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# Watermarking Qr Code Application On Birth Certificates Using The Discrete Cosine Transform (Dct) Method

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**ABSTRAK**

Dokumen penting seperti kartu keluarga sering menjadi bahan pemalsuan. Maka dari itu kita harus mampu menjaga kerahasiaannya. Permasalahan ini bisa diatasi dengan metode watermarking. diambil oleh mesin dengan bentuk pendekatan berdasarkan sampling *Watermarking* adalah teknik yang dapat digunakan untuk menyisipkan informasi ke suatu citra. Citra digital merupakan representatif dari citra yang dan kuantisasi. Citra yang digunakan yaitu QR Code. Qr Code merupakan bentuk evolusi kode batang dari satu dimensi menjadi dua dimensi. Penelitian ini menggunakan *Algoritma Discrete Cosine Transform* (DCT). Algoritma DTC menjalankan konversi dari bentuk spasial dengan tujuan untuk memisahkan gambar pada sub bagian dengan ftingkatan rekuensi berbeda-beda. Penerapan *metode Discrete Cosine Transform (DCT)* dalam proses watermarking QR Code pada akta kelahiran telah berhasil memberikan kontribusi yang signifikan terhadap keamanan dan otentikasi dokumen tersebut. Dalam keseluruhan penerapan ini, DCT telah terbukti sebagai alat yang efektif dalam menyematkan informasi tambahan ke dalam gambar akta kelahiran tanpa mengorbankan integritas informasi utama. Namun, perlu diperhatikan bahwa penggunaan DCT juga dapat mempengaruhi kualitas visual gambar. Dengan demikian, penyesuaian parameter diperlukan untuk mencapai keseimbangan yang tepat antara keamanan dan estetika visual.

***ABSTRACT***

Modern developments lead us to better understand data security. Important documents such as family cards are often the subject of forgery. Therefore, we must be able to maintain confidentiality. This problem can be overcome with the watermarking method. Watermarking is a technique that can be used to insert information into an image. Digital images are representative of images taken by machines using an approach based on sampling and quantization. The image used is a QR Code. Qr Code is a form of evolution of bar codes from one dimension to two dimensions. This research uses the Discrete Cosine Transform (DCT) algorithm. The DTC algorithm carries out a conversion from spatial form with the aim of separating the image into subsections with different frequency levels. The application of the Discrete Cosine Transform (DCT) method in the QR Code watermarking process on birth certificates has succeeded in making a significant contribution to the security and authentication of these documents. In all of these applications, DCT has proven to be an effective tool in embedding additional information into birth certificate images without compromising the integrity of the primary information. However, it should be noted that the use of DCT can also affect the visual quality of the image. Thus, parameter adjustments are necessary to achieve the right balance between security and visual aesthetics.

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## 1. INTRODUCTION

In current developments, important documents, especially birth certificates, can be used as proof of identity and are often requested in various administrative processes such as registering for school, making passports or visas, opening bank accounts, and so on. Documents that have an important level like this have the potential to be falsified or manipulated by irresponsible parties. Because of this, affected individuals can experience quite serious problems, so special techniques are needed to protect these documents. One of the techniques to increase the security of birth certificates is to use watermarking techniques.

Watermarking is a technique that can be used to insert information into an image, with the aim of protecting authenticity and providing identification or copyright to the document. The digital image is a representation of the image taken by the device using a sampling and quantization approach. The sampling technique describes the number of boxes arranged in rows and columns. In the context of an image, the sampling technique indicates the size of the pixels (points) in the image, while quantization indicates the range of brightness level values represented in grayscale according to the number of binary bits used by the device. In other words, quantization of the image refers to the number of color variations contained in the image [1].

Watermarking can be explained as a method of inserting confidential information or data into other data to become part of it, while remaining undetectable by other parties using the main data [2]. The application of digital watermarking is based on the gaps or limitations of the human sense of sight and hearing, where humans tend to be less responsive to changes that occur [3]. This research applies the QR Code system. Qr Code is a form of barcode evolution from one dimension to two dimensions. QR-codes are very widely used to store URLs on several website articles every day [4]. Qr-Code has the goal of making media more practical, so that it can be accessed anywhere [5]. Later in this study the QR Code will be inserted into the birth certificate image, but it will not interfere with the visual appearance of the image. By applying the discrete cosine transform method, the QR Code is inserted at a lower frequency coefficient by changing the image signal from the spatial domain to the frequency domain. The discrete cosine transform method was chosen because it is able to provide a high level of security for digital images and can be applied easily.

This method enables the embedding of watermarks into digital documents with reversible characteristics, so that watermarks can be removed with precision without reducing the quality of the original information. DCT as a frequency transformation technique also provides advantages in representing small blocks of birth certificates, increasing efficiency and speed in

the watermarking process. By combining the security of the QR code method and the DCT coefficient, it is hoped that this solution can provide an optimal level of protection against falsification and unauthorized alteration of birth certificates, thereby guaranteeing the trust and reliability of this official document in an increasingly complex and risky digital era.

Based on this description, it is necessary to develop a draft for watermarking on birth certificates in order to protect document authenticity and grant copyrights. This study uses the Discrete cosine transform method to apply QR Code watermarking to birth certificates. This method can be used to insert images or other information into images [6]. To maintain the security of embedded confidential information data, the watermarking technique used must have properties that are not known by other parties using the five senses. This can be achieved by applying invisible or inaudible properties to watermarking techniques for digital data such as images, video, text, as well as for audio types [7].

## 2. METHOD

The method used to find out the process flow of a method that can be applied to the application being built. The development of the QR Code watermarking application on birth certificates uses the Discrete Cosine Transform (DCT) method to match each part of an image.

In this study, the Discrete Cosine Transform (DCT) Algorithm was used. This method converts data from spatial form to frequency form by dividing the image into sub-sections with different frequencies. Frequencies with minimal information will be removed, while frequencies with important information will be kept in the low frequency component of the signal. Other frequencies have very small data, which can be represented with a few bits. After that, frequency data processing is carried out and returned to spatial form using the appropriate inversion method [8]. The DCT equation for an N x N block matrix can be formulated as follows:

$$S(u,v) = \frac{2}{\sqrt{nm}}\, C\,(u)C\,(v) \sum_{y=0}^{m-1}\sum_{x=0}^{n-1} s(x.y)\cos\frac{(2x+1)u\pi}{2n} cos\frac{(2y+1)u\pi}{2m}$$

With u = 0,…,n-1,v = 0,…,m-1

Where:

S(u, v) = data in the frequency domain

S(x,y) = data in the space domain The DCT inverse formula is as follows:

$$S(u,v) = \frac{2}{\sqrt{nm}}\, C\,(u)C\,(v) \sum_{v=0}^{m-1}\sum_{u=0}^{n-1} s(u.v)C(u)C(v)\cos\frac{(2x+1)u\pi}{2n} cos\frac{(2y+1)u\pi}{2m}$$

With x = 0,….,n – 1, y = 0, …., m – 1

Where: S(u, v) = data in the frequency domain

S(x,y) = data in the spatial domain

### 2.1 Flowchart

The process design that will be built in the development of the QR code watermarking application on birth certificates using the Discrete Cosine Transform (DCT) method will have a flowchart description as follows:

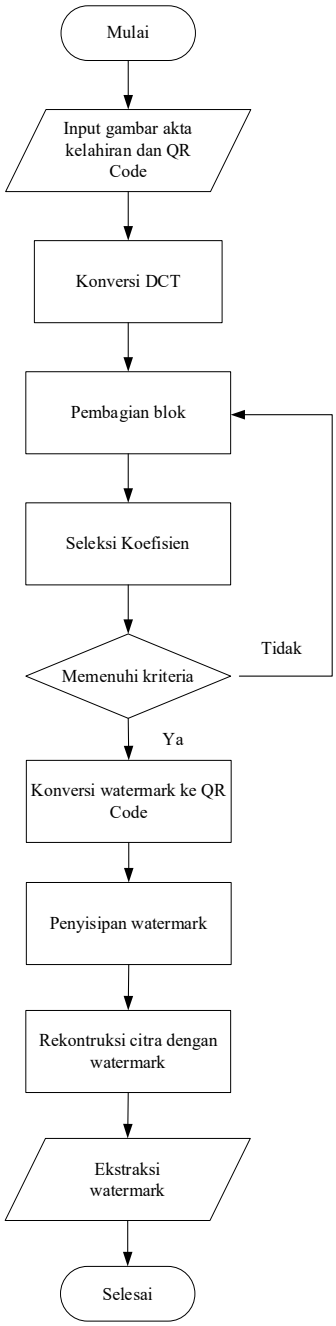


Figure 1. Flowchart System

## 3. RESULTS AND DISCUSSION

### 3.1. System Design Process

In applying this method, there are several initial processes that are carried out in the watermark insertion, namely the first step is to select the image to be inserted with the watermark, the second step is to digitize the image with the aim of the image being read by a computer, the third step is to analyze the image using discrete cosine transform (DCT) as the watermark method. Process the watermark on the following image by doing the barcode first:

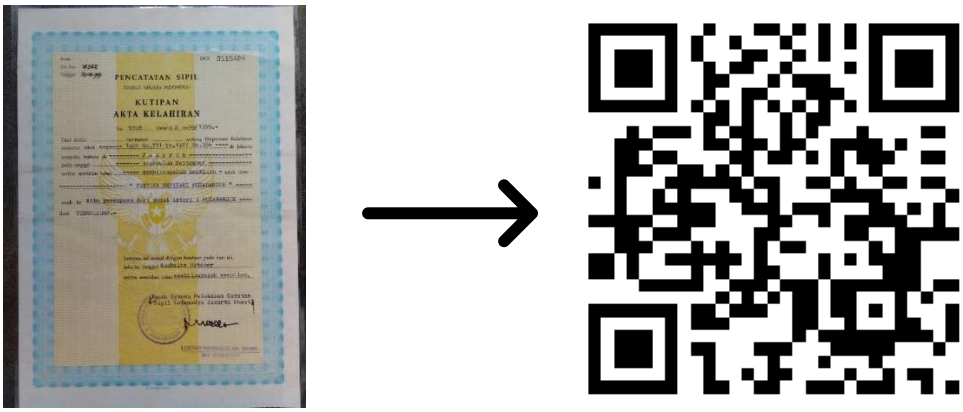


Figure 3. Birth Certificate and Barcode Result

After the process is complete, the next step is to insert Figure III.3 with a size of 16 x 16 pixels into Figure III.1 to serve as a watermark as shown in the image below:

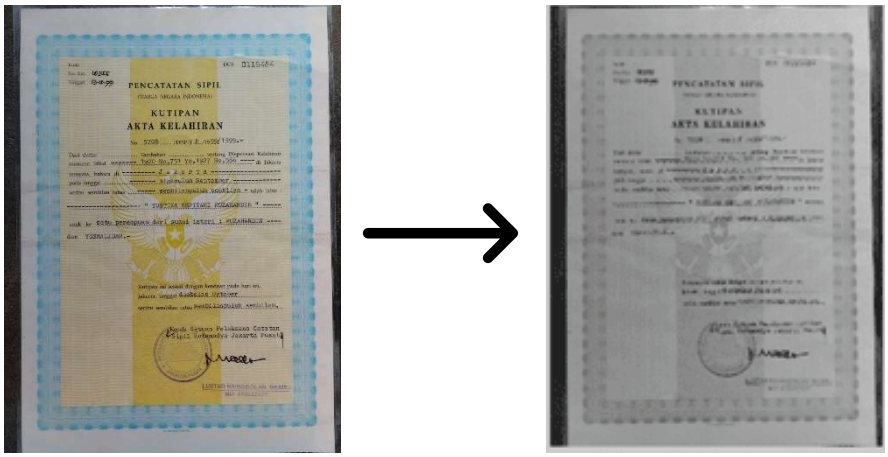


Figure 4. Original Image and Watermark Results

In this study, the host image will be taken as a sample with dimensions of 1600 x 1204 pixels. In this study, the original image must have a multiple of 8 dimensions. If the image does not meet this criterion, the system will resize the original image to a multiple of 8.


Figure 5. RGB Color Image

From the original image above, the RGB value for the first matrix is taken. Retrieval of RGB values using matlab R2014a software. We can see the matrix for the red, green and blue values as shown below. Starting from the point (x,y) = (0,0) to (7,7)

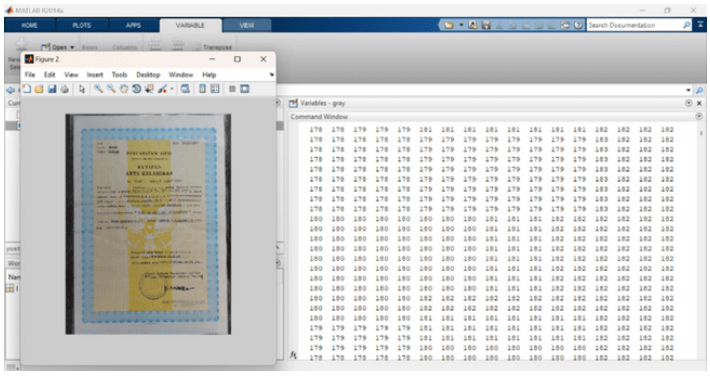

Figure 6. Display of Taking RGB Values with Matlab R2014a

The next step is to calculate the binary value of the label image that will be inserted and converted to a grayscale image. After the grayscale image is obtained, the middle value (threshold) will be sought by finding the minimum grayscale value and the maximum grayscale value of the image.

Before the image is converted to a binary image, the label image will be resized according to the original image.

Figure 7. Label image 3150 x 3150 pixels

The label image will be resized according to the equation
Llabel = Lhost/8
Tlabel = Thost/8
Then the resolution of the label image to be inserted is:
Llabels = 1600/8 = 200
Tlbael =1204/8 = 150.5

After resizing the label image, the grayscale value of the image will be calculated to obtain a threshold value in order to calculate the binary image value of the label image.

Figure 8. Image of a grayscale Label resized to 200 x 150.5 Pixels

The image above is a grayscale image of a label image. After the insert label is converted to a grayscale image, the minimum and maximum values will be searched. After filtering all the values in the label image, a binary image will be obtained as below:



Figure 9. Label Image Bit Value

The next step is to insert the table into the image, then transform the image in Figure III.1 into a transformation matrix (A).

1. Calculate the transform matrix
   For the first row in the i=0 image, the 1/√N formula is used, for A (0.0) to A(0.7) it is 0.3536. For the second row i>0, the formula 2/√N is used, for phi = 3.14

$$A(1,0) = \sqrt{\frac{2}{8}} \cos\left[\frac{2*0+1)*1*\pi}{2*8}\right] = 0.4904$$

$$A(1,1) = \sqrt{\frac{2}{8}} \cos\left[\frac{2*1+1)*1*\pi}{2*8}\right] = 0.4158$$

$$A(1,2) = \sqrt{\frac{2}{8}} \cos\left[\frac{2*2+1)*1*\pi}{2*8}\right] = 0.278$$

$$A(1,3) = \sqrt{\frac{2}{8}} \cos\left[\frac{2*3+1)*1*\pi}{2*8}\right] = 0.0979$$

$$A(1,4) = \sqrt{\frac{2}{8}} \cos\left[\frac{2*4+1)*1*\pi}{2*8}\right] = -0.0971$$

$$A(1,5) = \sqrt{\frac{2}{8}} \cos\left[\frac{2*5+1)*1*\pi}{2*8}\right] = -0.2773$$

$$A(1,6) = \sqrt{\frac{2}{8}} \cos\left[\frac{2*6+1)*1*\pi}{2*8}\right] = -0.4154$$

$$A(1,7) = \sqrt{\frac{2}{8}} \cos\left[\frac{2*7+1)*1*\pi}{2*8}\right] = -0.4902$$

Then the X' matrix will be multiplied by the A matrix (transform) with the formula (X = X' * A) as follows:

X(0.0) = (721.920*0.3536) + (721.721*0.4904) + (722.280*0.462) + (721.479*0.4158) + (722.572*0.3537) + (720.903*0.278) + (723.577*0.1916) + (717.849*0.0979) = 1907.787

The calculation is continued until the calculation (7.7) so that it produces a matrix as shown in Table 1.

Table 1. DCT Result Image Matrix (X)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1907.787 | -519.405 | 410.759 | -142.884 | 219.843 | -18.120 | 125.205 | 60.695 |
| 947.424 | 1779.011 | -411.987 | 356.656 | -143.520 | 633.682 | 107.522 | 221.175 |
| -317.412 | 613.452 | 1847.132 | -167.069 | 448.871 | -172.338 | 191.211 | 77.118 |
| -58.169 | -459.848 | 354.872 | 1917.858 | -29.377 | 318.507 | 89.756 | 187.417 |
| -156.970 | -49.160 | -527.037 | -29.679 | 1860.162 | 461.817 | 460.932 | 303.913 |
| -48.608 | -128.742 | -15.868 | -399.497 | -180.492 | 1417.033 | 250.645 | 320.762 |
| -84.711 | -68.959 | -164.502 | -151.942 | -533.690 | -92.503 | 1879.684 | 687.049 |
| -15.362 | -29.245 | -9.633 | -43.243 | -4.245 | -613.970 | -744.997 | 1798.351 |

## 3.2 Application View

The first stage involves dividing the birth certificate image into pixel blocks which are then converted into the frequency domain via DCT. Furthermore, the QR Code watermark is carefully inserted through modification of the relevant DCT coefficients. The reverse transformation process allows extraction of the QR Code watermark at the verification stage.
An analysis of the results was also carried out, including an evaluation of the impact on the visual quality of birth certificate images and resistance to various attacks. While this method improves document security by providing an additional layer of protection, it should be remembered that DCT transformations can affect visual quality and parameters need to be adjusted to strike a balance between security and visual integrity. That way, this application provides a strong solution in dealing with the challenge of counterfeiting documents and securing identity and important information in today's digital era.
The interface of this program has a main form which displays the GUI elements relevant to the QR Code watermarking on the birth certificate. The main form contains a button to go to the watermarking process and an about page. The interface display can be seen in the image below.
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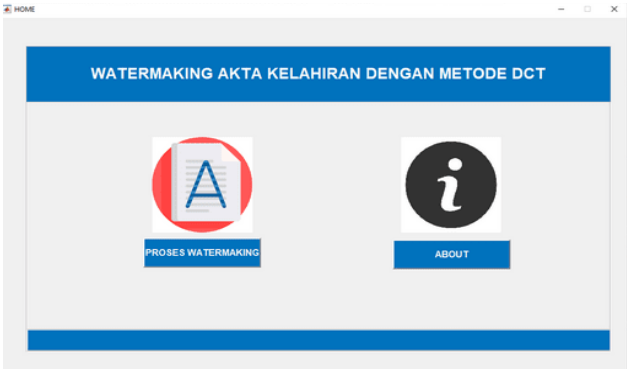


Figure 10. Main form display

Next is the display of the watermarking process. The interface in this section displays buttons in the form of uploading a birth certificate, uploading a QR Code, processing and calculating PSNR (Peak Singal-to-Noise Ratio). In this menu, the process of uploading birth certificates and QR Code will be carried out which will be processed in the Discrete Cosine Transform (DCT) algorithm which has been successful in making watermarking, the results will be displayed in the form of an image or image that already has a watermark in the form of a QR Code. These results can be downloaded or saved to the storage on the device. This menu also displays the results of PSNR calculations.


Figure 11. Display of the Watermarking Process

Next, the interface for the about page will appear. This section has a display that explains the background and purpose of making the QR Code watermarking application on birth certificates. In an effort to improve the security of birth certificate documents, an innovative solution has been implemented by way of QR Code watermarking using the Discrete Cosine Transform (DCT) method. The implementation process begins with an in-depth understanding of the DCT concept and QR Code watermarking techniques. This method was chosen because of its ability to insert information without significantly changing the visual quality of the document.

In the early stages of implementation, the program was developed using the Matlab programming language. The birth certificate document to be watermarked is uploaded into the program, and then a QR Code containing birth certificate information is pasted on the document. The DCT algorithm is applied to birth certificate images, where the appropriate DCT coefficient is selected and modified according to the QR Code data to be inserted.

Furthermore, the testing phase is carried out using various scenarios that represent real conditions. The impact of implementing watermarking on the visual quality of birth certificates was evaluated using the PSNR (Peak Signal-to-Noise Ratio) metric.


Figure 12. About page display

## 4. CONCLUSION

The application of the Discrete Cosine Transform (DCT) method in the QR Code watermarking process on birth certificates has succeeded in making a significant contribution to the security and authentication of these documents. First, in the context of how to apply the DCT method, concrete steps have been described in detail, starting from dividing the birth certificate image into pixel blocks, transforming the DCT to convert it into the frequency domain, and inserting a QR Code as a watermark through modifying the relevant DCT coefficients. The DCT inversion process then allows watermark extraction at the verification stage. Second, related to how to implement QR Code watermarking, comprehensive steps have been explained, starting from the preparation of data such as images of birth certificates and QR Codes, to the concrete processes of transformation and extraction in them.

Across these applications, DCT has proven to be an effective tool in embedding additional information into birth certificate images without compromising the integrity of the primary information. However, it should be noted that the use of DCT can also affect the visual quality of the image. Thus, parameter adjustments are necessary to strike the right balance between safety and visual aesthetics. In this digital era, where falsification of documents is a real threat, the implementation of QR Code watermarking using DCT on birth certificates shows significant potential in strengthening the security and validity of identity, while taking into account the aesthetic aspects and image quality..

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