Searching for Compressed Natural Gas (CNG) Fuel Station using Geographic Information System (GIS) on Pocket PC

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Abstract

The purpose of this research is to analyze, design, and develop the Searching for Compressed Natural Gas (CNG) Fuel Station using Geographic Information System (GIS) on Pocket PC for ordinary users. The development of this system is composed of two parts. The first part is to design and develop database on server appropriately for searching CNG Fuel Station. The second one is to design and develop application on Pocket PC that can search the shortest route from user location to CNG fuel station by using Dijkstra's algorithm that is part of this procedure. The way is using server to collect all information about CNG Fuel Station that users can search the information easier. And the system can show location of CNG Fuel Station on GIS format with all information on the Pocket PC.

Keyword: Geographic Information System (GIS), Compressed Natural Gas (CNG), Pocket PC, Unified Modeling Language (UML)

1. Introduction

Geographic Information System (GIS) is technology which integrates hardware, software, and data for importing, collecting, capturing, managing, analyzing, and displaying all forms of geographically referenced information. It can provide a great deal more problem-solving capabilities and management in geographic data.

By capabilities of integrating various data format so GIS is applied to be a tool for traveling. It can help making right decision.

Nowadays, there are not enough CNG fuel stations for the growing demand for them. So the searching for CNG fuel station system comes more important for people who would like to use CNG and entrepreneurs of many stations. It provides convenience for locating CNG fuel stations on GIS format.

Pocket PC is now a popular handheld-sized computer because it can function as mobile phone and has low price. Therefore, it's one of choices to use with this system.

The goal of this research is to develop the application on Pocket PC for searching for CNG fuel station by using GIS technology. The development of this system proposes collecting all CNG fuel station information in server. So administrator can add, edit, and delete data via website. Users can download up-to-date data via their Pocket PC. In the part of the application, it will be designed that users can use easily to search data. It can show location of CNG fuel station on GIS format with all information via Pocket PC.

2. Literature Review

2.1 Personal digital assistant (PDA)

Personal digital assistant (PDA) is a handheld device designed to facilitate organizational ability from a mobile platform. In this moment, PDAs can be categorized by currently operating system (OS) such as Palm OS, Windows Mobile, iPhone OS, etc. PDA using Palm OS is usually called Palm as its OS name. And PDA using Microsoft Windows Mobile OS is usually called Pocket PC.

A Pocket PC has many of the capabilities of personal computer (PC). It's composed of hardware, software and accessories. Some of these devices include mobile features. Pocket PCs can also be used with many other add-ons like GPS receivers, barcode readers, RFID readers, and cameras. All of abilities are provided by Microsoft Windows Mobile OS [7], [8].

2.2 Geographic Information System (GIS)

Geographic Information System (GIS) is technology which integrates hardware, software, data, and people for importing, collecting, managing, analyzing, and displaying all forms of geographically referenced information. It can provide a great deal more problem-solving capabilities and management in geographic data.

GIS consists in 5 parts which are hardware, software, methods, data, and people. There're described in detail as follows.

2.2.1 Hardware: Computer, hardware, and accessories that used for importing, compiling, and displaying data.

2.2.2 Software: Software programs that have tools for importing and editing data, managing database, analyzing, and emulating such as Arc/Info, MapInfo, etc.

2.2.3 Data: Data which used for GIS is collected in database system.

2.2.4 People: People that concern in GIS such as database administrator, technician, system analyst, etc. People are considered as the most important part of GIS.

2.2.5 Methods: Methods are the ways that organizations use GIS appropriately for responding requirements [4], [9].

2.3 Dijkstra's algorithm

Dijkstra is an algorithm that solves the single-source shortest path problem for a directed graph with nonnegative edge weights and often used in routing. This algorithm was named after its discoverer, Dutch computer scientist Edsger Dijkstra.

The algorithm can find the path with the shortest path between that node and every other node. It can also be used for finding costs of shortest paths from a single node to a single destination node by stopping the algorithm once the shortest path to the destination node has been determined. For example, nodes of the graph represent cities, bus stop or gas station and edge path costs represent driving distances between pairs of them that are connected by a direct road, Dijkstra's algorithm can be used to find the shortest route between one place and all other places [10].

2.4 Web Services and XML

Web service is web-based application that can be used to exchanged data between different platforms and programming languages by using the XML (Extensible Markup Language), SOAP (Simple Object Access Protocol), WSDL (Web Services Description Language) and UDDI (Universal Description, Discovery and Integration).

XML (Extensible Markup Language) is markup language simplified from SGML. It was developed by W3C for communicating between different operating systems or applications especially transferring data via internet [5], [6], [7].

3. System Development and Design

The research consists in 7 steps as follows.

3.1 Algorithm of searching for CNG fuel station in Bangkok

3.2 Studying and searching for locations of CNG fuel station

3.3 Studying technologies that concern in this system.

3.4 Analyzing system requirements and designing database, user interface, output, and system process.

3.5 Developing website application and application on PDA.

3.6 Testing and debugging system.

3.7 Documentation

The algorithm of searching for CNG fuel station in Bangkok aims for finding the shortest path from current position of user to the destination (CNG fuel station). This algorithm was applied from basic knowledge of mathematics and Dijkstra's algorithm.

The algebraic equation to find the distances between pairs of nodes, as follows.

$$L = \int_{x_1}^{x_2} \sqrt{1 + y'^2}\, dx \tag{1}$$

$$= (x_2 - x_1)\sqrt{1 + a^2} \tag{2}$$

$$= (x_2 - x_1)\sqrt{1 + \left(\frac{y_2 - y_1}{x_2 - x_1}\right)^2} \tag{3}$$

$$= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}\,, \tag{4}$$

L = Distances between pair of nodes

X1 = Latitude value at node 1

X2 = Latitude value at node 2

Y1 = Longitude value at node 1

Y2 = Longitude value at node 2

Dijkstra's algorithm

It should be noted that distance between nodes can also be referred to as weight.

1. Create a distance list, a previous vertex list, a visited list, and a current vertex.

2. All the values in the distance list are set to infinity except the starting vertex which is set to zero.

3. All values in visited list are set to false.

4. All values in the previous list are set to a special value signifying that they are undefined, such as null.

5. Current vertex is set as the starting vertex.

6. Mark the current vertex as visited.

7. Update distance and previous lists based on those vertices which can be immediately reached from the current vertex.

8. Update the current vertex to the unvisited vertex that can be reached by the shortest path from the starting vertex.

9. Repeat (from step 6) until all nodes are visited.

The algorithm of searching for CNG fuel station in Bangkok has steps as follows.

1. Identify coordinate at current position

2. Identify zone from derived coordinate

3. Search for CNG fuel stations in identified zone and neighborhood

4. Create a list of CNG fuel stations

5. Find three shortest path coordinates of CNG fuel stations by using radius that measured from current position

6. Finally, find the shortest route by Dijkstra's algorithm

In part of system analysis and design, it can be summarized the system requirements by use case model, see picture 1.
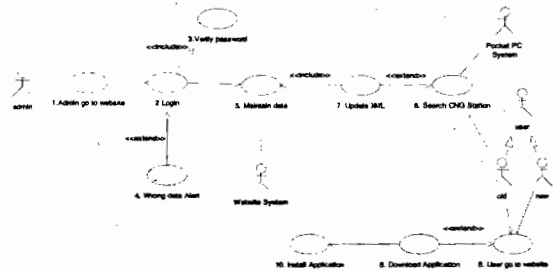

Picture 1 Use case diagram

Once the use case diagram is complete, use case description will be used for describing the use case diagram, for example see picture 2.

| Use case Name : Admin go to website	ID : 1
Primary Actor : Administrator	
Stakeholder and Interest :	
Administrator: Administrator enters URL for managing information of CNG fuel stations.	
Brief Description: Displaying website for administrator to maintain the information of CNG fuel stations.	
Trigger: When administrator would like to manage information of CNG fuel stations.	
Type : External	
Relationship :	
Association : Administrator, login	
Include :	
Extend :	
Generalization :	
Pre Condition: When administrator would like to manage information of CNG fuel stations.	
Normal Flow of Event:	
1. Administrator enters URL.	
2. Welcome page will be displayed if URL is correct.	
3. Administrator clicks "Maintain Data" button to enter Login page.	
Post Condition : Login	
Alternate/Exception Flows :	
a: Close Website	

Picture 2 Use case description

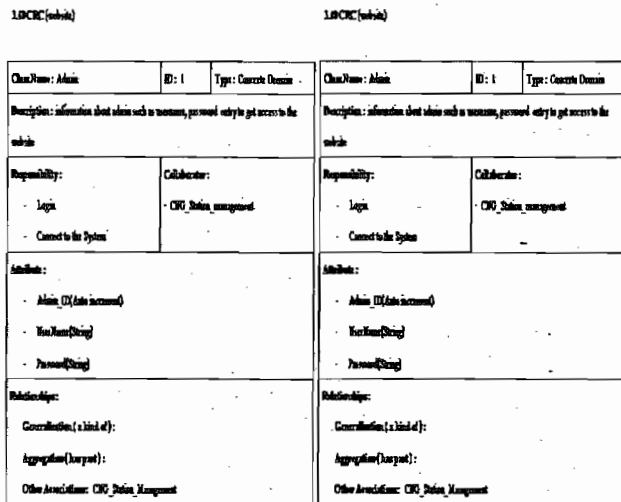Next there is the activity diagram which is analyzed from use case description, see picture 3.
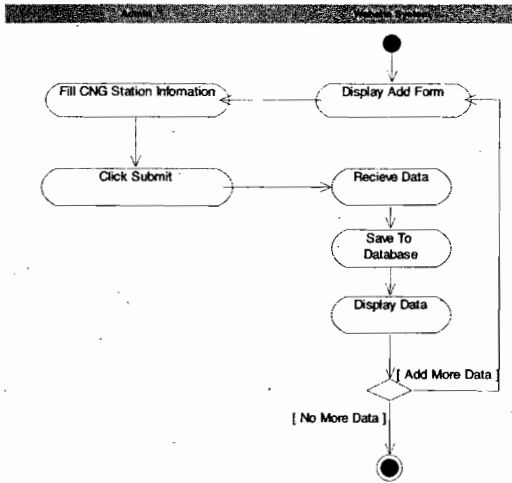
Picture 3 Activity diagram

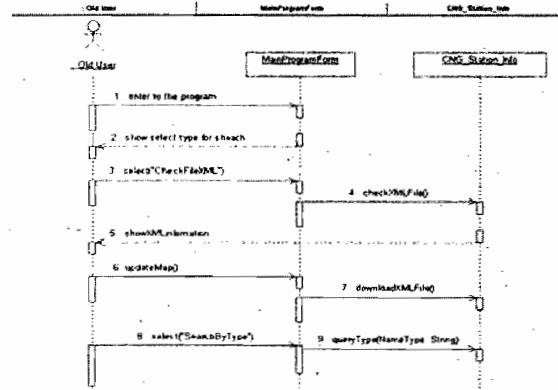The next stage is domain class (see picture 4) and CRC (Class Responsibility Collaborator) (see picture 5)
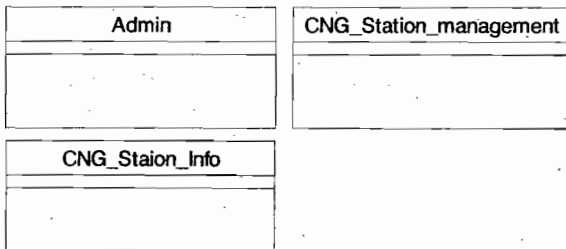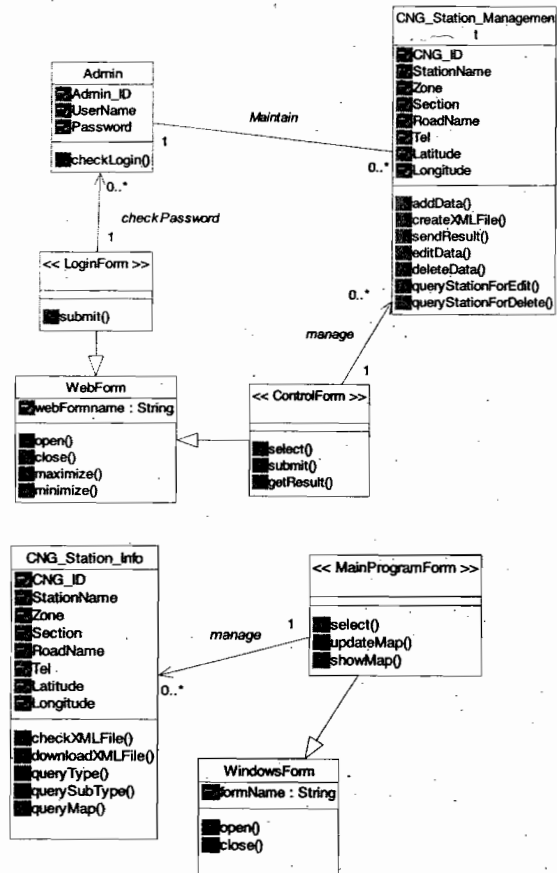

Picture 4 Domain class

Picture 5 CRC

The next stage is sequence diagram which is analyzed from activity diagram and domain class, see picture 6.
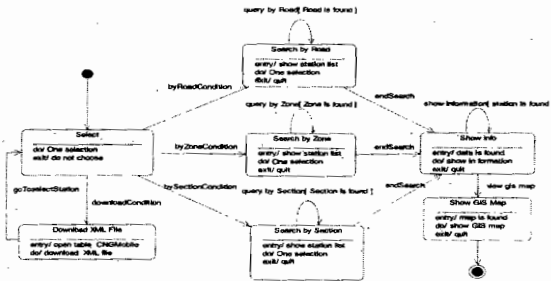

Picture 6 Sequence diagram

Once the sequence diagram is complete, the next stage is class diagram, see picture 7.

Picture 7 Class diagram

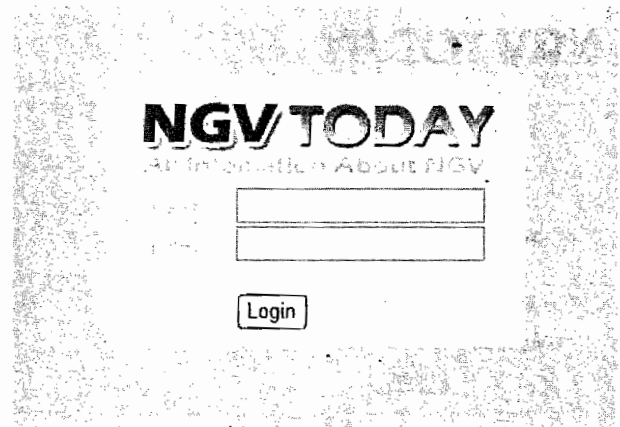The final stage is state diagram which used for application development. For example see picture8

Picture 8 State diagram of CNG_Station_info class

4. System Implementation

This system development achieves in responding requirements both of users and administrators. Administrators can easily add, edit, and delete data. Users can search for CNG fuel station conveniently.

The system has 2 parts. The first part is website and the second one is application on Pocket PC, see picture 9 – picture 14.

Picture 9 Login page

Picture 10 Main page

Picture 11 Page for adding CNG fuel station data

Picture 12 Page for editing CNG fuel station data

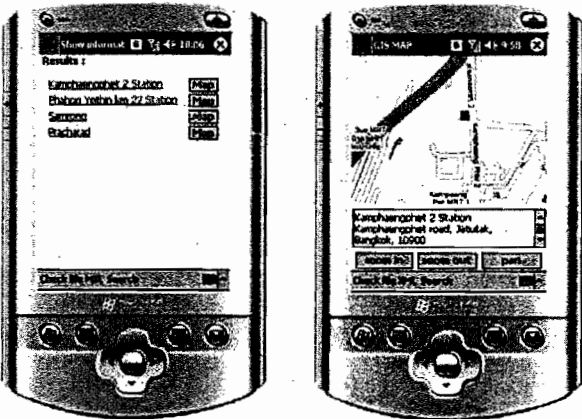**Picture 13** The process on Pocket PC

Picture 14 Displaying list of CNG fuel stations and

GIS map

5. Summary

This research applies GIS and Pocket PC technology to reach the aim that user can easily search CNG fuel station. And the future development is intended to make the application more capabilities and functions such as considering in traffic flow, guiding appropriate way considered in driving directions, searching for famous places, and recording favorite places. So it will be easier to make a decision for travel.

6. References

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