001) The ideas exchange and chatting between designers during software development process is the key point to decide whether the software project is succeeded or not.

According to the book written by GoF, there are 23 classical design patterns which can be divided into three large classes by their purpose. They are creational, structural and behavioral patterns. Creational ones aim at creating objects with the abstraction of real examples. Structural patterns handle the association of classes and objects. Behavioral ones are responsible for describing the interaction and allocated tasks of classes and objects. (Christopher A 1979) The brief introductions of the 23 patterns are given in Table 1.

<table>
<thead>
<tr>
<th>Creational Design Patterns</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract Factory</td>
<td>Provide an interface to create related or dependent objects without assigning specific class</td>
</tr>
<tr>
<td>Builder</td>
<td>Separate the create and appearance of complicated objects</td>
</tr>
<tr>
<td>Factory Method</td>
<td>Define an interface to create objects</td>
</tr>
<tr>
<td>Prototype</td>
<td>Use prototype to decide the type of objects</td>
</tr>
<tr>
<td>Singleton</td>
<td>Guarantee the unique implement in the whole environment and provide a access point</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structural Design Patterns</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adapter</td>
<td>Transfer the interface into the one users expected and make incompatible interfaces cooperate well</td>
</tr>
<tr>
<td>Bridge</td>
<td>Separate the abstracting and implementation of objects</td>
</tr>
<tr>
<td>Composite</td>
<td>Uniform the usage of single object and combination objects</td>
</tr>
<tr>
<td>Decorator</td>
<td>Add functionalities dynamically with no changes in objects</td>
</tr>
<tr>
<td>Pattern</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Facade</td>
<td>Define an upper interface to integrate a series of interfaces in sub-systems</td>
</tr>
<tr>
<td>Flyweight</td>
<td>Support large amount of fine-grained objects using sharing technique</td>
</tr>
<tr>
<td>Proxy</td>
<td>Control the access to one object by providing a proxy to other objects</td>
</tr>
<tr>
<td><strong>Behavioral Design Patterns</strong></td>
<td></td>
</tr>
<tr>
<td>Chain of Responsibility</td>
<td>Make a chain of all objects and pass on the request until one object handles this. In other words, avoid the coupling between the request’s sender and receiver</td>
</tr>
<tr>
<td>Command</td>
<td>Packet a request into an object that it can be parametric using different requests</td>
</tr>
<tr>
<td>Interpreter</td>
<td>Create a language interpreter to explain the sentences</td>
</tr>
<tr>
<td>Iterator</td>
<td>Provide a method to access aggregate objects in sequence</td>
</tr>
<tr>
<td>Mediator</td>
<td>Give interactive packages using mediating object to decrease the coupling</td>
</tr>
<tr>
<td>Memento</td>
<td>Catch the inner states of an object without destroying the package</td>
</tr>
<tr>
<td>Observer</td>
<td>Design the one-to-many relationship between objects and keep updating once changes happen</td>
</tr>
<tr>
<td>State</td>
<td>Make objects lead to different results with same actions under different states</td>
</tr>
<tr>
<td>Strategy</td>
<td>Packet the algorithm and make it changeable and extensible to system</td>
</tr>
<tr>
<td>Template Method</td>
<td>Define the framework in one algorithm and postpone some steps into child classes</td>
</tr>
</tbody>
</table>
2.5 Related Projects

2.5.1 Customer Management System

Customer management combined with internet has been a common, instant, efficient and convenient technique applied in office software. Based on DNN, this project is built upon website in the style of modules, including designing own database and system testing after the project is completed. All the information should be inserted and stored in the database on web server. The aim of this project is to implement the resource sharing inside of enterprise through the integration of users’ information. Designers use the skin system to change the outward appearance of the applications by creating users’ .ascx controls, defining related .css and .xml files. (Chenghui Yu 2006) In additional, the communication technology inside DNN helps achieve the functionality of connecting between modules.

In the method of software engineering design, the website is designed and analyzed using structuralized method and implemented using prototyped and object-oriented methods. Main functionalities of the website are website-based role-oriented management, basic information maintain, client information maintain, client service and information searching. Under the software environment of Microsoft Visual Studio 2005, DNN and SQL Server 2000, the webpages are commonly divided into four parts. On top of page are the LOGO and the main menu of the whole website. At the bottom of the page lays the copyright of the website. During the middle of the total page, right side is the area of advertisement and the left side is the content
which appears differently according to different management roles. (Linda M 2002) There are two default administrators for managing the website. One is admin who is responsible for the webpages; another is host to manage the deployment of both computer and DNN. The system has some features, like flexibility to keep the long-term vitality and better adjust to several environments, systemic characteristics to decrease the iterations, reliability to withstand the interference outside and quickly recover from damages and economic quality to save the developing cost. (Wei Liu 2006)

2.5.2 Small and Medium-sized express Delivery Logistics System

Delivery logistics system has four foremost functional modules. Basic information management is constituted by system setting, authority design and VIP setting. Express delivery management is responsible for order, settlement and dispatching management. Warehouse management records the in and out of goods, supports real-time search function. Customer service management has customer information, order track and complaints, etc. The open source framework DNN can develop the system’s advantages and features in a more convenient and easy way under the B/S three-layer construction. Technologically, this project uses the standard structure of DNN but extends both on the depth and width of the system, as well as the reusability. SQL Server acts as the database which separates the data and functionalities by allocating data operation in stored procedures. Geographic Information System is based on geographic space database and applied in express delivery for delivery analysis, route planning and facility location. Electronic data interchange refers to the data communication between goods owner, delivery person and other related units. Using DNN and combined with UML and MVC design pattern, this system has loose coupling, flexible extensibility, and free open-source standard. The journal records the message communications between modules which can be divided into two classes, one is for normal event and the other is
for abnormal ones. Based on requirements analysis in all aspects, different modules connect with each other mainly through data and sometimes by characters for the more independent individual module, the better overall structure is. (Dong Wang 2011) The safety of the system relays on the cooperation working between ASP.NET and IIS safety mechanism. Strait system testing is necessary to find and avoid functional, system, processing and coding errors in software design so that no needless lose will happen.

2.5.3 Agile Development Multiple Portal Systems

This project creates the system in agile development method which is different from original development way in the ability to sort out unexpected and sudden changes in software implementing process. Agile development focuses on the cooperation work, face-to-face communication between the tense programmer team, frequent updating of software version and humanity during developing process. Applied the software engineering developing process to this project, the planning period puts forward the main purpose of the project. After giving detailed definition of requirements which is focus on the multi-portals access, the design process gives a corresponding architecture as well as the framework and design manuals. Based on a programming language, designers transform the design idea into clear coding. It is necessary to install all developed modules and skins into the framework. Then is the system testing and maintaining. Without DNN, the multi-portals feature could only be implemented by building a website for each company rely on a basic system and modify the coding for different website appearances. Once combine DNN, the different business logic can be abstracted to get the multiple portals websites. Instead of aspx pages development, this project focus on the user control in modules as well as the extended Ajax functionalities. (Le Gu 2004)
2.5.4 Web2.0-based Knowledge Management Platform

The ultimate goal of the knowledge management platform is to allow users to utilize the existing Web2.0 framework in the area of cooperation, communication and sharing of knowledge, combining with the functionalities of blog, Wiki, forum and IM refers to instant messaging. Most of the disadvantages of traditional projects, for example, the limitation of recessive knowledge development, the weak participation of workers, the tardy updating of new content and the lacking communication and personality, can be avoided in the new platform.

Among the modules of this platform, there are several typical ones to be emphasized. Blog module is the free space for posting personal knowledge, experience, ideas and feelings. Users can write blogs, visit each other and comment to illustrate the recessive knowledge. Wiki module is the platform used for coordinate edition, updating and publish of knowledge.  

(Xiaohuang Xu 2008) Applied the protect measures as version control, page lock, IP forbidden; the content would be more and more perfect instead of wrong modified. Users can give tags to their interested resources to collect, sort and sequent with the abstract module. The related file’s uploading and downloading functionalities are implemented in file management module. During the uploading process, tags or topics could be added to help management. Based on the Push technique, this platform can be personalized as according to the RSS or key word subscription the latest resources will be pushed to clients. This is the RSS subscribing module which simultaneously improves the timeliness and efficiency of information spreading as well as filtrate pointless information.
2.6 Conclusion

By reviewing literature theories, research and projects related to areas of website design based on CMS DNN, the author has gained perspectives for reviewing in the design and development of the website project proposed in this thesis. Goals and initial ideas of the thesis project have been shaped and emphasized throughout the discussion and will direct the author in following practical design that are presented in the following sections.
Chapter 3: DotNetNuke Framework

3.0 Introduction

DNN demonstrates that the open source philosophy has a very important role even in the world of Microsoft and the areas surrounding it for offering role-based authentication and multiplexing across any number of websites in a single installation. All these features are benefits from the N-layer architecture of DNN. DNN framework provides basic functionality such as security, user administration and content management, while modules are used to tailor the website for specific deployment needs. Modules can be placed in almost any areas of the portal and do not necessarily require any HTML experience to be developed for the only real coded page is Default.aspx which can read skin information in URL address. SQL Server technology is most commonly used along with DNN is for it is compatible to most personal digital assistants. (Iwan H 2010)

3.1 4-layer Architecture of DotNetNuke

The latest version of DNN has the features of easy use which provide a completely redesigned user interface and a dramatically improved user experience, improved productivity with the help of new auto-save and recover mechanism, and more advanced development platform. DNN web development platform supports building and exposing secure web services through the service framework which is based on Microsoft’s web API. (Lowe D 2006) More databases can interact with the system much simpler with less code at the same time by using a micro-ORM. Combining with jQuery, jQueryUI and Knockout.js, it is even more easily to consume web services. The overhauled Cascading Style Sheets (CSS) foundation provides easy way to create beautiful website and guarantees the improved cross-browser compatibility, site
performance and the extended standards compliance.

With the extensible and customizable core framework, application modules, skins and other parts, it improves application scalability and maintainability, decreases development cycles, divides administrative options between host level and individual portal level, reduces development costs, and has achieved good results in practical applications. (DotNetNuke Corporation 2013) A comprehensive analysis of DNN framework will be given base on DNN4.0.3.

DNN using typical N-tier architecture, the overall structure contains four layers: Presentation Layer, Business Logic Layer and Data Access Layer and Data Layer. All these four layers make DNN powerful and modernized and easier in identifying components conveniently. Presentation Layer is the layer where forms or interface for our modules exists which refers to everything that we see in the browser for our module. Business Logic Layer is all the backend code for our Modules, named Business Logic stored. Data Access Layer is where we access the database through concrete data providers and application blocks. Data Layer is where data storage. (Egan D et al 2006) The four layers are distributed in the web server and database server. Web server contains the presentation layer, business logic layer and data access layer. Data layer exists in database server. As shown in Figure 4.
3.1.1 Data Layer

A variety of data storage, such as ORACLE, SQLSERVER, MYSQL and ACCESS can be applied in DNN. Data layer which are responsible for providing data to the data access layer has the database tables, stored procedures that as the foundation to achieve all data operations rather than through SQL language or statements. In addition, the stored procedure can exist as database scripts so that it is easy to transplant and modify.

3.1.2 Data Access Layer

Based on differences between different databases, DNN creates an intermediate layer support multiple database operations. Data access layer encapsulates database-related implementation details that provide data services to and receive data from business logic layer. Data layer calls
the stored procedure to the data stored in the data storage device or stores procedure data from
data access layer and then the data storage device will read out and sent to the business logic
layer.

Data Access Layer as a whole corresponds to Microsoft practices and patterns in order to
simplify common data access functionalities for application blocks. Such as reading data from
database to display, obtaining data which pass to application layers, and updating changed data
back to the database storage. (Egan D et al 2006) Data Provider is an abstract class to process
different kinds of database operations. Concrete data providers inherit data provider help users
to write data provider class for any database like Microsoft SQL Server, MySQL etc.

<table>
<thead>
<tr>
<th>Provider</th>
<th>Provider Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>Provides data independence from the database</td>
</tr>
<tr>
<td>HTML Editor</td>
<td>Allows usage of HTML editor</td>
</tr>
<tr>
<td>Scheduling</td>
<td>Execution of scheduled tasks</td>
</tr>
<tr>
<td>Membership, roles, profiles</td>
<td>Permits personalized security management to interact with any other context</td>
</tr>
<tr>
<td>Logging</td>
<td>Service for logging of errors, security, events...</td>
</tr>
<tr>
<td>Friendly URL</td>
<td>Allows the generation of personalized URLs</td>
</tr>
<tr>
<td>Search</td>
<td>Personalize contents indexing</td>
</tr>
</tbody>
</table>

Table 2 Provider Module Utilizations in DNN

One of the important concepts of DNN is most benefit out of the provider model used in
ASP.NET 2.0. Provider model, aims at replacing system’s core functions without modifying it,
consists of the publication of a public API and the separation of the implementation on a
separate module. As more evidence of the vision developed and its growth capacities, DNN used to offer a dual platform version: versions 3.x for ASP.NET 1.1 and versions 4.x for ASP.NET 2.0. Provider model utilizations in DNN are shown in Table 2.

3.1.3 Business Logic Layer

Be defined effectively in the \Components sub-folder, the Business Logic Layer contains various application calling service classes of presentation layer. In terms of data access, business logic layer forwards calls to the appropriate application program interface to each data provider.

The database cannot be accessed through directly but must pass the data access layer. To the data access layer calling, Data Provider classes of data access layer are applied to complete the procedure. The relationship between then the business logic layer and data access layer is of loose coupling since there is nothing to do with the specific data access logic. Realization SQL Data Provider or Oracl Data Provider has slightest relationship with business logic.

The CBO and the CBO Controller is also located in the BLL. CBO which refers to self-defined Custom Business Object in each table in the database encapsulates the data object-oriented technology and provides a great degree of flexibility and independence of application definition within the scope of its own abstract data structures. CBO Controller's is to using data source CBO and CBO Hydrato to complete all function of association between presentation layer and data source. In another word, presentation layer calls CBO to access and transfer data stored in it and CBO controller gets the data from the data access layer and fill CBO by CBO Hydrator. (Egan D et al 2006)

Business logic layer also provide varies services for third-party modules and the kernel. These
services include: Localization, Exception Management, Event Logging, Caching, Personality, Membership& Roles& Profile and Security Permissions.

3.1.4 Presentation Layer

Presentation layer provides application access to the clients, display information and also provides a mechanism to allow the user who has certain permissions to enter or update such information. Presentation layer depends on the business logic above it and CBO and CBO Controller establish a basic interface between the two layers. However, presentation layer cannot call methods of the data access layer directly.

There are five necessary elements in Presentation Layer. They are as below :

- Web forms: Default.aspx, exists in the root installation directory, is the most basic web form page of DNN which should be the entrance of integral application. It is responsible for dynamically loading all elements of presentation layer.
- Skins: The Default.aspx will load the skin for each page based on the portal setting of every page or the whole website. Base class of skins is in /admin/Skins/Skin.vb.
- Module User Controls: Each module should have at least one user control which is the client interface. These user controls are all in the style of .ascx and are loaded and inserted in containers and skins.
- Containers: The Default.aspx will load the container for each page based on the portal setting of every page or the whole website. Base class of containers is in /admin/Skins/Container.vb.
- Client-Side Scripts: The core user controls, as well as the self-defined modules, apply client-side JavaScript. If skins use the client-side JavaScript, it will be in the
installation directory of skins. JavaScript of DNN kernel stores in the folder /js.

3.2 Advantages and Disadvantages of DotNetNuke

The biggest advantage of the hierarchically architecture is flexible which makes the whole system in clear structure and assign individual responsibilities for each level. If the business logic of a database or an application server changes, there is no need to change the client side and verse. In this case, the whole system module has a higher reusability, shorter development cycle and less maintenance costs.

Another advantage is making it clear to divide works and to manage. After finishing define the interfaces between every two levels, developers responsible for different logic design could distract their attention and go forwards synchronously. For example, UI designers only consider the feeling and operation of user interface while another group can focus on the implementation of business logic design. With the confirmation of every developer’s task, the speed of developing progress can increase rapidly.

Inevitably there are some drawbacks of the hierarchical structure. Firstly, it reduces the performance of the system. Without the structure, lots of business can visit the database directly in a shorter time. However, by using caching mechanism, this inference becomes neglected. Secondly, it may cause cascade changes sometimes, especially in the top-down direction. Once the designer wants to add a function in presentation layer, it might be necessary to add relevant code in business logic layer and data access layer. Finally, as the number of CBO increases, the complexity of business logic layer will increase as well for DNN creates a self-defined CBO for each table in database.
3.3 Conclusion

This framework analyzing informs author that having explicit 4-layer architecture is the essential of the thesis project. Personalized design can be implemented by the skin designed and installed into the framework. Before starting design, the development environment has been built by installing SQL that acts at database and IIS as the web server. Deep understanding of the DNN architecture can better help to complete the MMRRC website project and highlight the advantages simultaneously avoid the excess working caused by the disadvantages.
Chapter 4: The Website Design Process

4.0 Introduction

This project has been designed by following guidelines set by the software engineering development process. The software engineering development process is a method where requirements are given at the beginning that combine with UML diagrams and keep changing through the whole process. This process is carried out at five steps circular activities so that designers or developers can analyze and foresee how the software meets with new appear requirements.

As the most important element in DNN, a suit of complete module contains the connection with database and some basic parts for designers to focus on, which are the module interface, module edition and module setting. The most important and difficult technological point that is how to graphically publish real-time data on the webpage has been discussed in this section.

4.1 Design Process

After thorough and exhaustive understanding about the features and requirements of CMS, the development process should take the following five points into consideration.

Firstly, the developing ideas should be determined through the research of the current situation, theories and technologies. Combining specific requirements and features of the MMRRC project, the developing ideas can be analyzed and determined. Secondly, the analysis and determination the detailed system functions need to be implemented by looking through large amount of reference about the MMRRC project and practice researches. Thirdly, it is necessary
to focus on the project as an entirety, such as the hierarchy of the whole system, the architecture of Internet, the division of the function modules, the key point of the technology and the difficult points which are hard to implement. Fourthly, the individually implementation of independent parts should be considered. For example, how to fulfill the corresponding functions of each part and how to obtain the connection and unity between different parts of the system. Fifthly, the integration and test of the system need to be conducted after all the functions and sub-systems has been implemented. By integrating separate function modules into an entire system, repeated testing, debugging and modification, the expected target of the project can be obtained.

The design process and implement flow is shows in Figure 5.

![Figure 5 Design Process and Implement Flow](image)

**4.1.1 Requirements Analysis**

During this period, the requirements and respects about both the researchers in MMRRC at University of Limerick and the majority users of the websites should be collected and determined through questionnaires or fieldworks. Researchers want to manage all the references, data, materials, activities projects conveniently and easily by using the websites since some of them know litter about coding. These materials include word description, pictures, videos and useful links about the marine robots, researches, international projects, experiments and exercises. In addition, the latest news about the MMRRC should be posted
on the websites for visitors to read. For normal users, this website must look clear and comfortable so that they can find the information they want easily. Take all these requirements and respects from several viewpoints into consideration, the websites should be designed to satisfy them as much as possible.

General requirement analysis process includes requirements elicitation, and analysis which is for system models, requirement validation for users and requirement management to form the corresponding documents. The aim is to demonstrate that the requirements define the system that the customer really wants. This process is recursive which means that the requirements keep changing during the whole stage. New requirements emerge during the process as better understanding of the system is developed or the changes of environment or meet some conflicts. The user diagram of this website in UML is shown in Figure 6.

![Figure 6 UML User Case Diagrams of Thesis Project](image)
4.1.2 Module Design

The main purpose of this stage is to give an introduction about general design of the website for MMRRC at University of Limerick, including the overall ideology of development and design, the composition of the system which includes the description about the architecture of both hardware and software, the design of separate modules, the safety design of the system. When it comes to the individual modules design, the log in mechanism, the content scanning mechanism and every module should be described one by one. In this project, besides getting start and contact pages, the website is divided into three main sub systems; they are OceanRINGS, About US and Support. OceanRINGS includes six sub modules which are Overview, Support Vessels, Features, Structures, ROVs and Trails. For About Us module, People, Resource, Researches, Publications and Projects provide detailed introduction and materials about all the activities in MMRC in University of Limerick. Gallery and F&Q modules are included in Support. The integral architecture is shown in Figure 7.
Figure 7 Integral Architecture of Website

As this website is a multi-user oriented website, administrator and normal users have different authority and they will log in different system. Administrator authentication is done on the DNN portal login module, and it is entirely handled by the ASP Membership. User authentication and user management will be processed by the DNN and ASP Membership. If
the user wants to log in as an administrator, the right username and password should be
provided.

4.1.3 Details Design

Based on the module design, more detailed design introduction is provided during this process,
including the description about different classes, how to define the classes and the
corresponding introduction about the class and the parameters.

OceanRINGS part:

- Overview: integral description about the scientific field, products and vehicles in
  MMRRC, including system concept, connections, input devices, visualization, voice
  navigation, auto tuning, implementation, benefits, applications and testimonials.
- Support Vessels: different vessels used in the research centre, Celtic Explorer, Celtic
  Voyager, Shannon One, L.E EITHNE and LEONARDO.
- Features: the interface, automation control modes, absolute DP, Relative DP, Fault
  Tolerance, ROV-SHIP Link and Universal Architecture.
- ROVs serial: LATIS, TETHRA, VideoRay Pro 3 and 4, UMAR and Holland I which are
  the marine robots in research centre.

About Us part:

- People: Research Team which give introduction to main researchers in MMRRC, PhD
  students, Visitors and Previous Members.
  Sensors, Mobile Robotics, Robot Arms.
Publications: Journals, Conferences, Seminars, Workshops, Patents, Press, Awards.

Projects: Active Projects, Completed Projects where Shannon Response in April post, Future Projects and Student Projects.

Support part:

- Gallery: Movies, Screenshots, Pictures, Documents and Brochures.
- F&Q: common questions or uncertainty and answers.

4.1.4 Implementation

According to the detailed design in previous part, specific implementation of the website carry out begin in this process. In another word, this period is to use coding to make the design ideas in previous process into reality website and then fulfill it. Few work needs to be done for integral design idea and how to implement the detailed design have been given already. After building the development environment and the basic frame of the website, the majority work is to collect the materials and content, then assort them by topic or activity or time before publishing on the website for MMRRC.

Content Implementation:

The author modifies the website content only after logging in with the administrator account. When mouse stops over the manage button of the content, the popup menu will come up. Click on ‘Edit content’, it will jump to the document editor. Author chooses either to work with visual editing or just coding. Visual editing has the character of WYSIWYG, which means what you see is what you get. Figures 8, 9 and 10 cover the sequential steps to
implement the content. Combing with MacroMedia Dreamweaver 8, the work will be easier than coding the content as a webpage in Dreamweaver with HTML language before insert into the DNN website.

Figure 8 Content Implementation Step 1
Dr Edin Omerdic received the Dipl. Eng. and M.S. degree in Electrical Engineering from the University of Zagreb, Croatia, in 1997 and 2001, respectively. In 2001 he joined the Mechatronics Research Centre, University of Wales, Newport, UK and took part in the EPSRC funded IMPROVES project. He received his PhD in Electrical Engineering from the University of Wales in 2004, with the thesis titled "Fault Diagnosis and Accommodation for Over-actuated Open-Frame Underwater Vehicles &DQs."

He is employed by the University of Ulster since 1 October 2004 as a postdoctoral research fellow in the Electronic and Computer Engineering Department, Mobile & Marine Robotics Research Centre. He is engaged in numerous research projects funded by the Higher Education Authority and the Marine Institute in the area of mobile robotics. He has started a 7-year post at Ul as a Senior Research Fellow for Ocean Systems Modeling (Charles Parsons Initiative) on 1st August 2007. His research interests include modelling & simulation of dynamic systems (marine platforms, ocean dynamics & disturbances), renewable energy, real-time simulation, virtual reality, development and design of guidance, navigation and control system for marine vessels, neural control systems, implementation of soft-computing techniques in intelligent systems, underwater robotics, fault-tolerant systems. Up to date he has over five published refereed journal and conference papers, two books, ten invited/parallel talks/papers, one desk study and two book chapters.

Dr Omerdic received five awards for his work, including First Prize Winner in National Competition in Mathematics (Sorina, 1985); Society of Underwater Technology (SUT) Prize for Best Multimedia Presentation (GNUM 2001); "Theater Fault Accommodation for Underwater Vehicles", IFAC prize for best oral presentation (MEIND 2003); Fault Detection and Accommodation for ROVs, MARESTE SHI Donald Maxwell Award Prize for Best Journal Paper (2004); "A Rugby Track Keeping Autodesk for Shop Sneaking" and Curricular Paper Contest National Instruments International Competition LabVIEW in the Curriculum 2006 (First Prize Winner) "Virtual Underwater Lab: Efficient Tool for System Integration & USV Control Development".

Figure 9 Content Implementation Step 2 - Visual Editor

Figure 10 Content Implementation Step 2 - Coding Interface
All pictures resource are uploaded and stored in the server of DNN. When designer wants to insert a picture in the article, the code should be like this:

```html
<p><img alt="" src="/dotnetnuke/portals/0/Images/EdinOmerdic.jpg" />
</p>
```

Change the existing picture is conveniently done in visual editor. Right click on the existing picture and chose the selection of ‘Properties’ and choose the new picture after entering Image Manager. If the update picture is not uploaded, the first step is to upload it into the image folder, showing in Figure 11 and 12.

![Image Manager](image-manager.png)

Figure 11 Change Existing Picture Step 1 - Image Manager
Video Implementation:

With a large number of video materials, it is necessary to upload some experiment field video on project website that cooperates with YouTube account. Firstly, author logs in YouTube and upload videos and get the number in the URL address, as Figure 13. The unique number for this video is nUGTX3onaq8.

Then adding the following code in the webpage which contains the number refers to the same
video. Figure 14 is the working sketch of playing the video.

<iframe width="560" height="315" src="http://www.youtube.com/embed/nUGTX3onaq8" frameborder="0"></iframe>

Figure 14 Working Sketch of Playing Video on Webpage

Gallery Implementation:

Gallery module is one of the most common used one that provide fluency way to scan photos. As well as under the authority of administrator, author adds gallery module in the website and click the Manage -> Add New Photo to enter the gallery editor. There are three steps to complete the process.
- Step 1: Choose the album or create a new album, which album designer wants to add the photo into.
- Step 2: Upload Photos that designer can choose one or more photos at one time.
- Step 3: Describe Photos, refers to adding word description for each photo.

The three steps are as Figure 15, 16 and 17.

**Figure 15 Gallery Implementation Step 1 - Select Album**

**Figure 16 Gallery Implementation Step 2 - Add New Photos**
4.1.5 System Testing

System testing is to test the functions of the already done part of the system whether it meet the design requirements or not, to exam the overall arrangement of the website and the flashes on the website page work or not, to test if the pictures can show normally or the video can play correctly, to click the useful link to inspect if it is correct. In addition, testing on some special data such as the threshold is necessary. Based on these tests, some errors might be found and need to be corrected to make the system more complete. Like the requirements analysis period, system testing is a repeated process which will last all the usage. Some corrections should be done as well after obtain the feedback of the website users.
4.2 Personalized Module Design

Module design combines with webpage design consists of the basic organization of webpage management mechanism. Figure 18 is the architecture of webpage management.

![Figure 18 Architecture of Webpage Management](image)

Complete personalized module contains the connection with database and some basic parts for designers to focus on, which are the module interface, module edition and module setting. Graphical User Interface (GUI) is used in module interface which take the user experience into consideration. In this thesis project, the basic color of website is blue to give a feeling of fresh and cool, the feeling of ocean. Module edition covers the edition of word, picture and video content in the module. Classify all the resources in MMRRC and fill them in different designed module. Module setting is the attributes setting of the module and the programming
in this area is the key point in personalized module design. This can be implemented by setting the value of function (String) Setting [“Visibility”] in chosen module. This value will be inserted into the database.

4.3 Graphic Module for Real-time Data

This part of thesis project connects closely to another project named “Integration of Smart Event Triggered Ocean Monitoring Platform with SmartBay” undertaken by Admir Kaknjo, who is a PhD student in MMRRC. With the ROV system (VideoRay) that can be controlled through remote interface with network to inspect and observe the area around the data buoy, this platform will be equipped with sensors and measuring equipment, as well as two way high-speed data exchange communication device. This event triggered monitoring platform will be deployed near the wave energy site located at the south offshore of the Spiddal to conveniently take use of the Wi-Fi Mikrotik equipment for streaming the data and sending commands of the existing SmartBay infrastructure in Galway Bay. Figure 19 shows the relative position of the platform and the existing SmartBay, on the left side is the smart event triggered monitoring platform of Admir and the right side is the SmartBay data buoy, already deployed in Galway Bay. Network, GSM and radio communications infrastructure provide technology to support multiple interfaces to access the data from remote location, as well as relay of data back to server in MMRRC lab.
Regarded as an ongoing project started in October 2012, it hasn’t been completed yet and no live data have been collected and transferred to the server. On the website of thesis project, the author uses another similar example that is Irish Marine Weather Buoy Network to demonstrate how it will work after the based project finish. (Marine Institute 2013)

The latest 24 hours data will be gained from the server which collected by the data buoys plotted in different direction and be written into a CSV file that is used for import in graphic module. Before implementation, the author should get the authority of using graphic module by purchasing form DotNetNuke Company and install on the server. Choosing graphic module to create a new module in one page and then get in the setting page, the author can
choose either line graph, bar graph or pie graph to visualise the data. During the editing step, the CSV file that contains the data needs to be chosen and imported into the module. Figure 20, 21 and 22 shows the steps.

Figure 20 Choose Graphs Module to Create New Module
Figure 21 Setting of Graphs Module and Choose Graph Type

When completed, as Figure 22, the data will be inserted to produce the graph automatically, which also simple the work of the author. The latest integral table of data that daily read from the server will be straightly shown under the map of the data buoys, as Figure 23. Users can click on each data to access to the detailed data and the graph by linking to a child page that at the top of the page is the hourly data gaining from the database on the server and the bottom is the corresponding data graph, as Figure 24. There is also a link on the child page that users can click to go back to the data table page.
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Figure 22 Data Inserted After Importing CSV File
Figure 23 Integral Data Table page
4.4 Conclusion

This design process almost decides the basic framework and structure of the MMRRC website. Variable requirements lead to a circular design process. During the design and development, previous work to be done might be modified or totally negated. Thus express and necessary requirements purport effective implementation.
Chapter 5: Project Implementation and Display

5.0 Introduction

Different contents are filled in the initial website after the design process. According to the three modules in the main menu of the website, author updates the materials in corresponding modules and sorts them by date, including some video and photo research resources. The exercise took place in the middle of April is also a part of the thesis project. Details on the implementation and the field exercise have been given in this section.

5.1 Project Implementation

5.1.1 OceanRINGS Module

Figure 25 is the implementation of OceanRINGS module. Children classifications under these six parts in OceanRINGS module cover the related contents and keep refreshing with latest materials.
5.1.2 About Us Module

Figure 26 shows the About Us module. When mouse stay on the label, child menu appears and users can visit personal page through the research team page as well as directly from the child menu by click the researcher name.
Figure 26 About Us Module
5.1.3 Gallery Module

Four steps need to be done if users want to scan the photos in the gallery. Click on the cover of each gallery to get in the gallery list. Choose the gallery want to scan, the page will jump to the photo list and click on each photo it will show in full size. Figure 27 shows the four steps of the operation.

Figure 27 Gallery Module

5.1.4 Contact Module

Insert the Google Map API into the website within the contact module. Users can grasp the exactly geographical location of MMRRC with the help of zooming in and zooming out the electrical map. Figure 28 is the map on website.
5.2 Shannon Response Exercise

In April, the research team has attended the exercise named “Cathach” in Shannon Estuary to simulate oil leak from the ship and identify the source of escaping fuel oil and response. The exercise lasted 2 days over the 17th and 18th of April 2013. This exercise was not an actual real event. This was a large-scale training exercise which has been created to simulate a real-to-life disaster in order to demonstrate effectiveness of remote sensors and to train personnel in the event of a real oil/chemical spill at sea. And to prompt action minimizes the impact once oil spill happens. A command centre was built nearby and colleagues from University of Limerick were responsible for sending the video shoot by the camera installed on the ROVs to the computer in the centre and attaching time stamp to live videos, sorting them by time, saving them and uploading to the temporary website for visitors to download during the exercise. After the exercise, the temporary website was integrated to the main MMMRC websites.
In dirty and dangerous environment, air and sea going robotic vehicles could provide new capabilities to operate which was impossible for human to complete. With the help of networking technologies, existing assets and new robotic systems and sensors are be enhanced for situational awareness and intervention. At the same time, new command & control and visualization tools can provide new capabilities for the coordination of existing assets, robotic systems, sensors and human operators over inter-operated networks. In this Shannon Response ROVs from MMRC in the University of Limerick would be deployed to investigate the damage to the ship’s hull and to identify the source of escaping fuel oil from the ship.

Exercise ‘Cathach’ was a Command Room Strategic Exercise with a real time interface to many external participants and interaction with live field operations. The principal entities involved in Exercise ‘Cathach’ were SEA-PT (including all SEA-PT stakeholders), NETMAR and the Irish Coast Guard. Northern shores of the outer reaches of the Shannon Estuary were the location of this incident. The 42,000 ton vessel 'Maire Noire', after suffering damage in a storm 40nm west of Kerry head, has lost steering while entering the Shannon Estuary and has grounded on five fathoms rock, which are 2km south of Corlis Point.

As it shows in Figure 29, 'Maire Noire' with a slight of port carried a significant amount of bunker oil, which partly was reported to be spilling into the sea. The area surrounding the ship was a special area of conservation, thus fast response and cleanup efforts should take precedence immediately.
The aims of this Shannon Response Exercise were as following: -)

One is to plan and execute a coordinated emergency response by simulating pollution leaking of hazardous and noxious substances. Another is to deploy emerging technologies for detection and monitoring pollutants, demonstrate the specific capabilities and evaluate their merits in an operational setting.

Limerick University’s ROV LATIS was deployed to investigate the damage to the ship’s hull suffered in the storm as well as by striking with Five Fathoms Rock, and to identify the sources of escaping fuel oil as it was extremely dangerous for manned diving in the poor underwater visibility, unknown locations, strong currents and uncertain hazardous substance. ROV LATIS would be assisted by Small unmanned robotic aircraft (UAVs) which launched and controlled from a temporary command centre (see Figure 30). Other vessels such as AUV with side scan sonar assisted in the search operation.
5.2.1 First Day

During the first day, a command centre at Moneypoint power station has been established where participants managed and directed the response effort in response to the grounding of the vessel ‘Marée Noire’. The Oil-map Web system has been operated by Shannon Estuary Anti-Pollution Team in collaboration with SFPC to track and predict the extent of the spill within the estuary accurately. Real-time data such as location, amount & type of oil, latest wind and current forecasts have been utilized to give details of trajectory and weathering results.

Irish Lights' vessel ILV Granuaile and the Irish Naval Service LÉ Orla have been tasked to the scene to assist in operations, being used as a launch platform for some of the remote sensor vehicles such as ROV and AUV. Low cost GPS tracking devices have been issued to the various ships by making use of existing mobile phone GSM networks operate at 900MHZ. The trackers transmit an updated GPS position to a web based database every 5 seconds. These data feedbacks were fed into a live map which was available through web address and was being displayed in real-time at the command centre.

Figure 30 ROV, AUV and UAV in Shannon Response Exercise
ROV LATIS from University of Limerick has located one of the two missing deck cargo containers at 15MSW depth under the sea. By using forward looking sonar configuration with high resolution multi-beam mounted at 90 degrees to the seabed, the ROV LATIS has searched and located the deck cargo after a couple of minutes. The use of forward looking sonar has allowed for distances of up to 120 meters to be mapped with a high degree of accuracy, minimizing time used for large area surveys. The sonar and onboard camera video streams from ROV LATIS were transmitted in real-time back to the command centre over Wi-Fi link, guaranteeing that this information can be assessed immediately and used for fast effective response ultimately. Figure 31 is the photo taken during the exercise in the commend centre.
This high resolution sonar data can not only give an accurate picture of the intact hull on the vessel, but also give an image of how the ship lies on the seafloor. Such surveys can be of particular interest when it comes to recovering the vessel or if the vessel is in danger of moving - such as in the case of the Costa Concordia.

5.2.2 Second Day

On the second day, large boom equipment has been loaded onto the ILV ‘Granuaile’ which has been tasked to operations 2km off Querrin Strand. Irish Coast Guard have confirmed that a number of potentially dangerous chemicals, such as Formaldehyde and Acrolein, have begun to leak into the surrounding environment. Originally it held as deck cargo on the
‘Marée Noire’ and located at a depth of 15MSW close to five fathoms rock. UAV FALCON, a sea robot under the development in NUIM, has completed a survey of Querrin Strand and surrounding area. The high resolution map which has been produced is being distributed to up to 150 personnels on the shore who have been assigned to help cleanup operation surrounding Querrin Strand.

200 meters of heavy boom equipment have been deployed at sea 2kms offshore and the oil and chemical slick has been contained. The collection of the contaminants is expected to take some hours. In addition, Queerin Creek has been protected from the incoming oil using sections of boom and another collection point has been established close to Querrin Strand. At the end of the second working day, cleanup operations on Querrin Strand are expected to take some time as well.

5.3 Conclusion

Some practical problems will arise during the implementation process. As a time-cost working, it is a challenge of patient and focus. Large amount of cumbersome work needs to be done by the author. Modification about the layout of the website has taken place after the discussions with both the users and researchers.
Chapter 6: Discussion and Conclusion

6.1 Introduction

The thesis has documented research, design and development of the author’s website project. This thesis project has been based on the design on relevant research conducted and related projects analyzed. This section provides the findings from this project, as well as the conclusion and future work has been put forward.

6.2 Discussion

Paying considerable attention to the layout and aesthetic quality of the website content was an important factor to attract and entice potential visitors the website. Varied modus of research materials published on the DNN website engraft the knowledge of MMRRC to visitors in different aspects that help them better understanding. The video representing field experiments rather than pure words description attracts more visitors.

Deep understanding of the research in MMRRC that this thesis project based on decides the content structure of the website. Marine robotics machines in MMRRC can be applied in research area to develop latest and unique functionality that might be the breakthrough in scientific technology, in the area of national undersea security, as well as the economic goals. The author filters the attractive main points and layouts them in noticeable module on the website in case visitors can easily acknowledge them.

Implementation of the thesis project cannot be completed if there is no clear DNN architecture and developing theories basis. The website acts as a client that installed on
remote PC and all actions can be taken on the client PC, including the administrator log in and modify the website. DNN structure is built on the server PC in the lab of MMRRC. Cooperation with the modules in DNN, the photos are shown on the website with mature flash animation, the real-time data transported to the server in lab through wireless communication appear on the website with graphic style.

6.3 Future Work

Based on the user evaluations and feedback from the supervisors, the following future developments have put forwards in three aspects: completion, graphical module and refresh.

- Being a student project, time and ability were common constraints with general limitations that initial concept. The thesis website has been built as opened to public but there are still lots of work to be done. Some modules still have not been fulfilled and these should be done in the coming time to consummate the website. In addition, the author would like to keep modifying the website according to user’s requirements to improve the performance and user satisfaction come attached. The author has to accept time constraints while maintaining the integrity of the

- The installation and application of graphic module gain the functionalities of showing static data. Data of undersea pressure, temperature and depth collected from the marine robotic machine in Galway are real-time transformed to the server in MMRRC lab. After change the data into CSV file and insert into the module, the static data can be shown on webpage in graph. How to show the real-time data on this website using graphic module is a breakthrough and difficult in future work.

- Another element in future enhances is the theme of refreshing website content according to the latest research and news in MMRRC. As the project completed, the content is all
research materials until now. It will be convenient for non-coding designers to refresh the website with the help of modules in DNN.

6.4 Conclusion

At the beginning of this paper, the author characterized the aims and objectives of the entire thesis. The aim of the project was to build a portal website for MMRRC at University of Limerick with DNN that attempted to cast real-time data, photo and document materials and experiment videos on the website. Before starting practice development, the author examined literature, related projects and conducted extensive research, analysis the software development process to shape the final design and implementation. As a web application designed based on DNN, this thesis project has better application layer architecture, clear structure, well extensive ability and convenient maintain. During the development process, full reuse has saved lots of work in framework design, module design and extended coding architecture within modules.

Undertaking this thesis has highlighted the importance of good research being conducted into the surrounding projects by studying academic publications, case studies and related work. These help author to understand the issues behind the project. The author learned to cooperate with team members, to solve the problems meet with patient and active attitude. Having understanding design and development process by her, the author thoroughly enjoyed taking on the challenge of this thesis to design a portal website for MMRRC that helps potential users to better understanding of MMRRC at University of Limerick. After this project, the author has also gained strengths and experience in the area of CMS website design.
Chapter 7: Reference


CONTENT MANAGEMENT SYSTEMS’, Computer Engineering and Information Technology Shobhit University, Meerut, India Vol. 1 No. 4 267-276.


Appendices

Appendice 1 Abbreviations

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<td>DotNetNuke</td>
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<tr>
<td>MMRRC</td>
<td>Marine Robotics Research Centre</td>
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<tr>
<td>HTML</td>
<td>Hyper Text Markup Language</td>
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<td>Extensible Hyper Text Markup Language</td>
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<td>Content Management System</td>
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