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MAP ONLINE SYSTEM USING INTERNET-BASED IMAGE CATALOGUE

(SISTEM PETA ATAS TALIAN DENGAN MENGGUNAKAN KAEDAH KATALOG IMEJ BERINTERNET)

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ABSTRCT

Digital maps carry along its geodata information such as coordinate that is important in one particular topographic and thematic map. These geodatas are meaningful especially in military field. Since the maps carry along this information, its makes the size of the images is too big. The bigger size, the bigger storage is required to allocate the image file. It also can cause longer loading time. These conditions make it did not suitable to be applied in image catalogue approach via internet environment. With compression techniques, the image size can be reduced and the quality of the image is still guaranteed without much changes. This report is paying attention to one of the image compression technique using wavelet technology. Wavelet technology is much batter than any other image compression technique nowadays. As a result, the compressed images applied to a system called Map Online that used Internet-based Image Catalogue approach. This system allowed user to buy map online. User also can download the maps that had been bought besides using the searching the map. Map searching is based on several meaningful keywords. As a result, this system is expected to be used by Jabatan Ukur dan Pemetaan Malaysia (JUPEM) in order to make the organization vision is implemented.

ABSTRAK

Peta digital adalah imej yang bersaiz besar disebarkan formatnya yang berlainan serta ia membawa sekali maklumat geodata yang penting dalam sesuatu peta topografi. Maklumat biasa yang dibawa dan bermakna adalah seperti koordinat yang penting terutamanya bagi kegunaan dalam bidang pertahanan. Disebabkan oleh imej peta topografi dan tematik yang bersaiz besar, maka wujud masalah lain yang berkait iaitu ruang storan yang tidak mencukupi serta masa muat turun yang lama. Disebabkan oleh masalah ini, maka peta tidak sesuai diaplikasikan di dalam pendekatan catalog imej dalam persekitaran internet. Namun begitu, dengan adanya kaedah pemampatan, saiz imej dapat dikurangkan manakala kualiti imej juga masih terjamin tanpa banyak perubahan yang dapat dilihat dengan mata kasar berbanding imej asal. Ruang lingkup kajian bagi laporan ini adalah tertumpu kepada satu teknik pemampatan imej menggunakan teknologi wavelet. Teknologi wavelet adalah lebih baik berbanding teknologi pemampatan yang lain. Hasil daripada pemampatam imej dengan menggunakan teknologi tersebut kemudiannya diaplikasikan ke dalam satu sistem yang diberi nama Sistem Peta Atas Talian. Sistem ini menggunakan pendekatan Katalog Imej Berasaskan Internet. Sistem yang dibangunkan ini membolehkan pengguna membuat pembelian peta secara atas talian. Pengguna juga boleh memuat turun peta yang telah dibeli selain dari melihat paparan serta melakukan carian peta. Carian peta adalah berdasarkan kepada beberapa kata kunci. Sistem yang dibangunkan ini diharapkan dapat membantu Jabatan Ukur dan Pemetaan Malaysia (JUPEM) dalam merealisasikan piagam permodenan yang menjadi salah satu visi utamanya.

CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

Internet-based Image Catalogue was a catalogue system by using searching method on catalogue medium such as texts or keywords for books, author, and publishing date and so on. The catalogue system applies small graphics as a map to actual objects in system. Small graphics contained a low quality image that refers to actual and make it easier to deliver on-line. Almost the system located in Local Area Network environment.

Increasing number of development in information technology and Internet helps a lot of applications implemented as web based system as Internet-based Image Catalogue. For instance, the web based application system like Map Online System Prototype using Internet-based Image Catalogue to represent the actual map images in system. This system is very powerful especially for technical people that involved in Geographical Information System. Main problem is the limited storage capacity to store very big size of map images. Normally, image data presented as GIF and JPEG format in Internet. Quality of the images data must be preserved as good as possible. The economic way to store images data with small size and maintains the quality is by compression technique. Images data must be compress first to cut out the size of actual image. Wavelet is the mathematical function that will be used as the compression method to compress map images in Map Online System Prototype.

Uncompressed images data require considerable storage capacity and transmission bandwidth. Despite rapid progress in mass-storage density, processor speeds, and digital communication system performance, demand for data storage capacity and data-transmission bandwidth continues to outstrip the capabilities of available technologies. The recent growth of data intensive digital audio, image, and video (multimedia) based web applications, have not only sustained the need for more efficient ways to encode signals and images but have made compression of such signals central to signal-storage and digital communication technology.

Although an international standard for still image compression, called 'Joint Photographic Experts Group' or JPEG standard has been established by ISO and IEC, the performance of such coders generally degrade at low bit-rates mainly because of the underlying block-based Discrete Cosine Transform (DCT) scheme. More recently, wavelet transform has become a cutting edge technology for image compression research. It is seen that, wavelet-based coding provides substantial improvement in picture quality at higher compression ratios mainly due to the better energy compaction property of wavelet transforms. Over the past few years, a variety of powerful and sophisticated wavelet-based schemes for image compression, as discussed later, have been developed and implemented. Because of the many advantages, the top contenders in the upcoming JPEG-2000 standard are all wavelet-based compression algorithms.

The goal of this article is two folds. First, for readers new to compression, we briefly review some basic concepts on image compression and present a short overview of the DCT-based JPEG standard and the more popular wavelet-based image coding schemes. Second, for slightly more advanced readers, we mention a few sophisticated and popular wavelet-based techniques recently developed including one we are currently pursuing, as well as the upcoming JPEG-2000 image compression standard, which is going to be wavelet-based.

1.2 GENERAL PROBLEM STATEMENT

Digital maps carry along its geodata information such as coordinate that is important in one particular topographic and thematic map. These geodatas are meaningful especially in a military field. Usually, the size of this map is big and need a big storage to store this data in the database. Thus, its will take more time for data downloading process using an image catalogue approach on the internet. According to time consuming and data transmitting factor, we used an image compression techniques to solve the problem. With image compression techniques, the storage size of the image can be reduced without affected the quality of the image [1, 2, and 3]. This research focused on image compression techniques using wavelet technology. As a result, the compressed images will be applied to a system called Map Online.

This section provides a high level description of the steps that must be performed by a compliant implementation of the versatility stressmark. Algorithmic details are intentionally left unspecified to allow implementations to make use of architecture-specific features. The minimal requirements described in this section are necessary to ensure that different implementations perform equivalent functions and that reasonable inferences can be drawn from benchmark results.

A compliant implementation of this stressmark will be required to perform the following four standard steps: wavelet transform, quantization, run-length encoding, and entropy coding (see Figure 1.0). While this requirement is necessary to guarantee that implementations are performing comparable work, implementers are allowed to perform each of these steps in a way that is appropriate for their architecture.

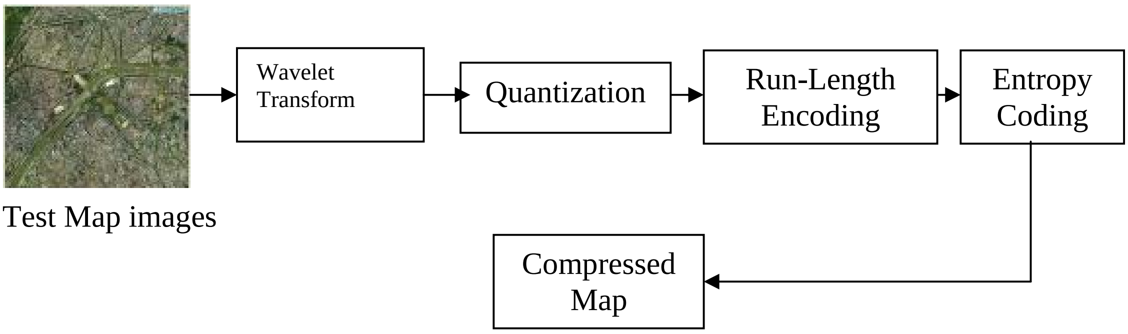


Figure 1.0: Steps of the Wavelet Image Compression Algorithm

A procedure for the corresponding four decompression steps will also be necessary in order to validate the benchmark. These corresponding steps (inverse wavelet transform, dequantization, run-length decoding, and entropy decoding) must be performed in reverse order and will generate a new image file. Computing the peak signal-to-noise ratio of the new image based on the original will assess the quality of the compression algorithm. Since this decompression routine will only be used for validation purposes, it may be performed entirely in software.

The following restrictions apply to the implementation of each of the compression steps:

1. ***Wavelet Transform.*** Any wavelet transform and filter banks may be used for this step as long as the final algorithm meets the minimum compression and image quality requirements specified by the acceptance tests (see section 5). Note that transforms other than wavelets (e.g., Fast Fourier Transform, Discrete Cosine Transform) may not be used.

2. ***Quantization.*** This step allows wavelet coefficients of small magnitude to be set to zero and reduces the number of distinct wavelet coefficients by mapping them to a smaller number of quantization indices. Since this step is inherently lossy, care must be taken to guarantee that enough information is retained to reconstruct the image at a high

enough quality level. Acceptable quantization algorithms may be vector or scalar, uniform or adaptive.

3. ***Run-Length Encoding (RLE)***. Runs of repeated coefficients are compressed through runlength encoding. Either arbitrary RLE or zero RLE is acceptable for this step.

4. ***Entropy Coding.*** A final lossy compression step must be performed to reduce the size of the run-length encoded data. Acceptable entropy coding algorithms include Huffman, Shannon-Fano, and arithmetic coding. A host processor will copy each of the test image files to memory that is accessible to the configurable computing system under test (SUT). The host computer will then initiate a timer and send a signal to the SUT. This timer will be stopped as soon as the SUT signals termination. At that time, the host will copy image information back to disk, perform any remaining compression steps in software, generate a compressed image file, and carry out the acceptance tests. If the compressed image file is deemed acceptable, the elapsed compression time will be reported. As noted above, a corresponding software-based decompression procedure will be required for carrying out the acceptance test.

1.3 OBJECTIVE

- **i.** To study the image compression technique to be applied in Map Online system using Internet-based Image Catalogue
- **ii.** To develop database for topographic
- **iii.** Evaluate the performance of chosen image compression techniques

1.4 SCOPE OF STUDY

Scope of this study will focus on the image catalogue approach using image compression technique that can be used for Map Online System. The study will cover the image compression techniques using wavelet technology; particularly to deal with image size that can be reduced without affected the quality of the image [1, 2, and 3]. Compressed images will be stored on a database. An Image transmitting process will be test using different internet connection speed to gain its efficiency.

CHAPTER II

LITERATURE STUDY

2.1 AN INTRODUCTION FOR WAVELETS

Digital maps carry along its geo-data such as coordinates, contour system, surface structures, and so on. High quality maps can retrieve essential information meaningful in Geographical Information System. It's so easy to capture the high quality map images, but the complicated is when to store it. Because the high quality map image must be allocated and handled in a giant storage. The bigger size means the bigger capacity needed. This is not an economic way in storage systems. To preserve the quality and to reduce the storage usage, the map images should be compress first using a mathematical tool called Wavelet. Wavelets are mathematical functions that split up data into different frequency components, and then study each component with a resolution matched to its scale. Wavelets have more advantages than traditional Fourier Transforms methods in analyzing physical situations where the signal contains discontinuities and sharp spikes. Wavelets were developed independently in the fields of mathematics, images processing, quantum physics, electrical engineering, and seismic geology. There are a lot of new applications born because of the interchange. For instances the applications in image and data compression, turbulence, human vision, radar, and earthquake prediction. This chapter will describes the history of wavelets beginning with Fourier, compare wavelet transforms with Fourier Transforms, state properties and other special aspects of wavelets, and finish with some interesting applications such as image compression. Most of the contents focus on the application for image compression that applied to a very big size of map image data.

2.2 WAVELETS OVERVIEW

The fundamental idea behind wavelets is to analyze according to scale. The scale or sizes of the data cause the memory usage increase. Wavelets are functions that satisfy certain mathematical requirements and are used in representing data or other functions. This is not a new idea. Early 1800's, Joseph Fourier discovered that he could superpose sines and cosines to represent other functions. However, in wavelet analysis, the scale that used to look at data plays a special role. Wavelet algorithms process data at different scales or resolutions. The result in wavelet analysis is to see both the forest and the trees, so to speak. This makes wavelets interesting and useful.

For many decades, scientists have wanted more appropriate functions than the sines and cosines, which comprise the bases of Fourier analysis, to approximate choppy signals (1). By their definition, these functions are non-local (and stretch out to infinity). They therefore do a very poor job in approximating sharp spikes. But with wavelet analysis, we can use approximating functions that are contained neatly in finite domains. Wavelets are well suited for approximating data with sharp discontinuities. The wavelet analysis procedure is to adopt a wavelet prototype function, called an analyzing wavelet or mother wavelet. Temporal analysis is performed with a contracted, high frequency version of the prototype wavelet, while frequency analysis is performed with a dilated, low frequency version of the same wavelet. Because the original signal or function can be represented in terms of a wavelet expansion (using coefficients in a linear combination of the wavelet functions), data operations can be performed using just the corresponding wavelet coefficients. And if you further choose the best wavelets adapted to your data, or truncate the coefficients below a threshold, your data is sparsely represented. This sparse coding makes wavelets an excellent tool in the field of data compression. Other applied fields that are making use of wavelets include astronomy, acoustics, nuclear engineering, sub-band coding, signal and image processing, neurophysiology, music, magnetic resonance imaging, speech discrimination, optics, fractals, turbulence, earthquake-prediction, radar, human vision, and pure mathematics applications such as solving partial differential equations.

2.3 HISTORICAL PERSPECTIVE

In the history of mathematics, wavelet analysis shows many different origins. Much of the work was performed in the 1930s, and at the time, the separate efforts did not appear to be parts of a coherent theory.

2.3.1 PRE-1930

Before 1930, the main branch of mathematics leading to wavelets began with Joseph Fourier (1807) with his theories of frequency analysis, now often referred to as Fourier synthesis. He asserted that any 2π-periodic function f(x) is the sum

$$a_0 + \sum_{k=1}^{\infty} (a_k \cos kx + b_k \sin kx) \qquad (1)$$

of its Fourier series. The coefficients a_0, a_k and b_k are calculated by

$$a_0 = \frac{1}{2\pi}\int_0^{2\pi} f(x)dx, \quad a_k = \frac{1}{\pi}\int_0^{2\pi} f(x)\cos(kx)dx, \quad b_k = \frac{1}{\pi}\int_0^{2\pi} f(x)\sin(kx)dx$$

Fourier's assertion played an essential role in the evolution of the ideas mathematicians had about the functions.

After 1807, by exploring the meaning of functions, Fourier series convergence, and orthogonal systems, mathematicians gradually were led from their previous notion of frequency analysis to the notion of scale analysis. That is, analyzing f(x) by creating mathematical structures that vary in scale. How? Construct a function, shift it by some amount, and change its scale. Apply that structure in approximating a signal. Now repeat the procedure. Take that basic structure, shift it, and scale it again. Apply it to the same signal to get a new approximation. And so on. It turns out that this sort of scale analysis is less sensitive to noise because it measures the average fluctuations of the signal at different scales.

The first mention of wavelets appeared in an appendix to the thesis of A. Haar (1909). One property of the Haar wavelet is that it has compact support, which means that it vanishes outside of a finite interval. Unfortunately, Haar wavelets are not continuously differentiable which somewhat limits their applications.

2.3.2 THE 1930S

In the 1930s, several groups working independently researched the representation of functions using scale-varying basis functions. Understanding the concepts of basis functions and scale-varying basis functions is key to understanding wavelets; the sidebar below provides a short detour lesson for those interested. By using a scale-varying basis function called the Haar basis function (more on this later) Paul Levy, a 1930s physicist, investigated Brownian motion, a type of random signal (2). He found the Haar basis function superior to the Fourier basis functions for studying small-complicated details in the Brownian motion.

Another 1930s research effort by Littlewood, Paley, and Stein involved computing the energy of a function f(x)

$$\text{energy} = \frac{1}{2}\int_{0}^{2\pi} |f(x)|^2 dx \tag{2}$$

The computation produced different results if the energy was concentrated around a few points or distributed over a larger interval. This result disturbed the scientists because it indicated that energy might not be conserved. The researchers discovered a function that can vary in scale and can conserve energy when computing the functional energy. Their work provided David Marr with an effective algorithm for numerical image processing using wavelets in the early 1980s.

2.3.3 1960-1980

Between 1960 and 1980, the mathematicians Guido Weiss and Ronald R. Coifman studied the simplest elements of a function space, called atoms, with the goal of finding the atoms for a common function and finding the “assembly rules" that allow the reconstruction of all the elements of the function space using these atoms. In 1980, Grossman and Morlet, a physicist and an engineer, broadly defined wavelets in the context of quantum physics. These two researchers provided a way of thinking for wavelets based on physical intuition.

2.3.4 POST-1980

In 1985, Stephane Mallat gave wavelets an additional jump-start through his work in digital signal processing. He discovered some relationships between quadrature mirror filters, pyramid algorithms, and orthonormal wavelet bases (more on these later). Inspired in part by these results, Y. Meyer constructed the first non-trivial wavelets. Unlike the Haar wavelets, the Meyer wavelets are continuously differentiable; however they do not have compact support. A couple of years later, Ingrid Daubechies used Mallat's work to construct a set of wavelet orthonormal basis functions that are perhaps the most elegant, and have become the cornerstone of wavelet applications today.

2.4 FOURIER ANALYSIS

Fourier's representation of functions as a superposition of sines and cosines has become ubiquitous for both the analytic and numerical solution of differential equations and for the analysis and treatment of communication signals. Fourier and wavelet analysis have some very strong links.

2.4.1 FOURIER TRANSFORMS

The Fourier transforms utility lies in its ability to analyze a signal in the time domain for its frequency content. The transform works by first translating a function in the time domain into a function in the frequency domain. The signal can then be analyzed for its frequency content because the Fourier coefficients of the transformed function represent the contribution of each sine and cosine function at each frequency. An inverse

Fourier transforms does just what you'd expect; transform data from the frequency domain into the time domain.

2.4.2 DISCRETE FOURIER TRANSFORMS

The Discrete Fourier Transform (DFT) estimates the Fourier transforms of a function from a finite number of its sampled points. The sampled points are supposed to be typical of what the signal looks like at all other times. The DFT has symmetry properties almost exactly the same as the continuous Fourier transform. In addition, the formula for the inverse discrete Fourier transform is easily calculated using the one for the discrete Fourier transform because the two formulas are almost identical.

2.4.3 WINDOWED FOURIER TRANSFORMS

If f(t) is a non-periodic signal, the summation of the periodic functions, sine and cosine, does not accurately represent the signal. You could artificially extend the signal to make it periodic but it would require additional continuity at the endpoints. The Windowed Fourier transform (WFT) is one solution to the problem of better representing the non-periodic signal. The WFT can be used to give information about signals simultaneously in the time domain and in the frequency domain.

With the WFT, the input signal f(t) is chopped up into sections, and each section is analyzed for its frequency content separately. If the signal has sharp transitions, we window the input data so that the sections converge to zero at the end points. This windowing is accomplished via a weight function that places less emphasis near the interval's endpoints than in the middle. The effect of the window is to localize the signal in time.

2.4.4 FAST FOURIER TRANSFORMS

To approximate a function by samples, and to approximate the Fourier integral by the discrete Fourier transform, requires applying a matrix whose order is the number sample points n. Since multiplying an n x n matrix by a vector costs on the order of n^2 arithmetic operations, the problem gets quickly worse as the number of sample points increases. However, if the samples are uniformly spaced, then the Fourier matrix can be factored into a product of just a few sparse matrices, and the resulting factors can be applied to a vector in a total of order n log n arithmetic operations. This is the so called Fast Fourier Transform or FFT (4).

2.5 WAVELET TRANSFORMS VERSUS FOURIER TRANSFORMS

2.5.1 SIMILARITIES BETWEEN FOURIER AND WAVELET TRANSFORMS

The Fast Fourier Transform (FFT) and the discrete wavelet transform (DWT) are both linear operations that generate a data structure that contains $\log_2 n$ segments of various lengths, usually filling and transforming it into a different data vector of length 2^n.

The mathematical properties of the matrices involved in the transforms are similar as well. The inverse transform matrix for both the FFT and the DWT is the transpose of the original. As a result, both transforms can be viewed as a rotation in function space to a different domain. For the FFT, this new domain contains basis functions that are sines and cosines. For the wavelet transform, this new domain contains more complicated basis functions called wavelets, mother wavelets, or analyzing wavelets. Both transforms have another similarity. The basis functions are localized in frequency, making mathematical tools such as power spectra (how much power is contained in a frequency interval) and scalegrams (to be defined later) useful at picking out frequencies and calculating power distributions.

2.5.2 DISSIMILARITIES BETWEEN FOURIER AND WAVELET TRANSFORMS

The most interesting dissimilarity between these two kinds of transforms is that individual wavelet functions are localized in space. Fourier sine and cosine functions are not. This localization feature, along with wavelets' localization of frequency, makes many functions and operators using wavelets “sparse" when transformed into the wavelet domain. This sparseness, in turn, results in a number of useful applications such as data compression, detecting features in images, and removing noise from time series.

One way to see the time-frequency resolution differences between the Fourier transform and the wavelet transform is to look at the basis function coverage of the time-frequency plane (5). Figure 2.1 shows a windowed Fourier transform, where the window is simply a square wave. The square wave window truncates the sine or cosine function to fit a window of a particular width. Because a single window is used for all frequencies in the WFT, the resolution of the analysis is the same at all locations in the time-frequency plane.

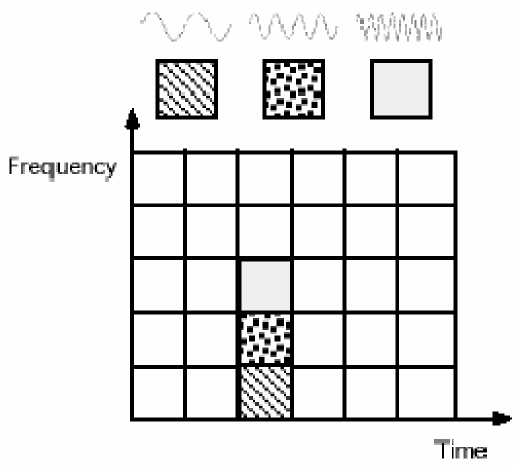


Fig. 2.1: Fourier basis functions, time-frequency tiles, and coverage of the time-frequency plane.

An advantage of wavelet transforms is that the windows vary. In order to isolate signal discontinuities, one would like to have some very short basis functions. At the same time, in order to obtain detailed frequency analysis, one would like to have some very long basis functions. A way to achieve this is to have short high-frequency basis functions and long low-frequency ones. This happy medium is exactly what you get with wavelet transforms. Figure 2.2 shows the coverage in the time-frequency plane with one wavelet function, the Daubechies wavelet.

One thing to remember is that wavelet transforms do not have a single set of basis functions like the Fourier transform, which utilizes just the sine and cosine functions. Instead, wavelet transforms have an infinite set of possible basis functions. Thus wavelet analysis provides immediate access to information that can be obscured by other time-frequency methods such as Fourier analysis.

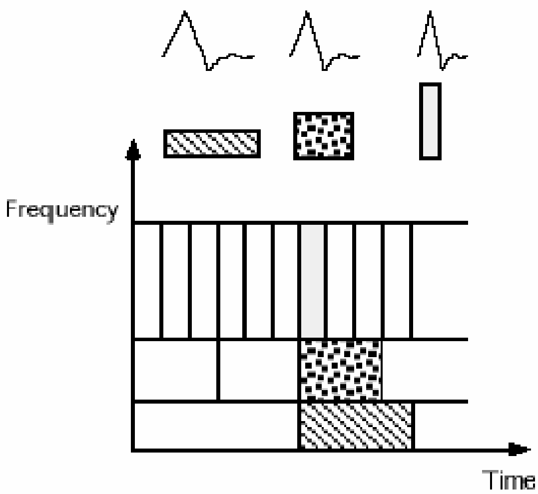


Fig. 2.2: Daubechies wavelet basis functions, time-frequency tiles, and coverage of the time-frequency plane.

2.6 THE WAVELET SIGNAL FORM

Wavelet transforms comprise an infinite set. The different wavelet families make different trade-offs between how compactly the basis functions are localized in space and how smooth they are. Some of the wavelet bases have fractal structure. The Daubechies wavelet family is one example (see Figure 2.3).

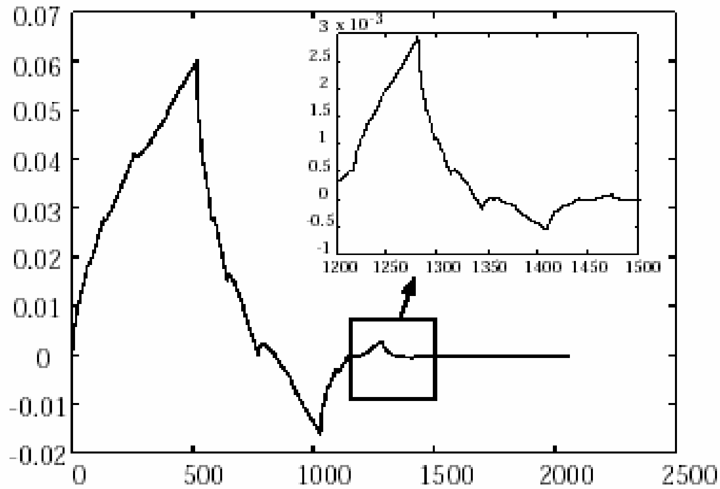


Fig. 2.3: The fractal self-similarity of the Daubechies mother wavelet

Within each family of wavelets (such as the Daubechies family) are wavelet subclasses distinguished by the number of coefficients and by the level of iteration. Wavelets are classified within a family most often by the number of vanishing moments. This is an extra set of mathematical relationships for the coefficients that must be satisfied, and is directly related to the number of coefficients (1). For example, within the Coiflet wavelet family are Coiflets with two vanishing moments, and Coiflets with three vanishing moments. In Figure 2.4, illustrates several different wavelet families.

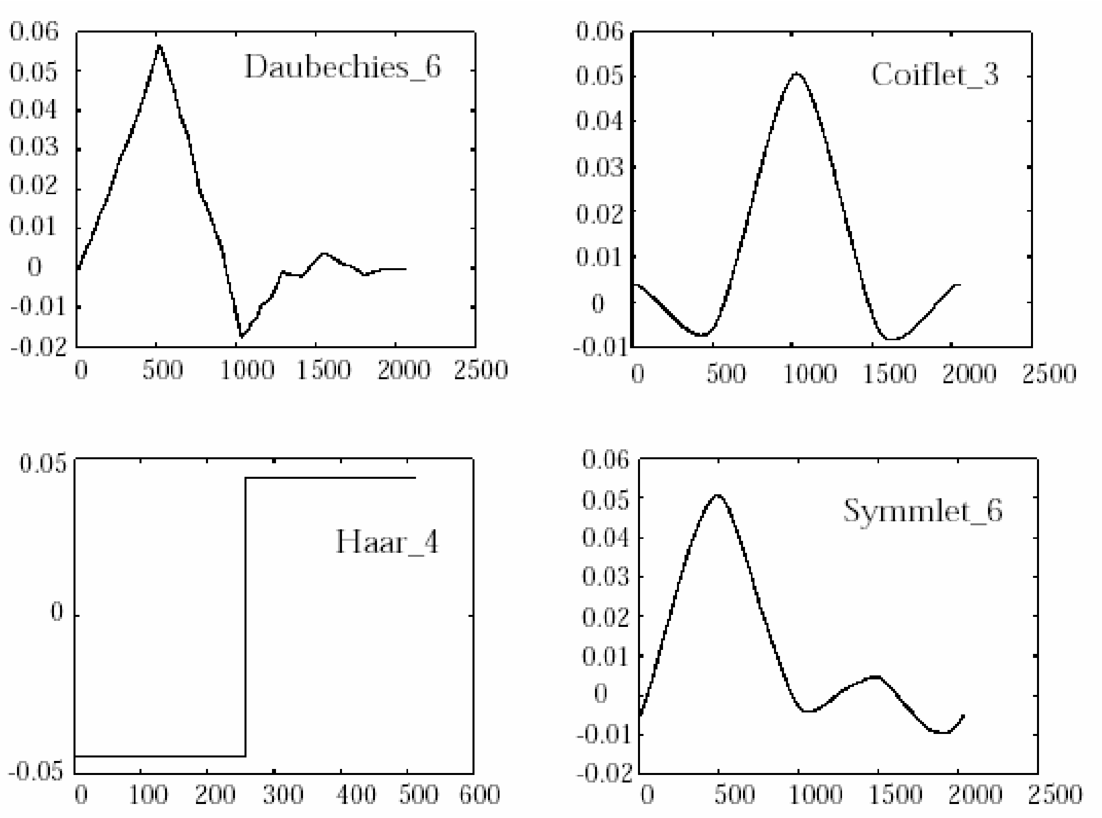


Fig. 2.4: Several different families of wavelets.

2.7 WAVELET ANALYSIS

Now we begin our tour of wavelet theory, when we analyze our signal in time for its frequency content. Unlike Fourier analysis, in which we analyze signals using sines and cosines, now we use wavelet functions.

2.7.1 THE DISCRETE WAVELET TRANSFORM

Dilations and translations of the "Mother function," or "analyzing wavelet" **Φ**(x); define an orthogonal basis, our wavelet basis:

$$\Phi_{(s,l)}(x) = 2^{-\frac{s}{2}}\Phi\left(2^{-s}x - l\right) \tag{3}$$

The variables s and l are integers that scale and dilate the mother function **Φ** to generate wavelets, such as a Daubechies wavelet family. The scale index s indicates the wavelet's width, and the location index l gives its position. Notice that the mother functions are rescaled, or "dilated" by powers of two, and translated by integers. What makes wavelet bases especially interesting is the self-similarity caused by the scales and dilations. Once we know about the mother functions, we know everything about the basis.

To span our data domain at different resolutions, the analyzing wavelet is used in a scaling equation:

$$W(x) = \sum_{k=-1}^{N-2} (-1)^k c_{k+1}\Phi(2x+k) \tag{4}$$

where W(x) is the scaling function for the mother function _; and ck are the wavelet coefficients. The wavelet coefficients must satisfy linear and quadratic constraints of the form

$$\sum_{k=0}^{N-1} c_k = 2, \quad \sum_{k=0}^{N-1} c_k c_{k+2l} = 2\delta_{l,0} \tag{5}$$

where δ is the delta function and l is the location index.
One of the most useful features of wavelets is the ease with which a scientist can choose the defining coefficients for a given wavelet system to be adapted for a given problem. In Daubechies' original paper (6), she developed specific families of wavelet systems that were very good for representing polynomial behavior. The Haar wavelet is even simpler, and it is often used for educational purposes.

It is helpful to think of the coefficients $\{c_0,\ldots,c_n\}$ as a filter. The filter or coefficients are placed in a transformation matrix, which is applied to a raw data vector. The coefficients are ordered using two dominant patterns, one that works as a smoothing filter (like a moving average), and one pattern that works to bring out the data's "detail" information. These two orderings of the coefficients are called a quadrature mirror filter pair in signal processing parlance. A more detailed description of the transformation matrix can be found elsewhere (4).

To complete discussion of the DWT, let's look at how the wavelet coefficient matrix is applied to the data vector. The matrix is applied in a hierarchical algorithm, sometimes called a pyramidal algorithm. The wavelet coefficients are arranged so that odd rows contain an ordering of wavelet coefficients that act as the smoothing filter, and the even rows contain an ordering of wavelet coefficient with different signs that act to bring out the data's detail. The matrix is first applied to the original, full-length vector. Then the vector is smoothed and decimated by half and the matrix is applied again. Then the smoothed, halved vector is smoothed, and halved again, and the matrix applied once more. This process continues until a trivial number of "smooth-smooth- smooth..." data remain. That is, each matrix application brings out a higher resolution of the data while at the same time smoothing the remaining data. The output of the DWT consists of the remaining "smooth (etc.)" components, and all of the accumulated "detail" components.

2.7.2 THE FAST WAVELET TRANSFORM

The DWT matrix is not sparse in general, so we face the same complexity issues that we had previously faced for the discrete Fourier transform. We solve it as we did for the FFT, by factoring the DWT into a product of a few sparse matrices using self-similarity properties. The result is an algorithm that requires only order n operations to transform an n-sample vector. This is the “fast" DWT of Mallat and Daubechies.

2.7.3 WAVELET PACKETS

The wavelet transform is actually a subset of a far more versatile transform, the wavelet packet transform. Wavelet packets are particular linear combinations of wavelets. They form bases, which retain many of the orthogonality, smoothness, and localization properties of their parent wavelets. The coefficients in the linear combinations are computed by a recursive algorithm making each newly computed wavelet packet coefficient sequence the root of its own analysis tree.

2.7.4 ADAPTED WAVEFORMS

Because we have a choice among an infinite set of basis functions, we may wish to find the best basis function for a given representation of a signal. A basis of adapted waveform is the best basis function for a given signal representation. The chosen basis carries substantial information about the signal, and if the basis description is efficient (that is, very few terms in the expansion are needed to represent the signal), then that signal information has been compressed.

According to Wickerhauser, some desirable properties for adapted wavelet bases are

1. Speedy computation of inner products with the other basis functions;
2. Speedy superposition of the basis functions;
3. Good spatial localization, so researchers can identify the position of a signal that is contributing a large component;
4. Good frequency localization, so researchers can identify signal oscillations; and
5. Independence, so that not too many basis elements match the same portion of the signal.

For adapted waveform analysis, researchers seek a basis in which the coefficients, when rearranged in decreasing order, decrease as rapidly as possible. to measure rates of decrease, they use tools from classical harmonic analysis including calculation of information cost functions. This is defined as the expense of storing the chosen representation. Examples of such functions include the number above a threshold, concentration, entropy, and logarithm of energy, Gauss-Markov calculations, and the theoretical dimension of a sequence.

2.8 WAVELET APPLICATIONS

The following applications show just a small sample of what researchers can do with wavelets.

2.8.1 MAPONLINE SYSTEM PROTOTYPE

The development of the computer technology and Internet, makes everything can be share and implemented online especially in Catalogue Information System. One of the most goodness using Internet Based Catalogue Images are the information could be spread comprehensively also involved images or graphics with their attributes. Typically, the main problem in handling the geodatas of digital map is how to manage the size but still get the best quality. The best quality becomes the main point in GIS. Higher quality of the images means the data more accurate. So how to preserve this map image and to load in the Internet server? Geodatas is a retrieved data from map images and the images size are very big, especially the data in raster form because the data scanned at the high resolution (>600 dpi). For map online system, map image data in database normally topography and orthophoto images that could be view as an actual earth surface. For example, size of entire California using one-meter resolution and colored images were about 1.5TB or 1500GB.

Image data required high capacity of memory and space usage in server. So it's become most problem in GIS. Basically, the data delivered in *.gif and *. jpeg format. To preserved and make the size smaller than actual size, the compression is needed. The compression method should destroy the image quality. One of the most popular compression techniques is wavelet image compression. This technology affords to reduce the image size and preserved the image quality. Wavelet divides images to several smaller blocks of data in decreasing the size. This technique also applied in software development. Using the technique, the image data delivered in *.wlt extension means the data already converted to wavelet form. In Map Online System, the *.wlt image data could be viewed using Java applets. A lot of data embedded with the data such as map series number, sheet number, scale, map edition and also the year of the images taken.

2.8.2 COMPUTER AND HUMAN VISION

In the early 1980s, David Marr began work at MIT's Artificial Intelligence Laboratory on artificial vision for robots. He is an expert on the human visual system and his goal was to learn why the first attempts to construct a robot capable of understanding its surroundings were unsuccessful. Marr believed that it was important to establish scientific foundations for vision, and that while doing so, one must limit the scope of investigation by excluding everything that depends on training, culture, and so on, and focus on the mechanical or involuntary aspects of vision.

This low-level vision is the part that enables us to recreate the three-dimensional organization of the physical world around us from the excitations that stimulate the retina. Marr asked the questions:

- How is it possible to define the contours of objects from the variations of their light intensity?
- How is it possible to sense depth?
- How is movement sensed?

He then developed working algorithmic solutions to answer each of these questions. Marr's theory was that image processing in the human visual system has a complicated hierarchical structure that involves several layers of processing. At each processing level, the retinal system provides a visual representation that scales progressively in a geometrical manner. His arguments hinged on the detection of intensity changes. He theorized that intensity changes occur at different scales in an image, so that their optimal detection requires the use of operators of different sizes.

He also theorized that sudden intensity changes produce a peak or trough in the first derivative of the image. These two hypotheses require that a vision filter have two characteristics: it should be a differential operator, and it should be capable of being tuned to act at any desired scale. Marr's operator was a wavelet that today is referred to as a “Marr wavelet."

2.8.2 FBI FINGERPRINT COMPRESSION

Between 1924 and today, the US Federal Bureau of Investigation has collected about 30 million sets of fingerprints. The archive consists mainly of inked impressions on paper cards. Facsimile scans of the impressions are distributed among law enforcement agencies, but the digitization quality is often low. Because a number of jurisdictions are experimenting with digital storage of the prints, incompatibilities between data formats have recently become a problem. This problem led to a demand in the criminal justice community for a digitization and compression standard.

In 1993, the FBI's Criminal Justice Information Services Division developed standards for fingerprint digitization and compression in cooperation with the National Institute of Standards and Technology, Los Alamos National Laboratory, commercial vendors, and criminal justice communities.

Let's put the data storage problem in perspective. Fingerprint images are digitized at a resolution of 500 pixels per inch with 256 levels of gray-scale information per pixel. A single fingerprint is about 700,000 pixels and needs about 0.6 Mbytes to store. A pair of hands, then, requires about 6 Mbytes of storage. So digitizing the FBI's current archive would result in about 200 terabytes of data.

CHAPTER III

ALGORITHMS OF WAVELETS IN MAPONLINE

3.8 AN INTRODUCTION TO IMAGE COMPRESSIONS ALGORITHM

Compression is used just about everywhere. All the images we get in the web are compressed, typically in JPEG or GIF. In this chapter we will use the generic term message for the images we want to compress, which is the map images. The task of compression consists of two components, an encoding algorithm that takes a message and generates a "compressed" representation (hopefully with fewer bits), and a decoding algorithm that reconstructs the original message or some approximation of it from the compressed representation. These two components are typically intricately tied together since they both have to understand the shared compressed representation. Everyone who's involved in image processing knows that compression techniques produce either lossless or lossy results. We distinguish between lossless algorithms, which can reconstruct the original message exactly from the compressed message, and lossy algorithms, which can only reconstruct an approximation of the original message.

Lossless algorithms are typically used for text, and lossy for images and sound where a little bit of loss in resolution is often undetectable, or at least acceptable. Lossy is used in an abstract sense, however, and does not mean random lost pixels, but instead means loss of a quantity such as a frequency component, or perhaps loss of noise. For example, one might think that lossy image compression would be unacceptable because they are imagining missing or switched pixel. Consider instead a system that reworded still images into a more standard form, or replaced that loss bit with synonyms so that the file can be better compressed. Technically the compression would be lossy since the image has changed, but the “meaning” and clarity of the message might be fully maintained, or even improved. The explanations for this two types of compression can be referred in section 3.4 below.

There were a lot of image compression techniques in image processing. More techniques exists mean more algorithms was used. This chapter will describe about famous image compression algorithms, but only wavelet image compression will be explained thoroughly. Comparison table attached to proof that the wavelet techniques more reliable. However because one can’t hope to compress everything, all compression algorithms must assume that there is some bias on the input messages so that some inputs are more likely than others, i.e. that there is some unbalanced probability distribution over the possible messages. Most compression algorithms base this “bias” on the structure of the messages i.e., an assumption that repeated characters are more likely than random characters, or that large white patches occur in “typical” images. Compression is therefore all about probability.

3.8 THE IMPORTANT OF COMPRESSIONS

The figures in Table 3.1 show the qualitative transition from simple text to full-motion video data and the disk space needed to store such uncompressed data

Table 3.1: Multimedia data types and uncompressed storage space required

Multimedia Data	Size/Duration	Bits/Pixel or Bits/Sample	Uncompressed Size
A page of text	11" x 8.5"	Varying resolution	16-32 Kbits
Telephone quality speech	1 sec	8 bps	64 Kbits
Grayscale Image	512 x 512	8 bpp	2.1 Mbits

Color Image	512 x 512	24 bpp	6.29 Mbits
Medical Image	2048 x 1680	12 bpp	41.3 Mbits
SHD Image	2048 x 2048	24 bpp	100 Mbits
Full-motion Video	640 x 480, 10 sec	24 bpp	2.21 Gbits

The examples above clearly illustrate the need for large storage space for digital image, audio, and video data. So, at the present state of technology, the only solution is to compress these multimedia data before its storage and transmission, and decompress it at the receiver for play back. With a compression ratio of 16:1, the space requirement can be reduced by a factor of 16 with acceptable quality.

3.8 PRINCIPLES OF COMPRESSION

A common characteristic of most images is that the neighboring pixels are highly correlated and therefore contain highly redundant information. The foremost task then is to find an image representation in which the image pixels are decorrelated. Redundancy and irrelevancy reductions are two fundamental principles used in compression. Whereas redundancy reduction aims at removing redundancy from the signal source (image/video), irrelevancy reduction omits parts of the signal that will not be noticed by the signal receiver (viz. HVS). In general, three types of redundancy in digital images and video can be identified:

- **Spatial Redundancy** or correlation between neighboring pixel values.
- **Spectral Redundancy** or correlation between different color planes or spectral bands.
- **Temporal Redundancy** or correlation between adjacent frames in a sequence of images (video).

Image compression research aims at reducing the number of bits needed to represent an image by removing the spatial and spectral redundancies as much as possible. Since in this article, we will focus only on still image compression, we will not worry about temporal redundancy.

3.8 TYPES OF COMPRESSION

(a) Lossless vs. Lossy compression: There are different ways of classifying compression techniques. Two of these would be mentioned here. The first categorization is based on the information content of the reconstructed image. They are 'lossless compression' and 'lossy compression' schemes. In lossless compression, the reconstructed image after compression is numerically identical to the original image on a pixel-by-pixel basis. However, only a modest amount of compression is achievable in this technique. In lossy compression on the otherhand, the reconstructed image contains degradation relative to the original, because redundant information is discarded during compression. As a result, much higher compression is achievable, and under normal viewing conditions, no visible loss is perceived (visually lossless).

(b) Predictive vs. Transform coding: The second categorization of various coding schemes is based on the 'space' where the compression method is applied. These are 'predictive coding' and 'transform coding'. In predictive coding, information already sent or available is used to predict future values, and the difference is coded. Since this is done in the image or spatial domain, it is relatively simple to implement and is readily adapted to local image characteristics. Differential Pulse Code Modulation (DPCM) is one particular example of predictive coding. Transform coding, on the other hand, first transforms the image from its spatial domain representation to a different type of representation using some well-known transforms mentioned later, and then codes the transformed values (coefficients). The primary advantage is that, it provides greater data compression compared to predictive methods, although at the expense of greater computations.

3.8 LOSSY COMPRESSION TECHNIQUES

Lossy compression is compression in which some of the information from the original message sequence is lost. This means the original sequences cannot be regenerated from the compressed sequence. Just because information is lost doesn't mean the quality of the output is reduced. For example, random noise has very high information content, but when present in an image or a sound file, we would typically be perfectly happy to drop it. Also certain losses in images or sound might be completely imperceptible to a human viewer (e.g. the loss of very high frequencies). For this reason, lossy compression algorithms on images can often get a factor of 2 better compression than lossless algorithms with an imperceptible loss in quality. However, when quality does start degrading in a noticeable way, it is important to make sure it degrades in a way that is least objectionable to the viewer (*e.g.*, dropping random pixels is probably more objectionable than dropping some color information). For these reasons, the way most lossy compression techniques are used are highly dependent on the media that is being compressed. Lossy compression for sound, for example, is very different than lossy compression for images.

In this section we go over some general techniques that can be applied in various contexts, and in the next two sections we go over more specific examples and techniques.

A typical lossy image compression system shown in Figure 3.1, consists of three closely connected components viz. (a) Source Encoder or Linear Transforms, (b) Quantizer, and (c) Entropy Encoder. Compression is accomplished by applying a linear transform to decorrelate the image data, quantizing the resulting transform coefficients, and entropy coding the quantized values.

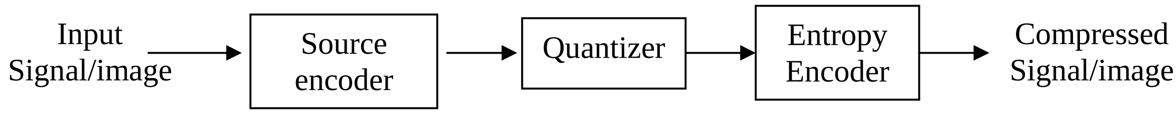


Figure 3.1: A Typical Lossy Signal/Image Encoder

Over the years, a variety of linear transforms have been developed which include Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT)[1], Discrete Wavelet Transform (DWT)[36] and many more, each with its own advantages and disadvantages. A thorough and excellent analysis of DCT and other related transforms and their applications can be found in [26]. A quantizer simply reduces the number of bits needed to store the transformed coefficients by reducing the precision of those values. Since this is a many-to-one mapping, it's a lossy process and is the main source of compression in an encoder. Quantization can be performed on each individual coefficient, which is known as Scalar Quantization (SQ). Quantization can also be performed on a group of coefficients together, and this is known as Vector Quantization (VQ). Both, uniform and non-uniform quantizers can be used depending on the problem at hand. For a thorough analysis on different quantization schemes, see section 3.51.
An entropy encoder further compresses the quantized values losslessly to give better overall compression. Most commonly used entropy encoders are the Huffman encoder and the Arithmetic encoder, although for applications requiring fast execution, simple run-length coding has proven very effective. A nice overview on various entropy encoding techniques can be found in [15,24]. A properly designed quantizer and entropy encoder are absolutely necessary along with optimum signal transformation to get best possible compression.

3.8.1 Scalar Quantization

A simple way to implement lossy compression is to take the set of possible messages *S* and reduce it to a smaller set *S'* by mapping each element of *S* to an element in *S'*. For example we could take 8-bit integers and divide by 4 (*i.e.*, drop the lower two bits), or take a character set in which upper and lowercase characters are distinguished and replace all the uppercase ones with lowercase ones. This general technique is called *quantization*. Since the mapping used in quantization is many-to-one, it is irreversible and therefore lossy. In the case that the set *S* comes from a total order and the total order is broken up into regions that map onto the elements of *S'*, the mapping is called *scalar quantization*. The example of dropping the lower two bits given in the previous paragraph is an example of scalar quantization.

Applications of scalar quantization include reducing the number of color bits or gray-scale levels in images (used to save memory on many computer monitors), and classifying the intensity of frequency components in images or sound into groups (used in JPEG compression). In fact we mentioned an example of quantization when talking about JPEG-LS. Their quantization is used to reduce the number of contexts instead of the number of message values. In particular we categorized each of 3 gradients into one of 9 levels so that the context table needs only M Ý entries (actually only $(9^3 + 1) / 2$ due to symmetry).

The term *uniform scalar quantization* is typically used when the mapping is linear. Again, the example of dividing 8-bit integers by 4 is a linear mapping. In practice it is often better to use a *nonuniform scalar quantization*. For example, it turns out that the eye is more sensitive to low values of red than to high values. Therefore we can get better quality-compressed images by making the regions in the low values smaller than the regions in the high values. Another choice is to base the nonlinear mapping on the probability of different input values. In fact, this idea can be formalized—for a given error metric and a given probability distribution over the input values, we want a mapping that will minimize the expected error. For certain error-metrics, finding this mapping might be hard. For the root-mean-squared error metric there is an iterative algorithm known as the Lloyd-Max algorithm that will find the optimal mapping. An interesting point is that finding this optimal mapping will have the effect of decreasing the effectiveness of any probability coder that is used on the output. This is because the mapping will tend to more evenly spread the probabilities in *S'*.

3.8.2 Vector Quantization

Scalar quantization allows one to separately map each color of a color image into a smaller set of output values. In practice, however, it can be much more effective to map regions of 3-d color space into output values. By more effective we mean that a better compression ratio can be achieved based on an equivalent loss of quality.

The general idea of mapping a multidimensional space into a smaller set of messages *S'* is called *vector quantization*. Selecting a set of representatives from the input space, and then mapping all other points in the space to the closest representative typically implement vector quantization. The representatives could be fixed for all-time and part of the compression protocol, or they could be determined for each file (message sequence) and sent as part of the sequence. The most interesting aspect of vector quantization is how one selects the representatives. Typically it is implemented using a clustering algorithm that finds some number of clusters of points in the data. A representative is then chosen for each cluster by either selecting one of the points in the cluster or using some form of centroid for the cluster. Finding good clusters is a whole interesting topic on its own.

Vector quantization is most effective when the variables along the dimensions of the space are correlated. Figure 3.2 gives an example of possible representatives for a height-weight chart. There is clearly a strong correlation between people's height and weight and therefore the representatives can be concentrated in areas of the space that make physical sense, with higher densities in more common regions. Using such representatives is very much more effective than separately using scalar quantization on the height and weight.

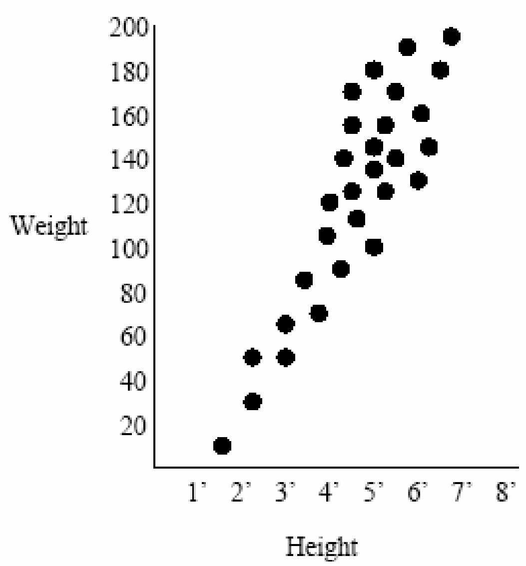


Figure 3.2: Example of vector quantization for a height-weight chart.

We should note that vector quantization, as well as scalar quantization, can be used as part of lossless compression technique. In particular if in addition to sending the closest representative, the coder sends the distance from the point to the representative, then the original point can be reconstructed. The distance is often referred to as the residual. In general this would not lead to any compression, but if the points are tightly clustered around the representatives, then the technique can be very effective for lossless compression since the residuals will be small and probability coding will work well in reducing the number of bits.

3.8.3 Transform Coding

The idea of transform coding is to transform the input into a different form which can then either be compressed better, or for which we can more easily drop certain terms without as much qualitative loss in the output. One form of transform is to select a linear set of basis functions (*Øi*) that span the space to be transformed. Some common sets include sin, cos, polynomials, spherical harmonics, Bessel functions, and wavelets. Figure 3.2 shows some examples of the first three basis functions for discrete cosine, polynomial, and wavelet transformations. For a set of *n* values, transforms can be expressed as an *n* x *n* matrix *T*. Multiplying the input by this matrix *T* gives, the transformed coefficients. Multiplying the coefficients by T^{-1} will convert the data back to the original form. For example, the coefficients for the discrete cosine transform (DCT) are

$$T_{ij} = \begin{cases} \sqrt{1/n}\cos\frac{(2j+1)i\pi}{2n} & i = 0, 0 \le j < n \\ \sqrt{2/n}\cos\frac{(2j+1)i\pi}{2n} & 0 < i < n, 0 \le j < n \end{cases}$$

The DCT is one of the most commonly used transforms in practice for image compression, more so than the discrete Fourier transform (DFT). This is because the DFT assumes periodicity, which is not necessarily true in images. In particular to represent a linear function over a region requires many large amplitude high-frequency components in a DFT. This is because the periodicity assumption will view the function as a sawtooth, which is highly discontinuous at the teeth requiring the high-frequency components. The DCT does not assume periodicity and will only require much lower amplitude high-frequency components. The DCT also does not require a phase, which is typically represented using complex numbers in the DFT.

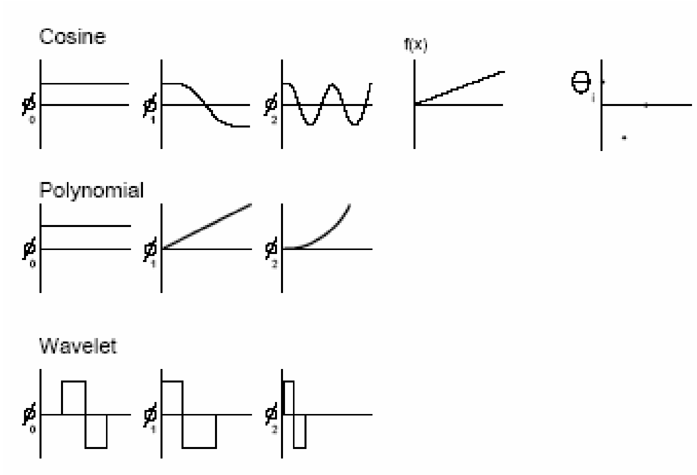


Figure 3.3: Transforms

For the purpose of compression, the properties we would like of a transform are

1. To decorrelate the data,
2. have many of the transformed coefficients be small, and
3. have it so that from the point of view of perception, some of the terms are more important than others.

3.6 WAVELET IMAGE COMPRESSION

JPEG decompose images into sets of cosine waveforms. Unfortunately, cosine is a periodic function; this can create problems when an image contains strong aperiodic features. Such local high-frequency spikes would require an infinite number of cosine waves to encode properly. JPEG and MPEG solve this problem by breaking up images into fixed-size blocks and transforming each block in isolation. This effectively clips the infinitely repeating cosine function, making it possible to encode local features.

An alternative approach would be to choose a set of basis functions that exhibit good locality without artificial clipping. Such basis functions, called “wavelets”, could be applied to the entire image, without requiring blocking and without degenerating when presented with high-frequency local features.

How do we derive a suitable set of basis functions? We start with a single function, called a “mother function”. Whereas cosine repeats indefinitely, we want the wavelet mother function, ø, to be contained within some local region, and approach zero as we stray further away:

$$\lim_{x \to \pm\infty} \phi(x) = 0$$

The families of basis functions are scaled and translated versions of this mother function. For some scaling factor *s* and translation factor *l*,

$$\phi_{sl}(x) = \phi(2^s x - l)$$

A well know family of wavelets are the Haar wavelets, which are derived from the following mother function:

$$\phi(x) = \begin{cases} 1 & : \quad 0 < x \leq 1/2 \\ -1 & : \quad 1/2 < x \leq 1 \\ 0 & : \quad x \leq 0 \text{ or } x > 1 \end{cases}$$

Figure 3.4 shows a family of seven Haar basis functions. Of the many potential wavelets, Haar wavelets are probably the most described but the least used. Their regular form makes the underlying mathematics simple and easy to illustrate, but tends to create bad blocking artifacts if actually used for compression.

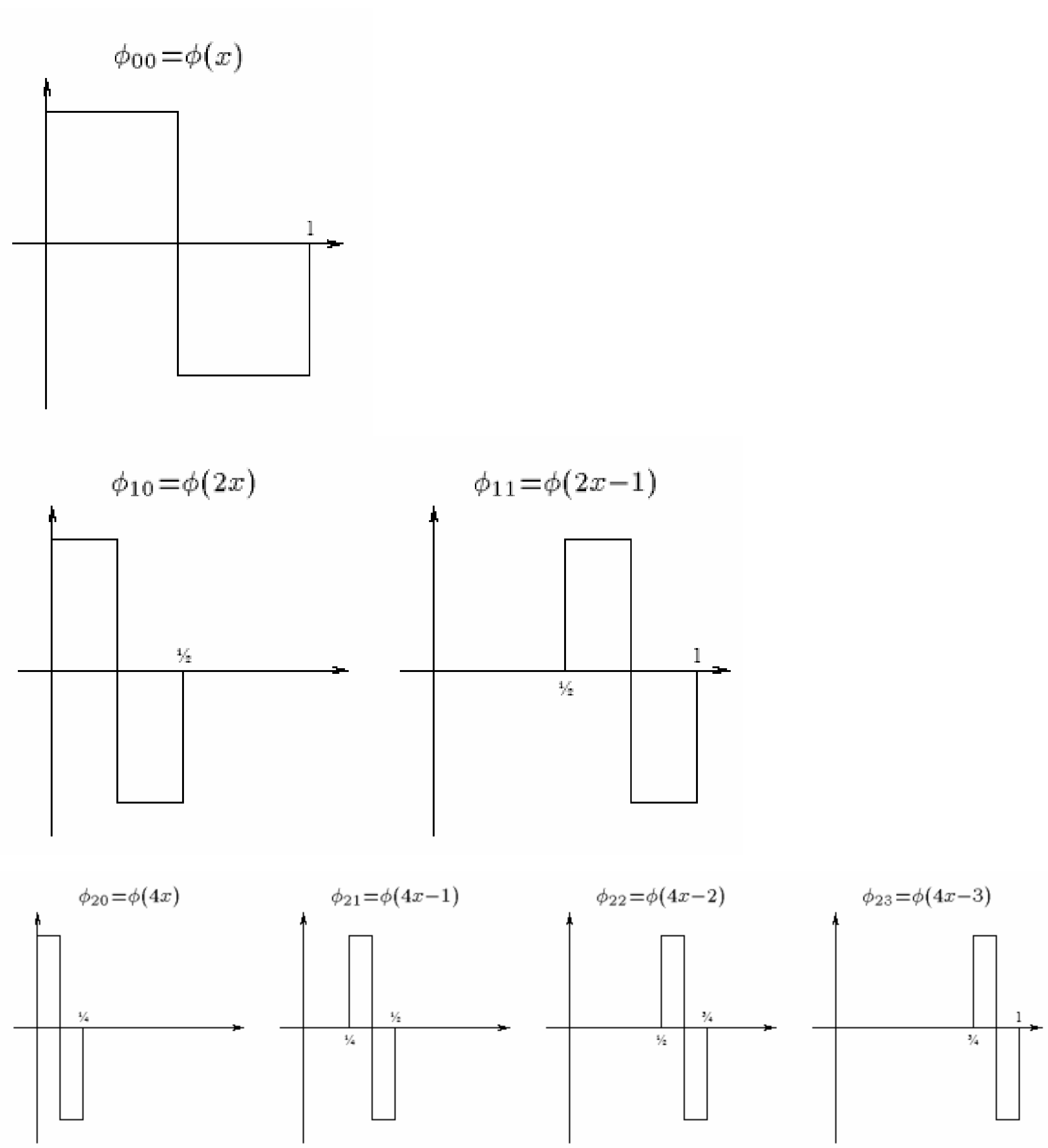


Figure 3.4: A small Haar wavelet family of size seven.

Many other wavelet mother functions have also been proposed. The Morret wavelet convolves a Gaussian with a cosine, resulting in a periodic but smoothly decaying function. This function is equivalent to a wave packet from quantum physics, and the mathematics of Morret functions have been studied extensively. Figure 3.5 shows a sampling of other popular wavelets. Figure 3.6 shows that the Daubechies wavelet is actually a self-similar fractal.

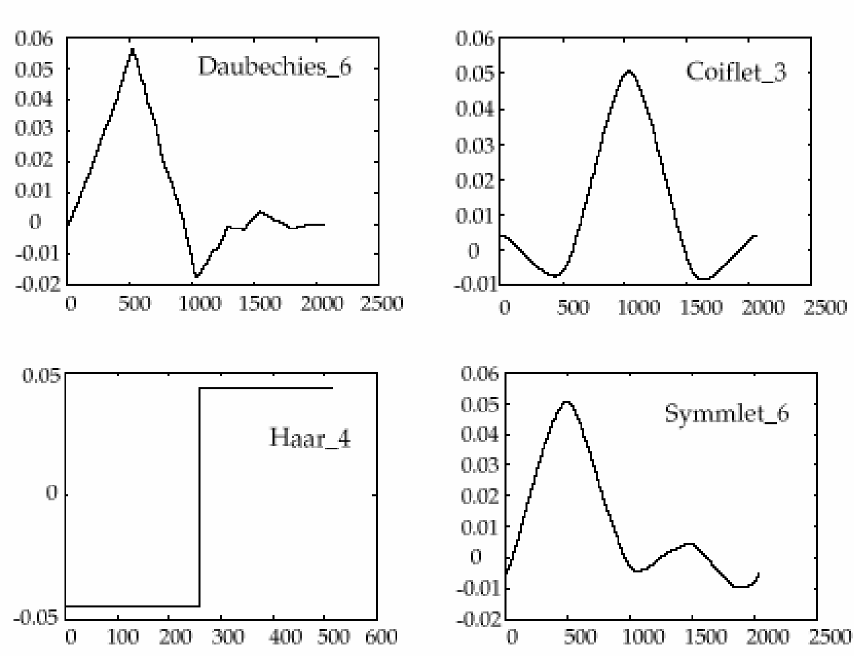


Figure 3.5: A sampling of popular wavelet

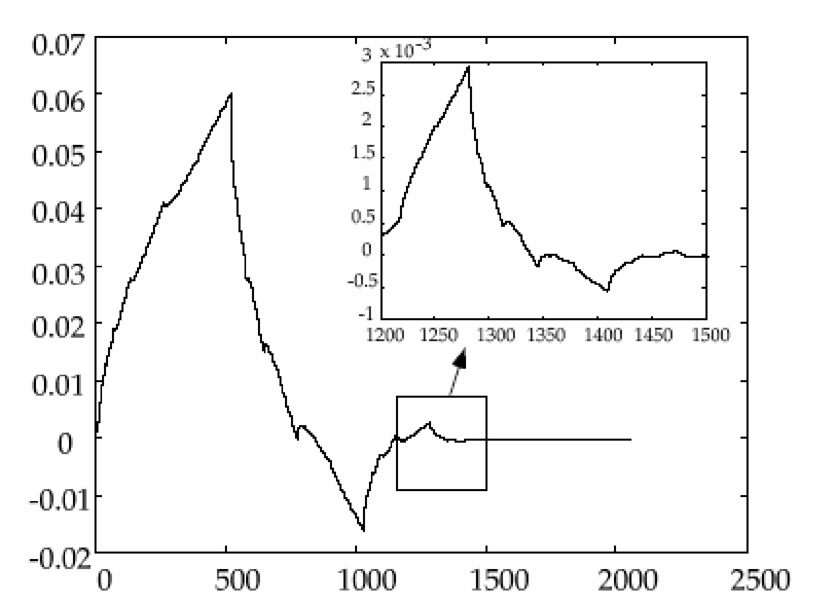


Figure 3.6: Self-similarities in the Daubechies wavelet

3.6.1 WAVELET IN THE REAL WORLD

Summus Ltd. is the premier vendor of wavelet compression technology. Summus claims to achieve better quality than JPEG for the same compression ratios, but has been loathe divulging details of how their wavelet compression actually works. Summus wavelet technology has been incorporated into such items as:

- Wavelets-on-a-chip for missile guidance and communications systems.
- Image viewing plugins for Netscape Navigator and Microsoft Internet Explorer.
- Desktop image and movie compression in Corel Draw and Corel Video.
- Digital cameras under development by Fuji.

In a sense, wavelet compression works by characterizing a signal in terms of some underlying generator. Thus, wavelet transformation is also of interest outside of the realm of compression. Wavelet transformation can be used to clean up noisy data or to detect self-similarity over widely varying time scales. It has found uses in medical imaging, computer vision, and analysis of cosmic X-ray sources.

3.7 IMPLEMENTING WAVELET IN MAPONLINE

Wavelet techniques were chosen among the other compression techniques. The result of the comparison between Wavelet, Jpeg, and Tiff technique has been studied. Wavelet result is better than others in compressing the map images.

3.7.1 WAVELET COMPRESSION ALGORITHM FOR MAPONLINE

As mentioned before, there were two kinds of compression results, lossy and lossless. Lossless compression algorithm used to compress image or data without discarding even one data. All the data were meaningful and normally implemented for text, experiment results, or object compiled code. The lossy compression algorithm will discard unused data to reduce the data or image size. Normally implemented for images and digital sound file.

To compress map image in Map Online System, lossy compression algorithm was used because the discarded data could not be vision by naked eye. Almost of this algorithm uses common method. The metadata or raw data will encode first to retrieve the signal of each dot in map pixels. The dot is represented by color scheme code. 000 is for darker dot to 255, which is lighter dot in pixels.

3.8 OTHER TYPES OF LOSSY IMAGE COMPRESSION TECHNIQUES

3.8.1 JPEG (Joint Photographic Experts Group)

JPEG is a lossy compression scheme for color and gray-scale images. It works on full 24-bit color, and designed to be used with photographic material and naturalistic artwork. It is not the ideal format for line drawings, textual images, or other images with large areas of solid color or a very limited number of distinct colors. The lossless techniques, such as JBIG, work better for such images. JPEG is designed so that the loss factor can be tuned by the user to tradeoff image size and image quality, and is designed so that the loss has the least effect on human perception. It however does have some anomalies when the compression ratio gets high, such as odd effects across the boundaries of 8x8 blocks. For high compression ratios, other techniques such as wavelet compression appear to give more satisfactory results.

An overview of the JPEG compression process is given in Figure 3.3. We will cover each of the steps in this process. The inputs to JPEG are three color planes of 8-bits per-pixel each representing Red, Blue and Green (RGB).

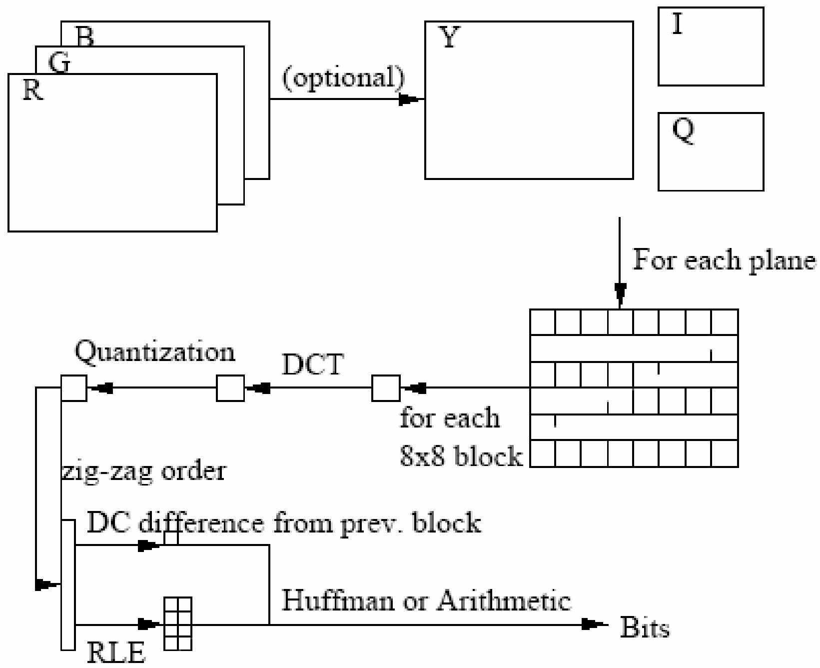


Figure 3.3: Steps in JPEG compression

These are the colors used by hardware to generate images. The first step of JPEG compression, which is optional, is to convert these into YIQ color planes. The YIQ color planes are designed to better represent human perception and are what are used on analog TVs in the US (the NTSC standard). The Y plane is designed to represent the brightness (luminance) of the image. It is a weighted average of red, blue and green (0.59 Green + 0.30 Red + 0.11 Blue). The weights are not balanced since the human eye is more responsive to green than to red, and more to red than to blue. The I (interphase) and Q (quadrature) components represent the color hue (chrominance). Likes an old black-and-white television, it uses only the Y signal and drops the I and Q components, which are carried on a sub-carrier signal. The reason for converting to YIQ is that it is more important in terms of perception to get the intensity right than the hue. Therefore JPEG keeps all pixels for the intensity, but typically down samples the two color planes by a factor of 2 in each dimension (a total factor of 4). This is the first lossy component of JPEG and gives a factor of 2 compression: (1 + 2 * 0.25) / 3 = 0.5

The next step of the JPEG algorithm is to partition each of the color planes into 8x8 blocks. Each of these blocks is then coded separately. The first step in coding a block is to apply a cosine transform across both dimensions. This returns an 8x8 block of 8-bit frequency terms. So far this does not introduce any loss, or compression. The block-size is motivated by wanting it to be large enough to capture some frequency components but not so large that it causes “frequency spilling”. In particular if we cosine-transformed the whole image, a sharp boundary anywhere in a line would cause high values across all frequency components in that line. After the cosine transform, the next step applied to the blocks is to use uniform scalar quantization on each of the frequency terms. This quantization is controllable based on user parameters and is the main source of information loss in JPEG compression. Since the human eye is more perceptive to certain frequency components than to others, JPEG allows the quantization scaling factor to be different for each frequency component. The scaling factors are specified using an 8x8 table that simply is used to element-wise divide the 8x8 table of frequency components. JPEG defines standard quantization tables for both the Y and I-Q components.

The table for Y is shown in Table 3.1. In this table the largest components are in the lower-right corner. This is because these are the highest frequency components which humans are less sensitive to than the lower-frequency components in the upper-left corner. The selection of the particular numbers in the table seems magic, for example the table is not even symmetric, but it is based on studies of human perception.
If desired, the coder can use a different quantization table and send the table in the head of the message. To further compress the image, the whole resulting table can be divided by a constant, which is a scalar “quality control” given to the user. The result of the quantization will often drop most of the terms in the lower left to zero. JPEG compression then compresses the DC component (upper-leftmost) separately from the other components. In particular it uses a difference coding by subtracting the value given by the DC component of the previous block from the DC component of this block. It then Huffman or arithmetic codes this difference. The motivation for this method is that the DC component is often similar from block-to-block so that difference coding it will give

better compression. The other components (the AC components) are now compressed. They are first converted into a linear order by traversing the frequency table in a zig-zag order (see Figure 3.4). The motivation for this order is that it keeps frequencies of approximately equal length close to each other in the linear-order. In particular most of the zeros will appear as one large contiguous block at the end of the order. A form of run-length coding is used to compress the linear-order. It is coded as a sequence of (skip,value) pairs, where skip is the number of zeros before a value, and value is the value. The special pair (0,0) specifies the end of block. For example, the sequence [4,3,0,0,1,0,0,0,1,0,0,0,...] is represented as [(0,4),(0,3),(2,1),(3,1),(0,0)]. This sequence is then compressed using either arithmetic or Huffman coding. Which of the two coding schemes used is specified on a per-image basis in the header.

16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

Table 3.1: JPEG default quantization table, luminance plane.

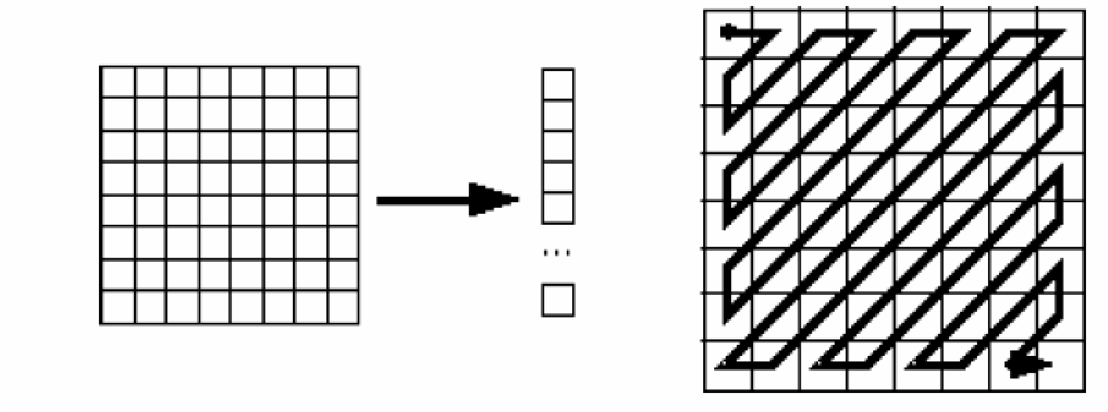


Figure 3.4: Zig-zag scanning of JPEG blocks

3.8.2 FRACTAL COMPRESSION

A function *f(x)* is said to have a fixed x_f if $x_f=f(x_f)$. For example:

$$\begin{aligned} f(x) &= ax + b \\ \Rightarrow x_f &= \frac{b}{1-a} \end{aligned}$$

This was a simple case. Many functions may be too complex to solve directly. Or a function may be a black box, whose formal definition is not known. In that case, we might try an iterative approach. Keep feeding numbers back through the function in hopes that we will converge on a solution:

$$\begin{aligned} x_0 &= \text{guess} \\ x_i &= f(x_{i-1}) \end{aligned}$$

For example, suppose that we have *f(x)* as a black box. We might guess zero as x_0 and iterate from there:

x_0	0
x_1	$f(x_0) = 1$
x_2	$f(x_1) = 1.5$
x_3	$f(x_2) = 1.75$
x_4	$f(x_3) = 1.875$

x_5 $f(x_4) = 1.9375$

x_6 $f(x_5) = 1.96875$

x_7 $f(x_6) = 1.984375$

x_8 $f(x_7) = 1.9921875$

In this example, $f(x)$ was actually defined ½ x + 1. The exact fixed point is 2, and the iterative solution was converging upon this value. Iteration is by no means guaranteed to find a fixed point. Not all functions have a single fixed point. Functions may have no fixed point, many fixed points, or an infinite number of fixed points. Even if a function has a fixed point, iteration may not necessarily converge upon it. In the above example, we were able to associate a fixed-point value with a function. If we were given only the function, we would be able to recompute the fixed-point value. Put differently, if we wish to transmit a value, we could instead transmit a function that iteratively converges on that value.

This is the idea behind fractal compression. However, we are not interested in transmitting simple numbers, like "2". Rather, we wish to transmit entire images. Our fixed points will be images. The functions, then, will be mappings from images to images. The encoder will operate roughly as follows:

1. Given an image, *i*, from the set of all possible images, *Image.*
2. Compute a function $f : Image \rightarrow Image$ such as $f(i) \approx i$.
3. Transmit the coefficients that uniquely identify *f*.

Now, the decoder will use the coefficients to reassemble f and reconstruct its fixed point, the image:

1. Receive coefficients that uniquely identify some function $f: Image \rightarrow Image$.
2. Iterate *f* repeatedly until its value converges on a fixed image, *i*.
3. Present the decompressed image, *i*.

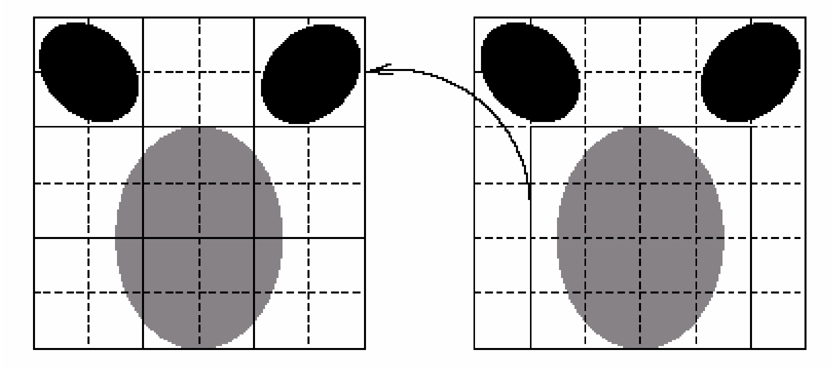


Figure 3.5: Identifying self-similarity. Range blocks appear on the left; one domain block appears on the left. The arrow identifies one of several collage function that would be composites into a complete image.

Clearly we will not be using entirely arbitrary functions here. We want to choose functions from some family that the encoder and decoder have agreed upon in advance. The members of this family should be identifiable simply by specifying the values for a small number of coefficients. The functions should have fixed points that may be found via iteration, and must not take unduly long to converge.

Figure 3.5 shows a simplified example of decomposing an image info collage of itself. Note that the encoder starts with the subdivided image on the right. For each "range" block, the encoder searchers for a similar "domain" block elsewhere in the image. We generally want domain blocks to be larger than range blocks to ensure good convergence at decoding time.

3.8.3 MODEL-BASED COMPRESSION

The idea here is to characterize the source data in terms of some strong underlying model. The popular example here is faces. We might devise a general model of human faces, describing them in terms of anatomical parameters like nose shape, eye separation, skin color, cheekbone angle, and so on. Instead of transmitting the image of a face, we could transmit the parameters that define that face within our general model. Assuming that we have a suitable model for the data at hand, we may be able to describe the entire system using only a few bytes of parameter data. Both sender and receiver share a large body of *a priori* knowledge contained in the model itself (e.g., the fact that faces have two eyes and one nose). The more information is shared in the model, the less need be transmitted with any given data set. Like wavelet compression, model-based compression works by characterizing data in terms of a deeper underlying generator. Model-based encoding has found applicability in such areas as computerized recognition of four-legged animals or facial expressions.

CHAPTER IV

IMPLEMENTATION OF WAVELET IMAGE COMPRESSION IN MAP ONLINE PROTOTYPE

4.1 INTRODUCTION

As mentioned before, Map Online System Prototype was the prototype system for end-user to get information their place around. All maps image will be displayed in catalogue system. Registered users can access the map all over Malaysia by upgrading their level in this system. For the first 15 days, users will give free evaluation registration. But user is unable to make purchasing for the map. The limited registration permits users only for viewing the all Malaysia maps only for 15 days. This chapter will describe about process in development of Map Online System Prototype thoroughly.

4.2 PLANNING FOR MAPONLINE

4.2.1 DATABASE PLANNING

Database planning is a critical part in system development. Normally database management system is essential in development of dynamic website. Database need to be managed and designed properly. Proper database delivers efficient and effective data for the system. There were many type of database out there that could be applied in web. For instances SQL Server, PostgreSQL, MySQL, and so on. But for Map Online System Prototype, MySQL database had chosen to manage data and designing database structure. Compatibility of MySQL and PHP Hypertext Preprocessor (PHP) make it more convenient to manage. For the system, the vision of database planning is to design database using MySQL that could be used to store topographic maps and thematic. From the observations on the other system, it also applied the common concept. Database planning was useful to detect every weakness and strength of the system as a guideline for the thorough development phase. Figure 4.1 shows the process in database planning.

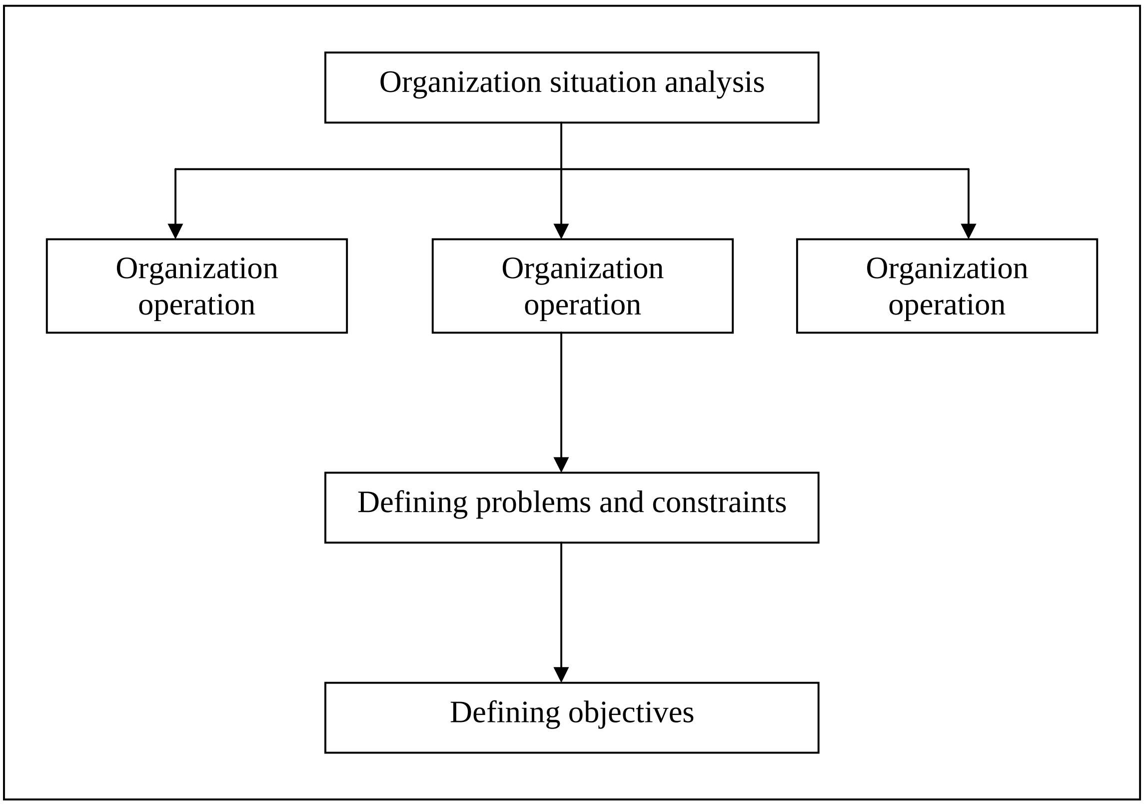


Figure 4.1: Database Planning Activities

4.3 SYSTEM VISUALIZATION

4.3.1 CONTEXT DIAGRAM

MapOnline System is a critical system that needs a solid visual view. This view has to be switched to actual system. Context diagram created to visualize the relationship between outside entity and Maponline System. Outside entity consists of personnel or other system that interacts with MapOnline. Context diagram was Top-Level View in Information System. All outside entity located around the process parameter and connected by data flow. Storage data could not viewed because it was internal process in MapOnline. Figure 4.1 shows to entity, System User and System Administrator connected to MapOnline system by data flow.

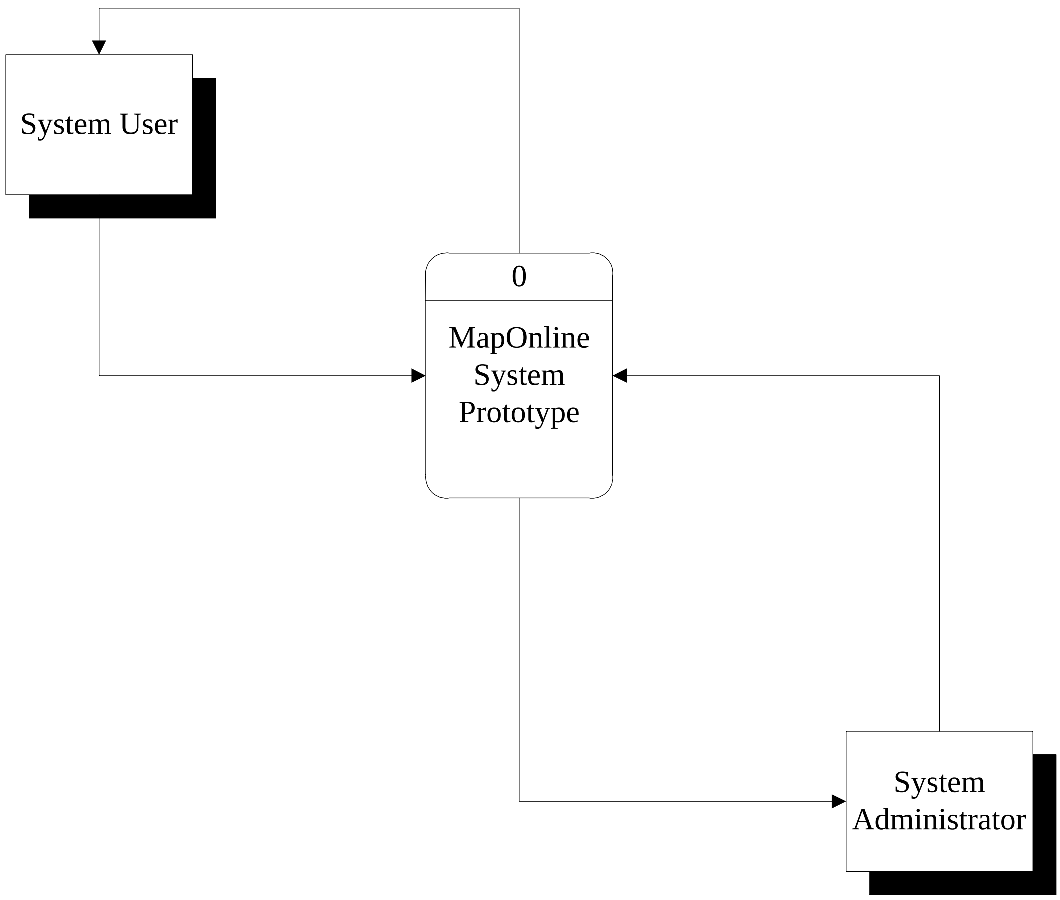


Figure 4.1: MapOnline System Prototype Context Diagram

4.3.2 Data Flow Diagram – DFD

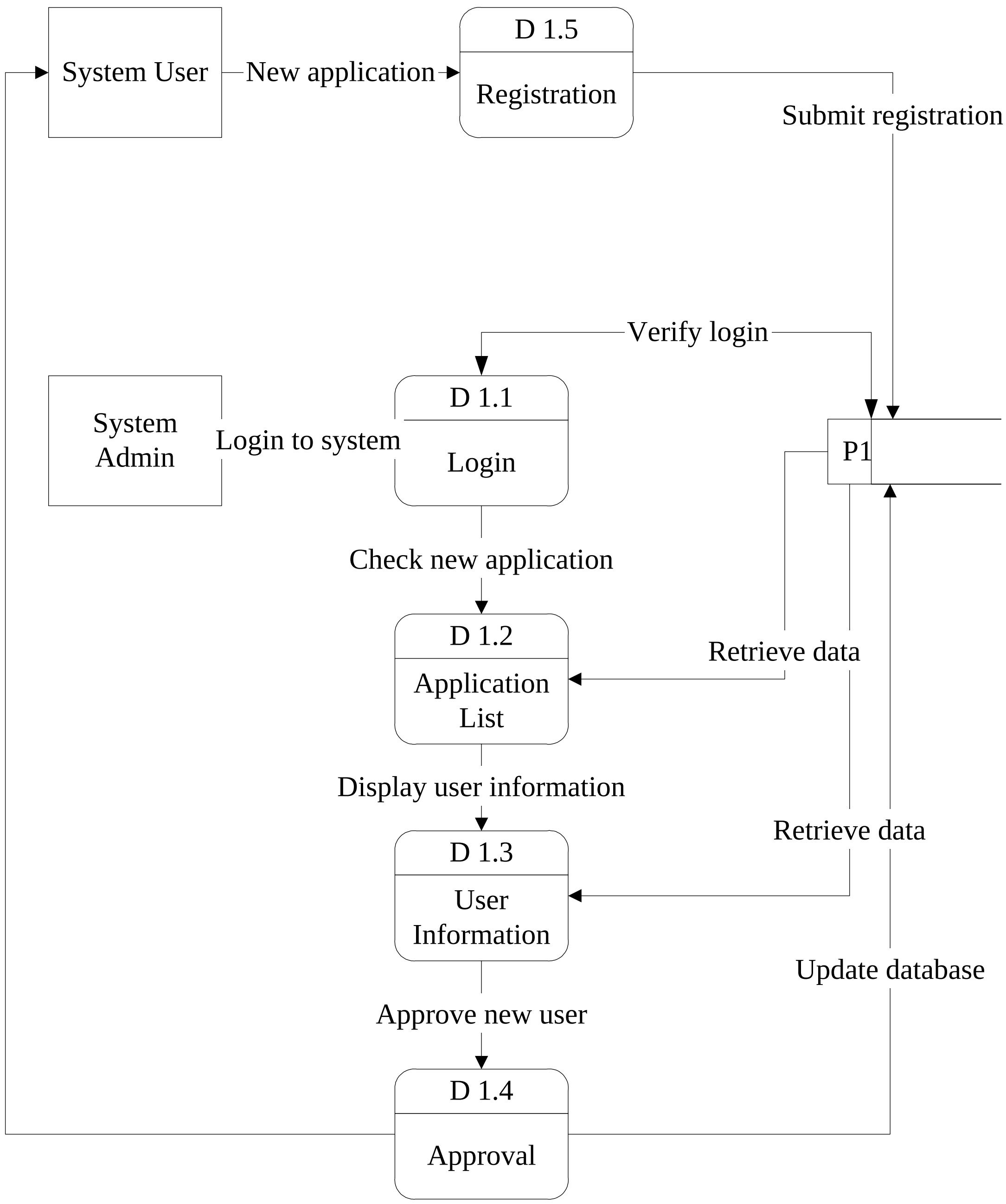


Figure 4.2: Data Flow Diagram for User Registration

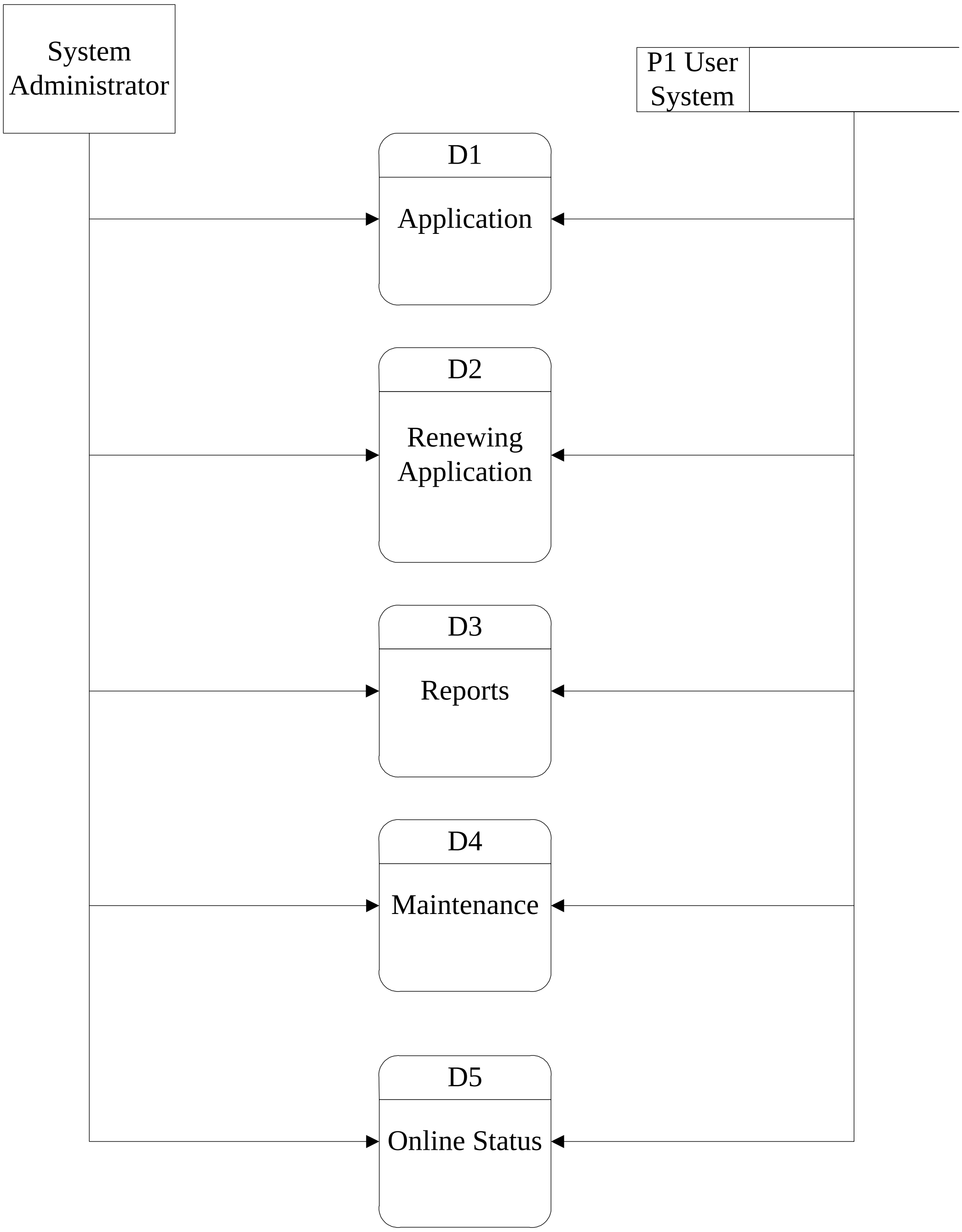


Figure 4.3: Data Flow Diagram for Administrator

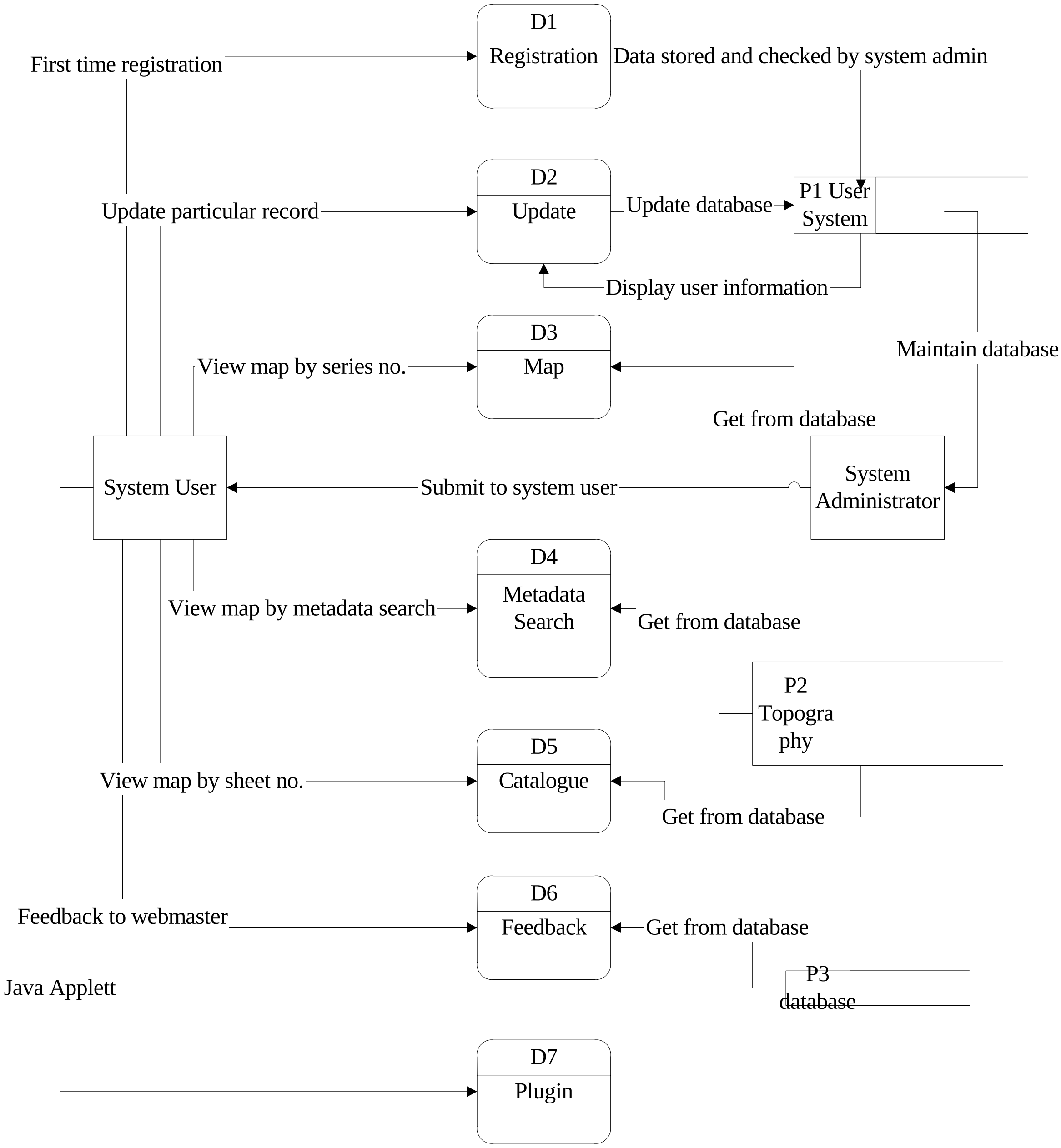
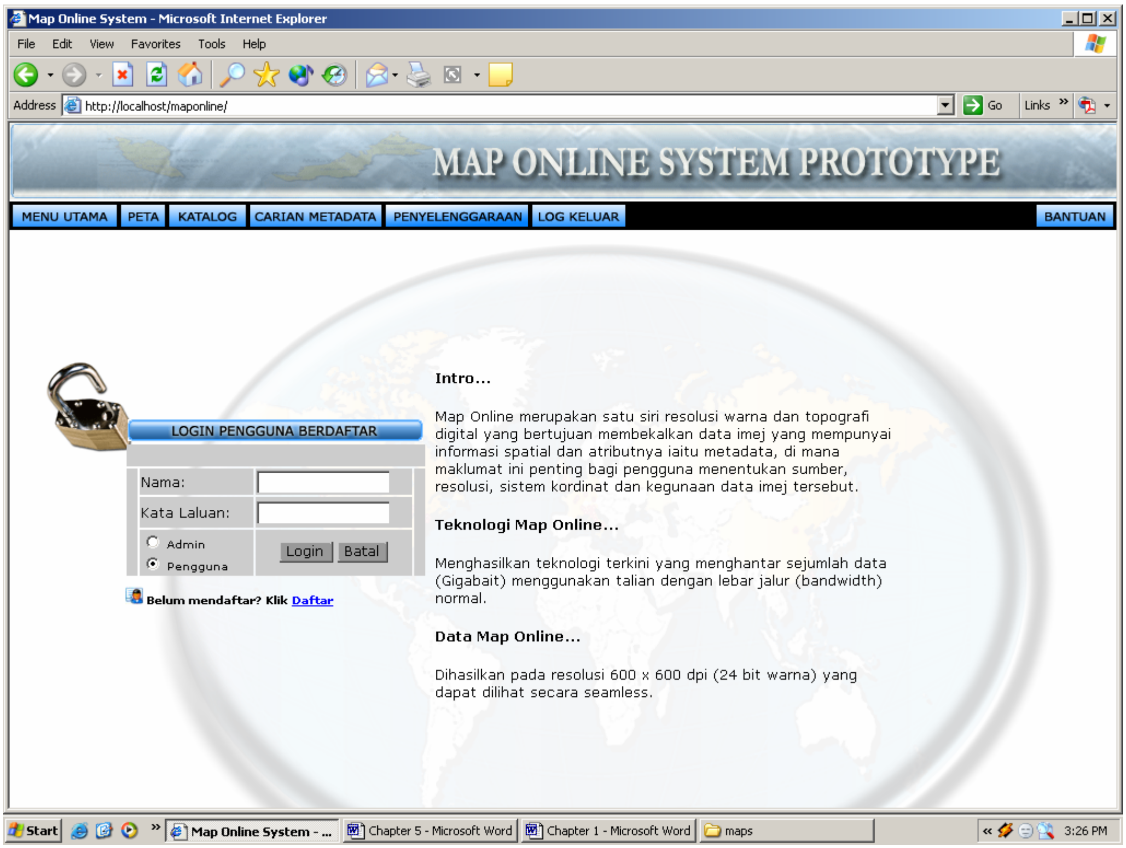


Figure 4.3: Data Flow Diagram for MapOnline System Prototype

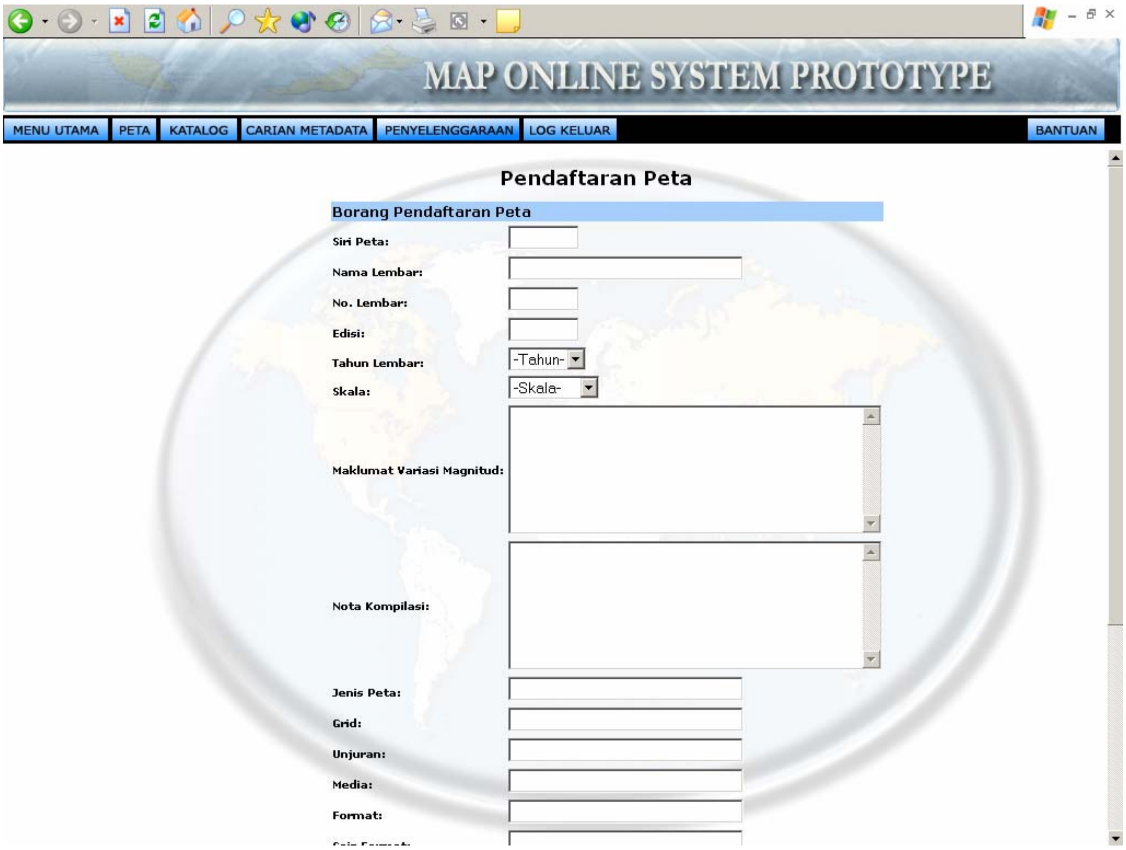
4.3 USER INTERFACE FOR MAP ONLINE SYSTEM PROTOTYPE

4.3.1 Main Page



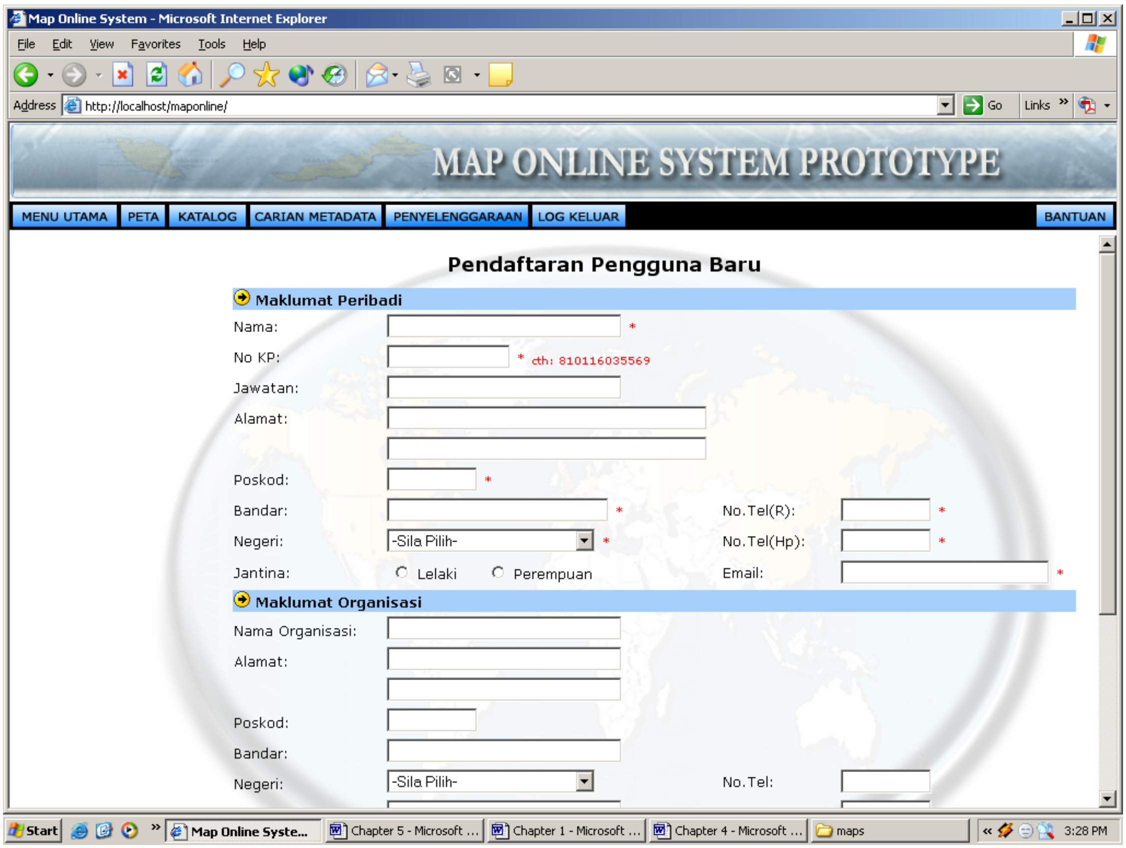
Firstly, user must pass through the interactive and user-friendly main page. Registered users must key-in their login name and password. Interactively, if someone who entered wrong combination or wrong password and login name, system will automatically generate alert. So, to be authorized users, they must be registered by click the link.

4.3.2 Maps Registration Page



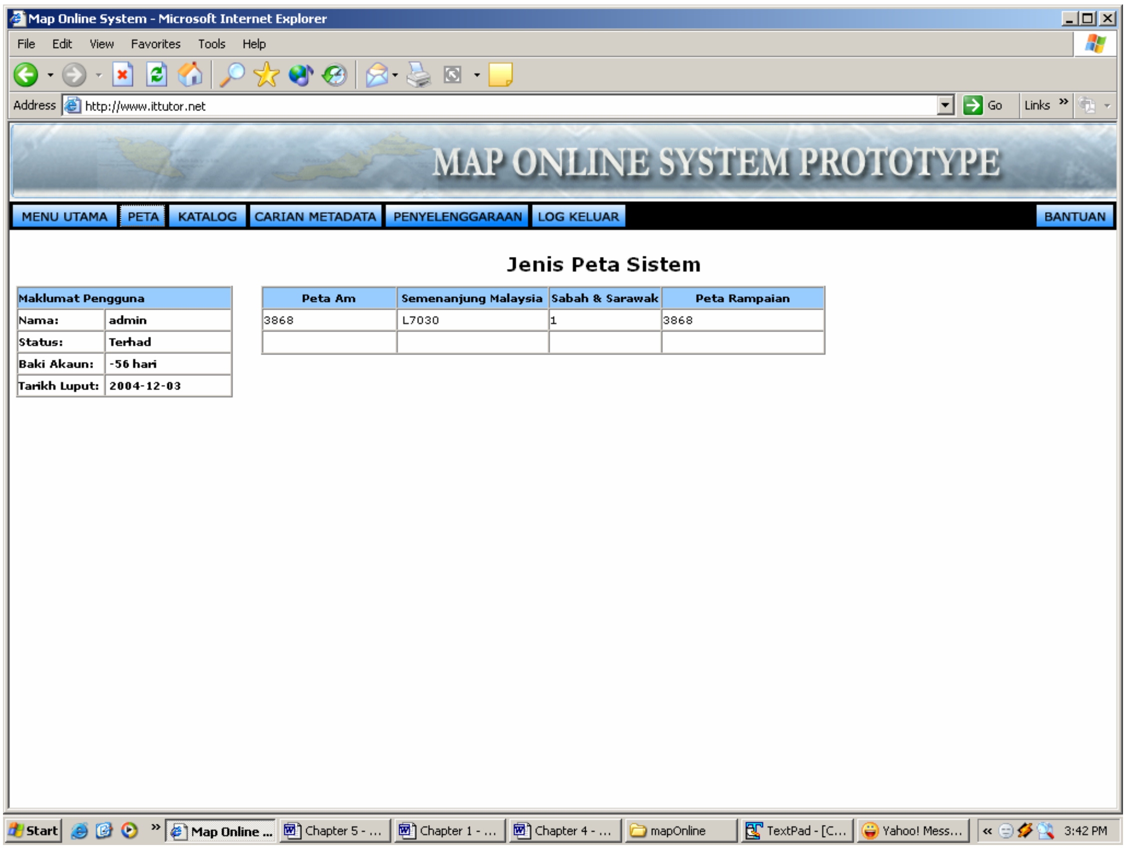
This page is restricted to normal user. Only admin has permitted to upload map images. Every field must be filled because it is important to make any metadata search.

4.3.3 User Registration Page

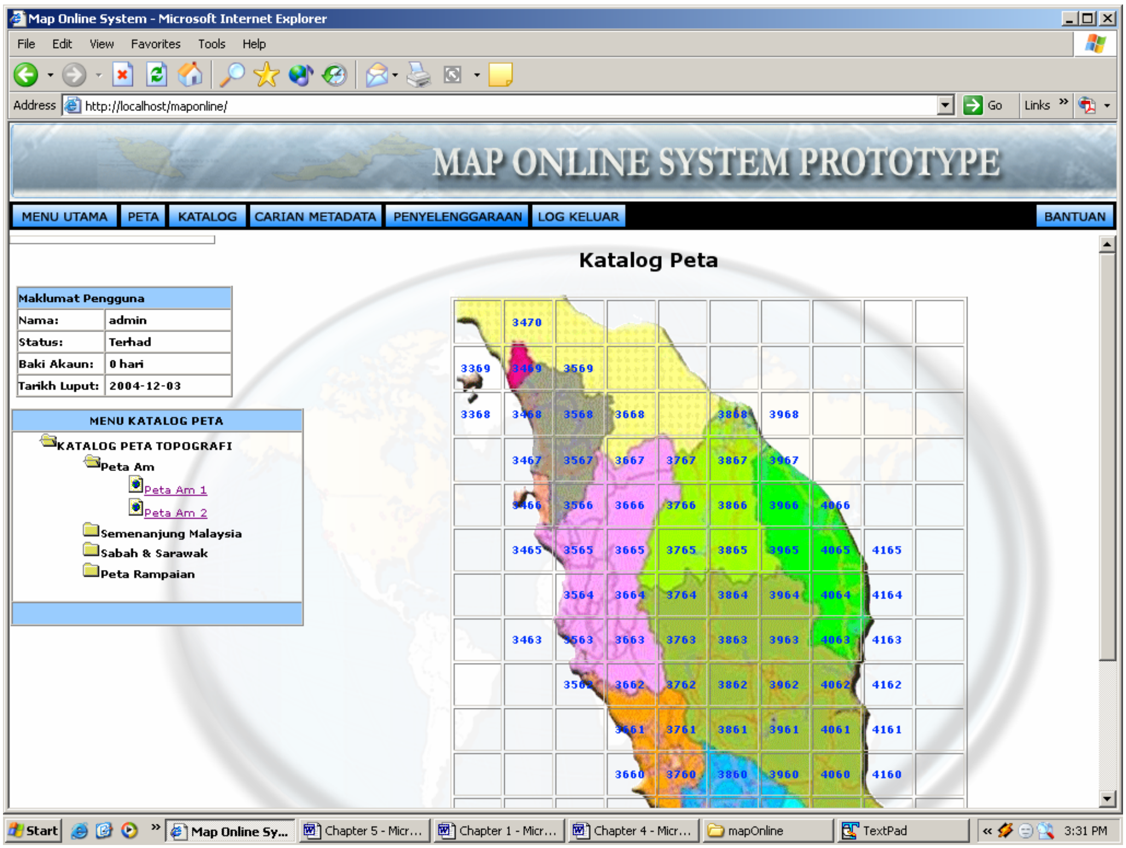


4.3.4 MapOnline Main Menu

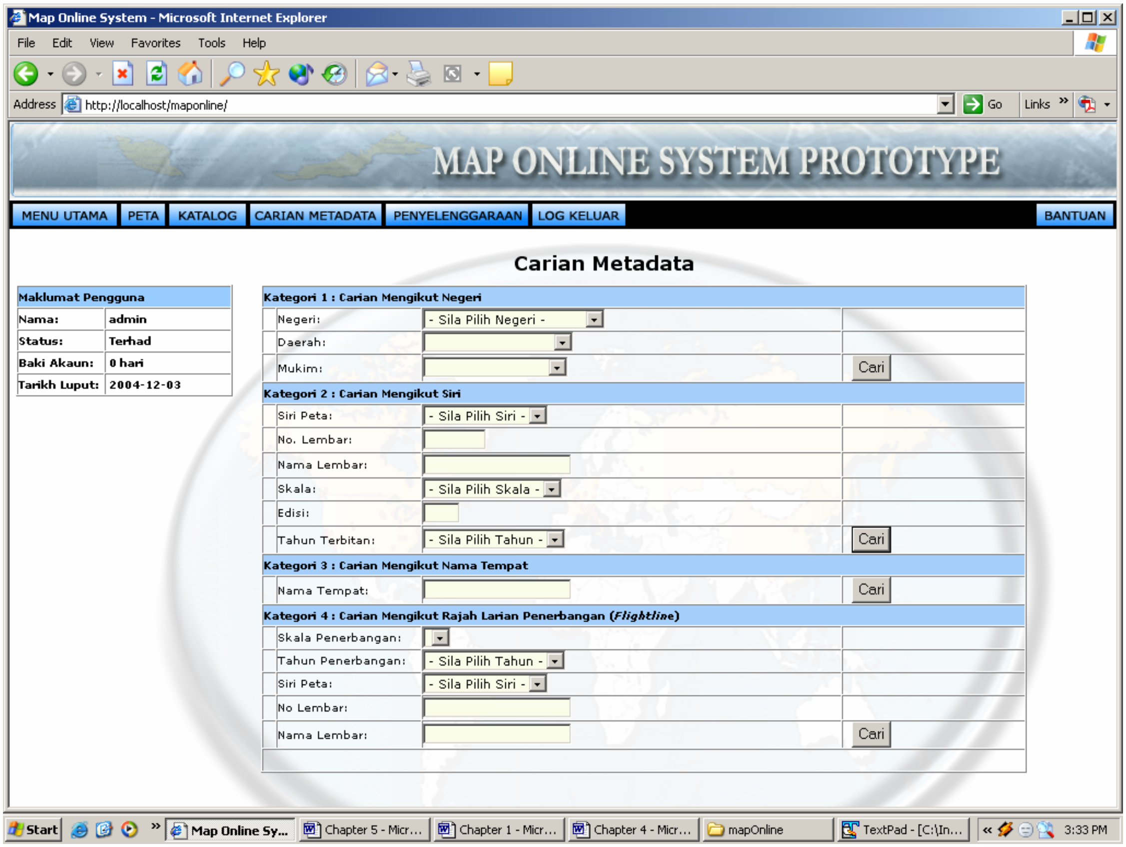
4.3.5 View Map by Serial Number



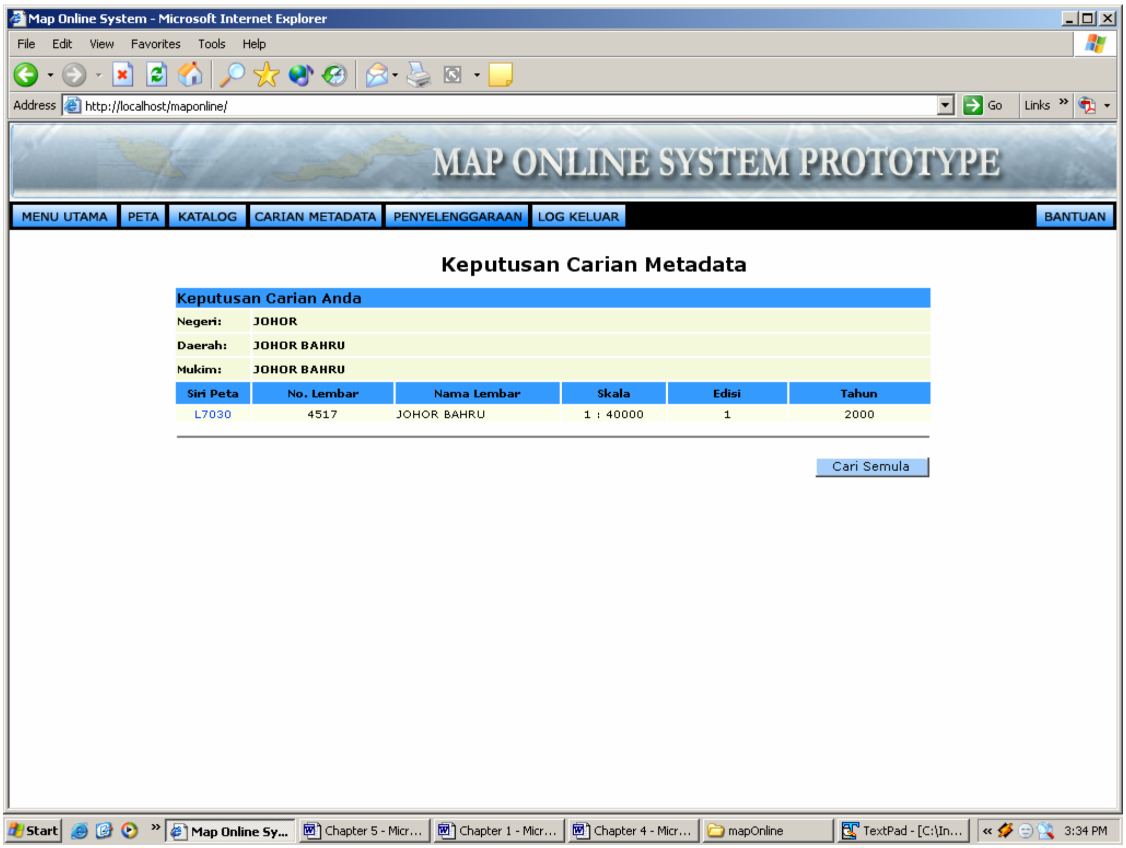
4.3.6 View Maps by Sheets Number



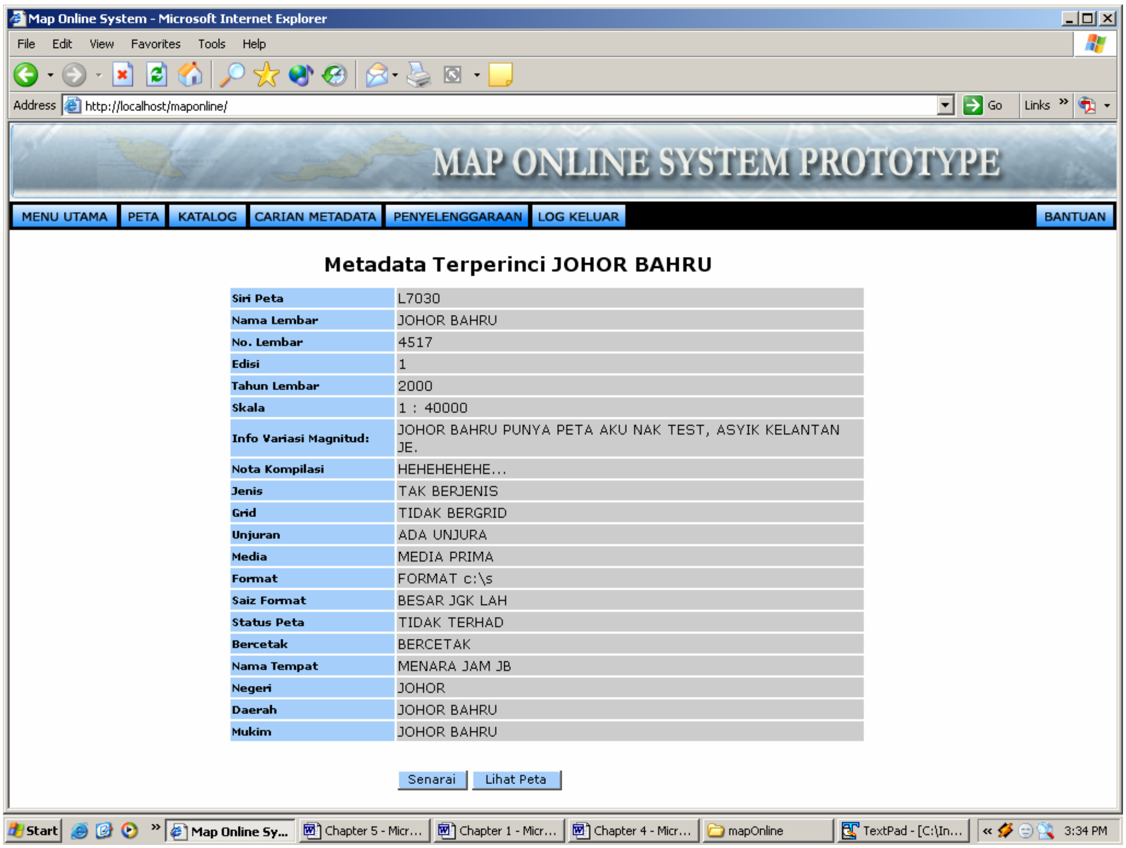
4.3.7 View Maps by Metadata Search Method



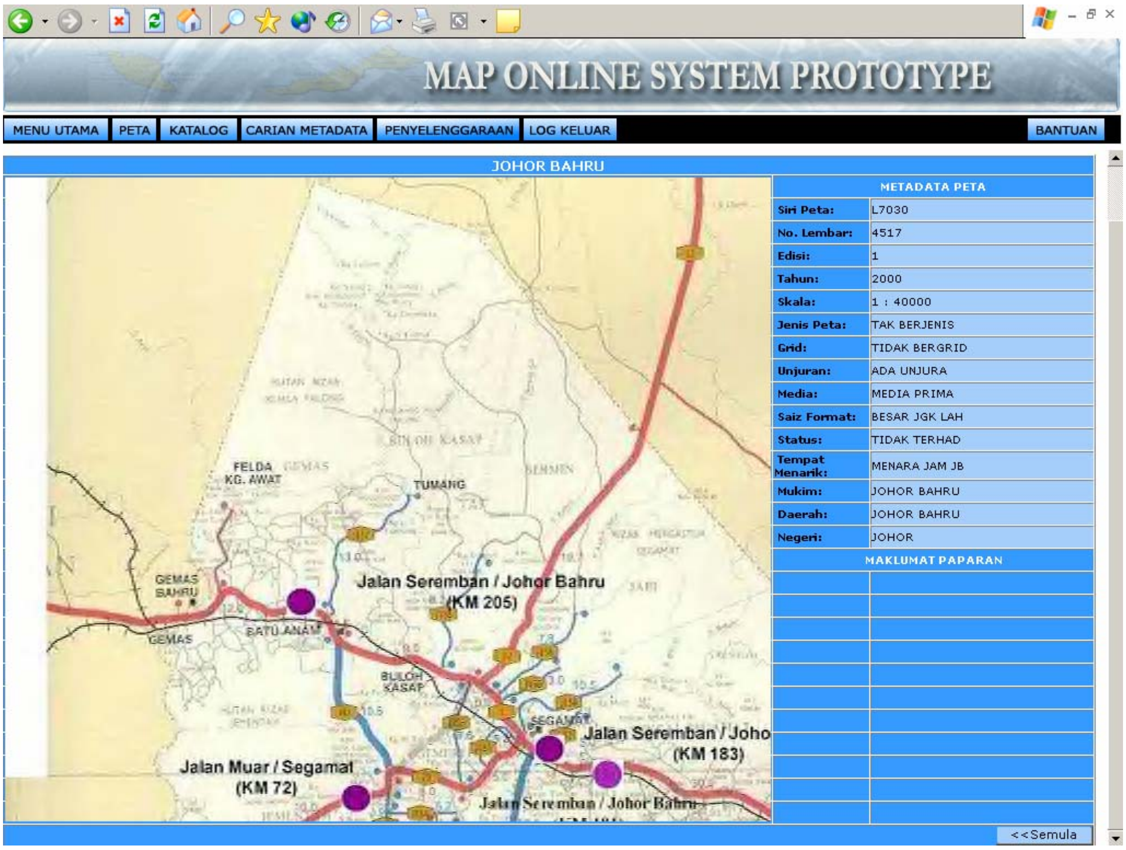
4.3.8 Display result for Metadata Search method



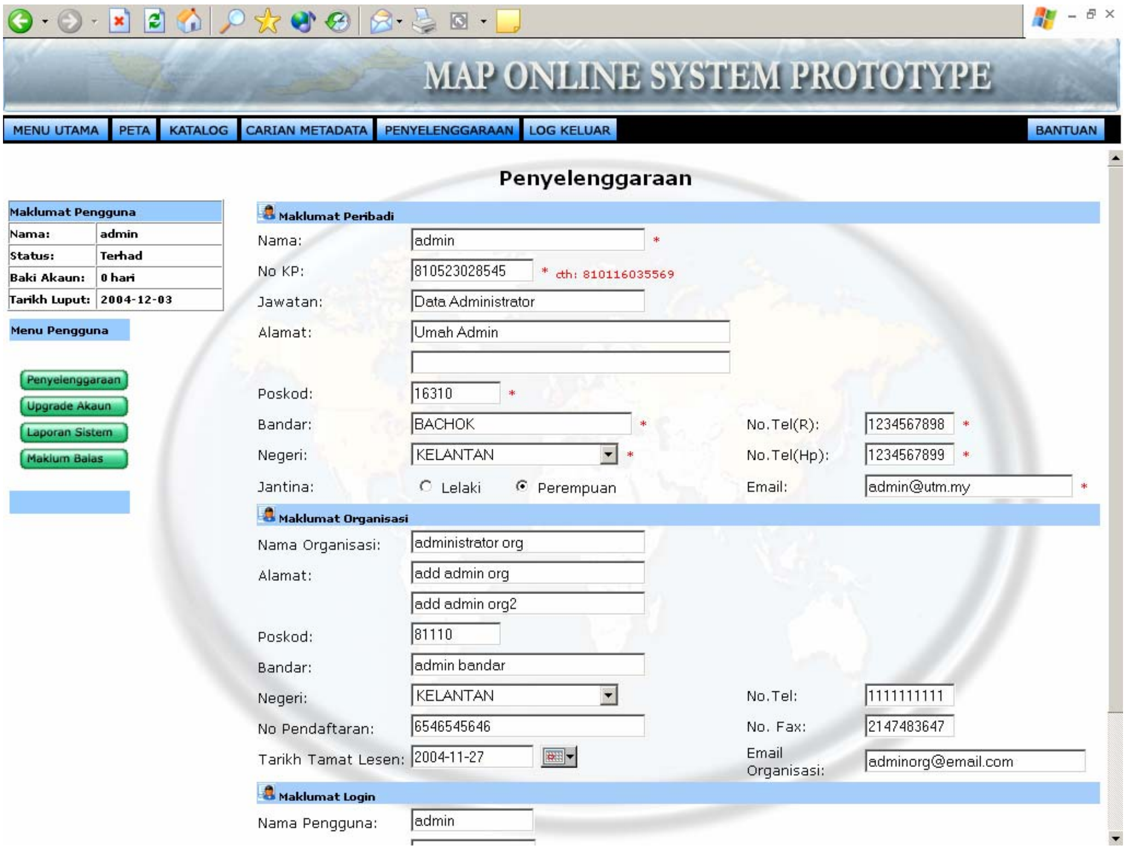
4.3.9 Map's Details Metadata Pages



4.3.10 Display Maps for Selected Metadata



4.3.11 User Particular Update



CHAPTER V

CONCLUSION

Based on the discussion on previous topic, clearly that wavelet image compression technique is more reliable and produce the best image than others. The quality of the still map images is preserved. Besides that capacity of storage is very economic.

BENEFIT REPORT

I. Description of the Project

A. Project Identification

1. Project number : 75080
2. Project title : Map Online System Using Internet-based Image Catalogue
3. Project Leader : Encik Noor Azam bin Md Sheriff

B. Type of research

Indicate the type of research of the project *(Please see definitions in the Guidelines for completing the Application Form)*

√	Scientific research (fundamental research)
	Technology development (applied research)
	Product/process development (design and engineering)
	Social/policy research

C. Objectives of the project

1. Socio-economic objectives

   Which socio-economic objectives are addressed by the project? *(Please identify the sector, SEO Category and SEO Group under which the project falls. Refer the Malaysian R&D Classification System brochure for SEO Group code)*

   Sector : 9

   SEO Category : 1

   SEO Group and Code : S 50105

2. Fields of research

   Which are the two main FOR Categories, FOR Group, and FOR Areas of your project? *(Please refer to the Malaysia R&D Classification System brochure for the FOR Group Code)*

   a. Primary field of research

      FOR Category: F10500

      FOR Group and Code: Information Systems F10501

      FOR Area: Compression techniques, GIS, Information System Management

b. Secondary field of research

FOR Category: F10500

FOR Group and Code: Current Information Technology F10504

FOR Area: Others current information technology

D. Project duration

What was the duration of the project?

1 February 2004 – 31 January 2005 (12 months)

E. Project manpower

How many man-months did the project involve?

F. Project costs

What were the total project expenses of the project

RM 24,000.00

G. Project funding

Which were the funding sources for the project?

Funding sources	**Total Allocation (RM)**
RMC	RM 24,000.00

II. Direct Output of the Project

A. Technical contribution of the project

1. What was the achieved direct output of the project:

For scientific (fundamental) research projects?

- [ ] Algorithm
- [ ] Structure
- [x] Data
- [ ] Other, Please specify:

____

For technology development (applied research) project:

- [ ] Method/technique
- [x] Demonstrator/prototype
- [ ] Other, Please specify:

____

For product/process development (design and engineering) projects:

- [ ] Product/component
- [x] Process
- [ ] Software
- [ ] Other, Please specify:

____

2. How would you characterize the quality of this output?

- [x] Significant breakthrough
- [ ] Major improvement
- [ ] Minor improvement

B. Contribution of the project knowledge

1. How has the output of the project been documented?

- [√] Detailed project report
- [ ] Product/process specification documents
- [ ] Other, please specify:

____

2. Did the project create an intellectual property stock?

- [ ] Patent obtained
- [ ] Patent pending
- [ ] Patent application will be filed
- [√] Copyright

3. What publications are available?

- [ ] Articles (s) in scientific publications How many:
- [ ] Papers (s) delivered at conferences/seminars How many:
- [ ] Book
- [√] Other, Please specify:

Technical report for RMC

4. How significant are citations of the results?

- [ ] Citations in national publications How many:
- [ ] Citations in international publications How many:
- [√] Not Yet
- [ ] Not known

III. Organizational Outcomes of the Project

A. Contribution of the project to expertise development

1. How did the project contribute to expertise?

- [ ] PhD degrees — How many:
- [ ] MSc degrees — How many:
- [√] Research staff with new specialty — How many: 1
- [ ] Other, Please specify:

____

2. How significant is this expertise?

- [ ] One of the key areas of priority for Malaysia
- [√] An important area, but not a priority one

B. Economic contribution of the project?

1. How has the economic contribution of the project materialized?

- [ ] Sales of manufactured product/equipment
- [ ] Royalties from licensing
- [√] Cost saving
- [ ] Time saving
- [ ] Other, Please specify:

____

2. How important is this economic contribution?

- [ ] High economic contribution — Value : RM
- [√] Medium economic contribution — Value : RM 80,000
- [ ] Low economic contribution — Value : RM

3. How important is this economic contribution?

- [ ] Already materialized
- [ ] Within months of project completion
- [√] Within three years of project completion
- [ ] Expected in three of project completion
- [ ] Unknown

C. Infrastructural contribution of the project

1. **What infrastructural contribution has the project had?**

- [ ] New equipment Value : RM
- [ ] New/improved facility Investment : RM
- [x] New information networks
- [ ] Other, Please specify:

____

2. **How significant is this infrastructural contribution for the organization?**

- [ ] Not significant/does not leverage other projects
- [x] Moderately significant
- [ ] Very significant/significantly leverages other projects

D. Contribution of the project to the organization's reputation

1. **How has the project contributed to increasing the reputation of the organization**

- [ ] Recognition as a Centre of Excellence
- [ ] National award
- [ ] International award
- [x] Demand for advisory services
- [ ] Invitations to give speeches on conferences
- [ ] Visits from other organization
- [ ] Other, Please specify:

____

2. **How important is the project's contribution to the organization's reputation?**

- [ ] Not significant
- [x] Moderately significant
- [ ] Very significant

IV. National Impacts of the Project

A. Contribution of the project to organizational linkages

1. Which kinds of linkages did the project create?

- [√] Domestic industry linkages
- [ ] International industry linkages
- [ ] Linkages with domestic research institutions, universities
- [ ] Linkages with international research institutions, universities

2. What is the nature of the linkages

- [ ] Staff exchanges
- [ ] Inter-organizational project team
- [ ] Research contract with a commercial client
- [√] Informal consultation
- [ ] Other, Please specify:

B. Social-economic contribution of the project

1. Who are the direct customer/beneficiaries of the project output?

Customers/beneficiaries: **Number:**

2. Who has/will the socio-economic contribution of the project materialized?

- [ ] Improvements in health
- [ ] Improvements in safety
- [ ] Improvements in the environment
- [ ] Improvements in the energy consumption
- [ ] Improvements in the international relations
- [x] √ Other, Please specify:

Improve in provision of IT services

3. How important is this socio-economic contribution?

- [ ] High social contribution
- [x] √ Medium social contribution
- [ ] Low social contribution

4. When has/will this social contribution materialized?

- [ ] Already materialized
- [ ] Within three years of project completion
- [x] √ Expected in three years or more
- [ ] Unknown

Date: **Signature:**

End of Project Report Guidelines

A. Purpose

The purpose of the End of Project is to allow the IRPA Panels and their supporting group of experts to assess the results of research projects and the technology transfer actions to be taken.

B. Information Required

The following Information is required in the End of Project Report :

- Project summary for the Annual MPKSN Report;
- Extent of achievement of the original project objectives;
- Technology transfer and commercialisation approach;
- Benefits of the project, particularly project outputs and organisational outcomes; and
- Assessment of the project team, research approach, project schedule and project costs.

C. Responsibility

The End of Project Report should be completed by the Project Leader of the IRPA-funded project.

D. Timing

The End of Project Report should be submitted within three months of the completion of the research project.

E. Submission Procedure

One copy of the End of Project is to be mailed to :

IRPA Secretariat
Ministry of Science, Technology and the Environment
14th Floor, Wisma Sime Darby
Jalan Raja Laut
55662 Kuala Lumpur

End of Project Report

A. **Project number:** 75080

Project title: Map Online System Using Internet-based Image Catalogue

Project leader: Encik Noor Azam bin Md Sheriff

Tel: 07 – 5532322 **Fax:** 07 – 5565044

B. **Summary for the MPKSN Report (**for publication in the Annual MPKSN Report, please summarise the project objectives, significant results achieved, research approach and team strucure)

Digital maps carry along its geodata information such as coordinate that is important in one particular topographic and thematic map. These geodatas are meaningful especially in a military field. Usually, the size of this map is big and need a big storage to store this data in the database. Thus, its will take more time for data downloading process using an image catalogue approach on the internet. According to time consuming and data transmitting factor, we used an image compression techniques to solve the problem. On the other hand, a comparisons study of image compression techniques for geodata such as topographic and thematic map has been done. With image compression techniques, the storage size of the image can be reduced without affected the quality of the image. This research focused on image compression techniques using wavelet technology. As a result, the compressed images will be applied to a system called Map Online. A benchmarking of the result for the compressed geodata transmitting over intranet and Internet connection has been done to prove the reliability of the techniques. The knowledge gathered from this study is very useful to for JUPEM and others government agency to implement a Map Online System in order to produce higher quality of images data transmitting.

C. Objectives achievement

- **Original project objectives** (Please state the specific project objectives as described in Section ll of the Application Form)

i) To study the image compression technique to be applied in Map Online system using Internet-based Image Catalogue
ii) To develop database for topographic
iii) Evaluate the performance of chosen image compression techniques.

- **Objectives Achieved** (Please state the extent to which the project objectives were achieved)

i) To study the image compression technique to be applied in Map Online system using Internet-based Image Catalogue
ii) To develop database for topographic
iii) Evaluate the performance of chosen image compression techniques.

- **Objectives not achieved** (Please identify the objectives that were not achieved and give reasons)

-

D. Technology Transfer/Commercialisation Approach (Please describe the approach planned to transfer/commercialise the results of the project)

In order to commercialise this research output, the transmitting time of the compressed image over the intranet and internet connection should be carry out and then the results obtained should be test at JUPEM. The prototype of **Map Online System** should be used in JUPEN in order to grow the potential of the product.

E. Benefits of the Project (Please identify the actual benefits arising from the project as defined in Section lll of the Application Form. For examples of outputs, organisational outcomes and sectoral/national impacts, please refer to Section lll of the Guidelines for the Application of R&D Funding under IRPA)

- **Outputs of the project and potential beneficiaries** (Please describe as specifically as possible the outputs achieved and provide an assessment of their significance to users)

1. A design of Map Online System Using Internet-based Image Catalogue
2. A comparisons study of image compression techniques for geodata such as topographic and thematic map.
3. A benchmarking result for the compressed geodata transmitting over intranet and Internet connection.
4. The knowledge gathered from this study is very useful to for JUPEM and others government agency.

- **Organisational Outcomes** (Please describe as specifically as possible the organisational benefits arising from the project and provide an assessment of their significance)

The benefits of this project are directly polishing the ability of the researcher of the UTM on the image catalogue approach using image compression technique that been used in Map Online System. It's also will improve the staff knowledge on image compression techniques using wavelet technology; particularly to deal with image size that can be reduced without affected the quality of the image.

- **National Impacts** (If known at this point in time, please describes specifically as possible the potential sectoral/national benefits arising from the project and provide an assessment of their significance)

The knowledge gathered from this research is very useful to for JUPEM and others government agency to implement a Map Online System in order to produce higher quality of images data transmitting. Output of this research can be used to cut the cost of buying high-priced software at the same level.

F. Assessment of project structure

- **Project Team** (Please provide an assessment of how the project team performed and highlight any significant departures from plan in either structure or actual man-days utilised)

  In order to complete this project, the project members have show a good performance and a highly team spirit. They finished their works on time.

- **Collaborations** (Please describe the nature of collaborations with other research organisations and/or industry)

  This research has collaborations with other faculty in UTM such as Faculty of Geoinfomation Science (FSKSG) and the government agency such as JUPEM.

G. Assessment of Research Approach (Please highlight the main steps actually performed and indicate any major departure from the planned approach or any major difficulty encountered)

The main steps actually performed as below;

i) Map Online system developed at the Department of Computer Graphic and Multimedia, FSKSM
ii) Comparison study of image compression techniques based on Internet-based Image Catalogue
iii) Evaluate the performance of chosen image compression techniques.
iv) Develop a database for compressed images.
v) Test transmitting time of the compressed image over the intranet and internet connection

H. Assessment of the Project Schedule (Please make any relevant comment regarding the actual duration of the project and highlight any significant variation from plan)

The actual duration of this project is good enough.

I. **Assessment of Project Costs** (Please comment on the appropriateness of the original budget and highlight any major departure from the planned budget)

Some of the equipment cannot be bought because the approved budget is not appropriate from to the planned budget.

J. **Additional Project Funding Obtained** (In case of involvement of other funding sources, please indicate the source and total funding provided)

No additional project funding obtained

K. **Other Remarks** (Please include any other comment which you feel is relevant for the evaluation of this project)

None

Date : **Signature :**

UNIVERSITI TEKNOLOGI MALAYSIA
Research Management Centre

PRELIMINARY IP SCREENING & TECHNOLOGY ASSESSMENT FORM

(To be completed by Project Leader submission of Final Report to RMC or whenever IP protection arrangement is required)

1. **PROJECT TITLE IDENTIFICATION** :

Map Online System Using Internet-based Image Catalogue **Vote No: 75080**

2. **PROJECT LEADER** :

Name : Noor Azam bin Md Sheriff

Address: Faculty of Computer Science and Information System

Universiti Teknologi Malaysia, 81310 Skudai, JOHOR

Tel : 07 – 5532322 **Fax :** 07 – 5565044 **e-mail :** azam@fsksm.utm.my

3. **DIRECT OUTPUT OF PROJECT** *(Please tick where applicable)*

Secientific Research	Applied Research	Product/Process Development
☑ Algorithm	☐ Method/Technique	☐ Product / Component
☐ Structure	☐ Demonstration / Prototype	☐ Process
☐ Data		☐ Software
☐ Other, please specify	☐ Other, please specify	☐ Other, please specify
____________	____________	____________
____________	____________	____________
____________	____________	____________

4. **INTELLECTUAL PROPERTY** *(Please tick where applicable)*

☑ Not patentable

☐ Patent search required

☐ Patent search completed and clean

☐ Invention remains confidential

☐ No publications pending

☐ No prior claims to the technology

☐ Technology protected by patents

☐ Patent pending

☐ Monograph available

☐ Inventor technology champion

☐ Inventor team player

☐ Industrial partner identified

5. LIST OF EQUIPMENT BOUGHT USING THIS VOT

1. Computers
2. Printer
3. Digital data capture

6. STATEMENT OF ACCOUNT

a)	APPROVED FUNDING	RM : 24,000.00
b)	TOTAL SPENDING	RM : -
c)	BALANCE	RM : -

7. TECHNICAL DESCRIPTION AND PERSPECTIVE

Please tick an executive summary of the new technology product, process, etc., describing how it works. Include brief analysis that compares it with competitive technology and signals the one that it may replace. Identify potential technology user group and the strategic means for exploitation.

a) Technology Description

Map Online System Prototype was the prototype system for end-user to get information their place around. All maps image will be displayed in catalogue system. Registered users can access the map all over Malaysia by upgrading their level in this system. For the first 15 days, users will give free evaluation registration. But user is unable to make purchasing for the map. The limited registration permits users only for viewing the all Malaysia maps only for 15 days. This chapter will describe about process in development of Map Online System Prototype thoroughly.

b) Market Potential

The output gathered from this study is very useful to for JUPEM and others government agency to implement a Map Online System in order to produce higher quality of images data transmitting.

c) Commercialisation Strategies

In order to commercialise this research, the prototype of **Map Online System** should be used in JUPEM and other govermance agencies

Signature of Projet Leader :- Date :-

8. RESEARCH PERFORMANCE EVALUATION

a) FACULTY RESEARCH COORDINATOR

	Excellent	Very Good	Good	Satisfactory	Fair	Weak
Research Status	( )	( )	( )	( )	( )	( )
Spending	( )	( )	( )	( )	( )	( )
Overall Status	( )	( )	( )	( )	( )	( )

Comment/Recommendations :

……………………………………………

Signature and stamp of
JKPP Chairman

Name : ………………………………………

Date : ………………………………………

b) RMC EVALUATION

Research Status	( )	( )	( )	( )	( )	( )
Spending	( )	( )	( )	( )	( )	( )
Overall Status	( )	( )	( )	( )	( )	( )
	Excellent	Very Good	Good	Satisfactory	Fair	Weak

Comments :-

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Recommendations :

☐ Needs further research

☐ Patent application recommended

☐ Market without patent

☐ No tangible product. Report to be filed as reference

……………………………………………….. Name : ………………………………………….

Signature and Stamp of Dean / Deputy Dean Date : ………………………………………….
Research Management Centre

Lampiran 20
UTM/RMC/F/0024 (1998)

UNIVERSITI TEKNOLOGI MALAYSIA

BORANG PENGESAHAN
LAPORAN AKHIR PENYELIDIKAN

TAJUK PROJEK: **MAP ONLINE SYSTEM USING INTERNET-BASED IMAGE CATALOGUE**

Saya **NOOR AZAM BIN MD SHERIFF**
(HURUF BESAR)

Mengaku membenarkan Laporan Akhir Penyelidikan ini disimpan di Perpustakaan Universiti Teknologi Malaysia dengan syarat-syarat kegunaan seperti berikut :

1. Laporan Akhir Penyelidikan ini adalah hakmilik Universiti Teknologi Malaysia
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3. Perpustakaan dibenarkan membuat penjualan salinan Laporan Akhir Penyelidikan ini bagi kategori TIDAK TERHAD
4. * Sila tandakan (/)

	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau Kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh Organisasi/badan di mana penyelidikan dijalankan)
√	TIDAK TERHAD	

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TANDATANGAN KETUA PENYELIDIK

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Nama & Cop Ketua Penyelidik

Tarikh : ________________