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Object Oriented Modeling of Optimal LSB-based Steganography for Secure Transmission of E-learning Documents

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***Abstract*—** In an e-learning system, all communications take places through Internet. When sender sends some secret documents to the receiver hiding them into the cover image, the image incorporates some sort of distortion, at the time of decompression. This LSB based steganographic approach will help the sender to send the documents after making compression and the receiver will receive the documents without having any sort of distortion. Here the proposed model has been wrapped in object oriented models to achieve the benefits of the object oriented approach.

***Keywords*—**e-Learning, LSB-based steganography, Use case diagram, Timing diagram

I. INTRODUCTION

In an e-learning system, the three main participants are administrator, teacher and learner[1]. Most of the documents, transmitted between the participants of an e-learning system, are either text or image. In this paper, we have considered the transmission of secret image hiding into a large cover image from administrator to learner. Our proposed algorithm is based on the LSB based steganography algorithm[2,3]. This algorithm[4] also provides security by implementing an option of error checking. By applying this algorithm, the administrator can send the secret image to the student after hiding it into the cover image without having any distortion. The hiding of secret image into the cover image is known as compression or encoding, which is done at the administrator's end and the decompression or decoding, i.e., extraction of the secret image from the payload image, is done at the learner's end.

Here, I have presented the object oriented diagrams like use case diagram, activity diagram and class diagram of the proposed model[5]. By using object oriented design, the administrator can achieve the code redundancy and code reusing which are the current trends of software engineering[6]. Data hiding is another advantage of object oriented paradigm which can also be achieved during the implementation of the model.

Section II covers the flowchart of the proposed LSB based optimal steganographic approach. In section III, I have discussed some of the UML diagrams (like use case diagram, timing diagram and class diagram) of the proposed model[7]. Section IV covers the conclusive remarks.

II. Flow chart of the proposed model

The encoding process will be done at the administrator's end and the decoding process at the learner's end. Here, we have shown two diagrams, one for encoding process and the other for decoding process. Figure 2.1(annexure) shows the steps which have to be followed by the administrator at the time of embedding the secret image into the chosen cover image. Figure 2.2(annexure) includes the steps of the decompression process which have to be followed at the learner's end.

III. Object oriented modeling of proposed model

A. Use Case Diagram

Use case diagrams of optimal LSB steganography model are shown in the following figures. Figure 3.1(annexure) is used to represent the use case diagram for the administrator where the encoding process of our proposed model takes place and Figure 3.2(annexure) is used to represent the use case diagram for the learner where the decoding process takes place.

Firstly, the administrator will select the image, which has to be sent secretly to the learner and choose the cover image accordingly, which should be large enough so that the secret image can be embedded. The encoding technique will embed the secret image into the cover image and create the payload image. Administrator will reserve the first 10 pixels of the cover image to store the payload length. Then divide the remaining pixels in a group of 25 pixels each, out of which 1st pixel is used as an index and the remaining 24 pixels are used to store the next 6 bits of payload after calculating the respective PSNR values.

The learner will receive the payload image sent by the administrator and extract the secret image by applying the decoding process. He/she will read the first 10 pixels to determine the size of the payload image. Divide the remaining pixels into a group of 25 pixels each and read the 1st pixel of the group to identify the position of the data. If position is higher than 23, the learner will request the administrator to resend the image; otherwise, read 6 bits from the selected pixel and do the concatenation and padding (if needed) to extract the secret image.

B. Activity Diagram

The activity diagram is an important part of UML diagram, which represents the flow from one activity to another activity in the form of a flowchart[8]. Here Figure 3.3(annexure) is used to show the flow of activities from the administrator to the learner in an e-learning system regarding the transmission of images secretly.

C. Class Diagram

Class diagram is a static UML diagram, which is used for visualizing, describing, documenting different aspects of a system and implementing executable code of the software application.

In the class diagram, as shown in Figure 3.4(annexure), we have used four classes, namely, OptimalStego, StegoEncoder, StegoDecoder and Verifier. The classes are discussed below:

Class OptimalStego

This class contains the main class and it is inherited by the classes StegoEncoder and StegoDecoder. OptimalStego contains ten public data members and one public member function, which are used to help the user regarding the encoding and decoding process. This is used as the base class. The member function of this class is given below.

printusage(): This function is used to help the user to make the system run.

Class Verifier

It is used to check whether the file is attacked by noise or hacker while transmitting from administrator to learner. If any kind of attack occurs, then the position will be altered and affect the stego image. Class Verifier contains six public data members and one public member function. The member function of this class is given below.

verify(): This function is used to verify the image for originality.

Class StegoEncoder

This class contains the functions for embedding the secret image into the cover image which happens at the administrator's (i.e., sender) end. The following are the member functions of this class.

encode(): It is used to encode the secret image into cover image.

computeAndPrintPSNR(): It is used to search for best PSNR value of individual cases.

getDataAsBitString():This function converts an array of bytes to a binary string.

*getEncodedARGB():*This function stores the first 6 bits of the data into the color value.

insertGroup(): It is used for embedding the secret image into cover image.

insertDataInGroup(): It is used for inserting data into group.

getPSNR(): This function is used for calculating PSNR after embedding secret image into cover image for quality measurement of cover image after reconstruction.

Class StegoDecoder

This class is used for extracting the secret image from the stego image and it happens at the learner's end. It contains nine public and two private data members, one public and three private member functions. We mention below the member functions of this class.

decode(): This function is used for decoding the encoded image.

getDataAsBitStringfromGroup(): This function deals with images in RGB format.

getLengthFromImage(): It is used to find the length of the image at the time of decoding.

getARGB(): This function is used to convert the image into RGB format.

IV. CONCLUSION

The proposed model is not only applicable for sending the images but also helpful while sending the secret text hiding into cover image. Most of the well known format of text documents like PDF, TXT, RTF, DOC are supported. The other online services like e-Commerce, e-Governance can also use this model for sending their secret data. Further work can be done by incorporating the cryptographic technique along with this model to provide better security, which is out of scope of this paper.

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Authors Profile

Dr. Soumendu Banerjee has completed his B.Sc(H) in Mathematics, MCA and Ph.D. from the University of Burdwan.

He has published approximately sixteen research papers in various National and International journals and proceedings.

Annexure

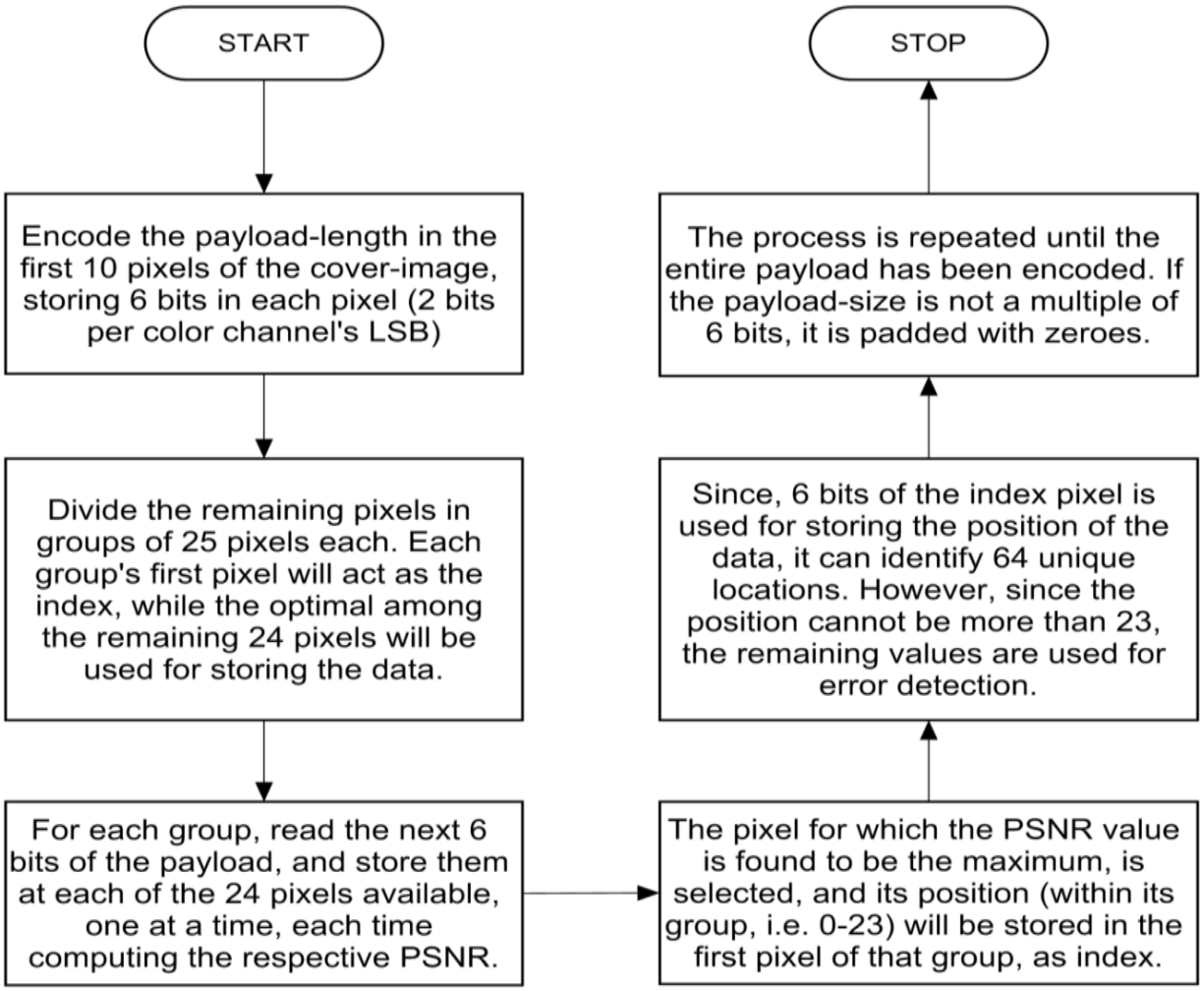

Figure 2.1. Flowchart of encoding process of optimal LSB steganography model

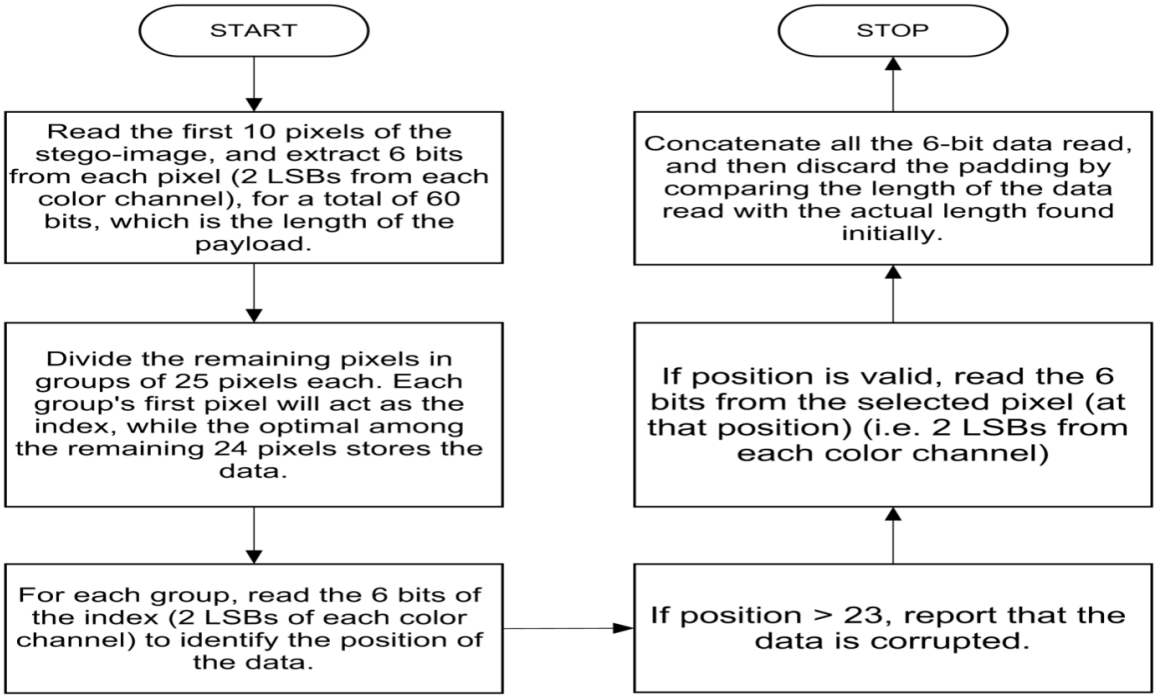

Figure 2.2. Flowchart of decoding process of optimal LSB steganography model

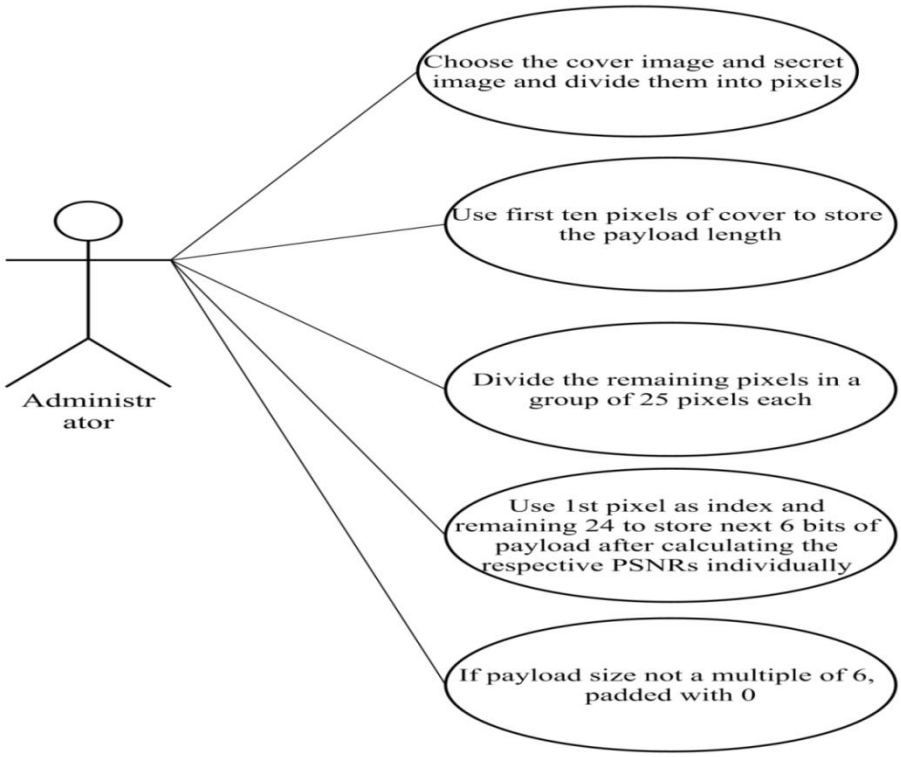

Figure 3.1. Use case diagram for the administrator

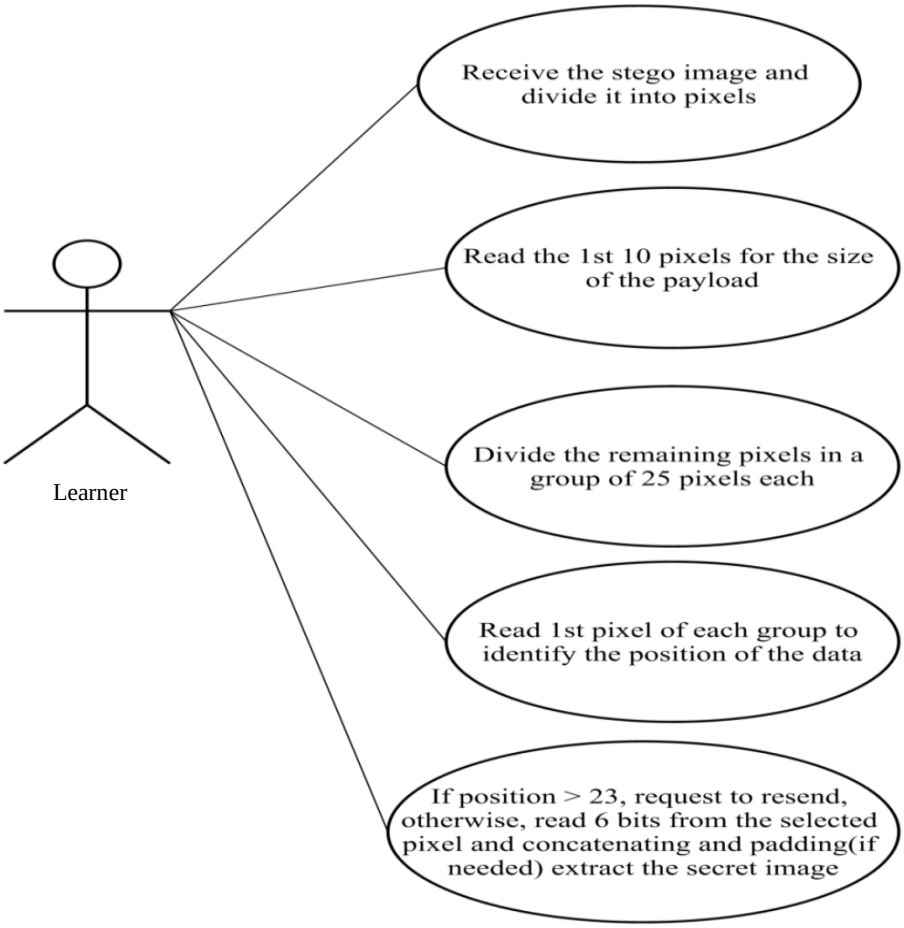

Figure 3.2. Use case diagram for the learner

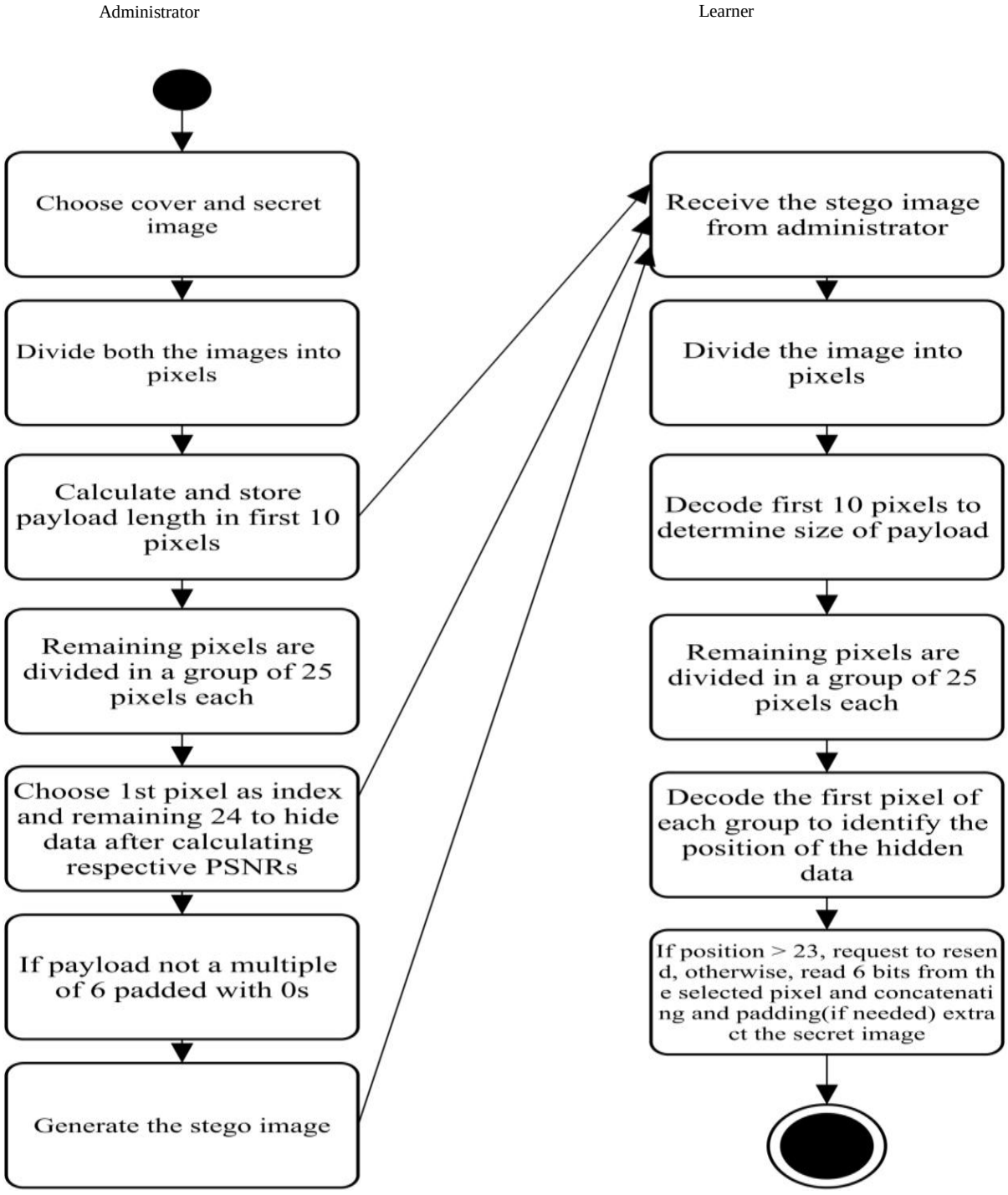

Figure 3.3. Activity diagram of the proposed model

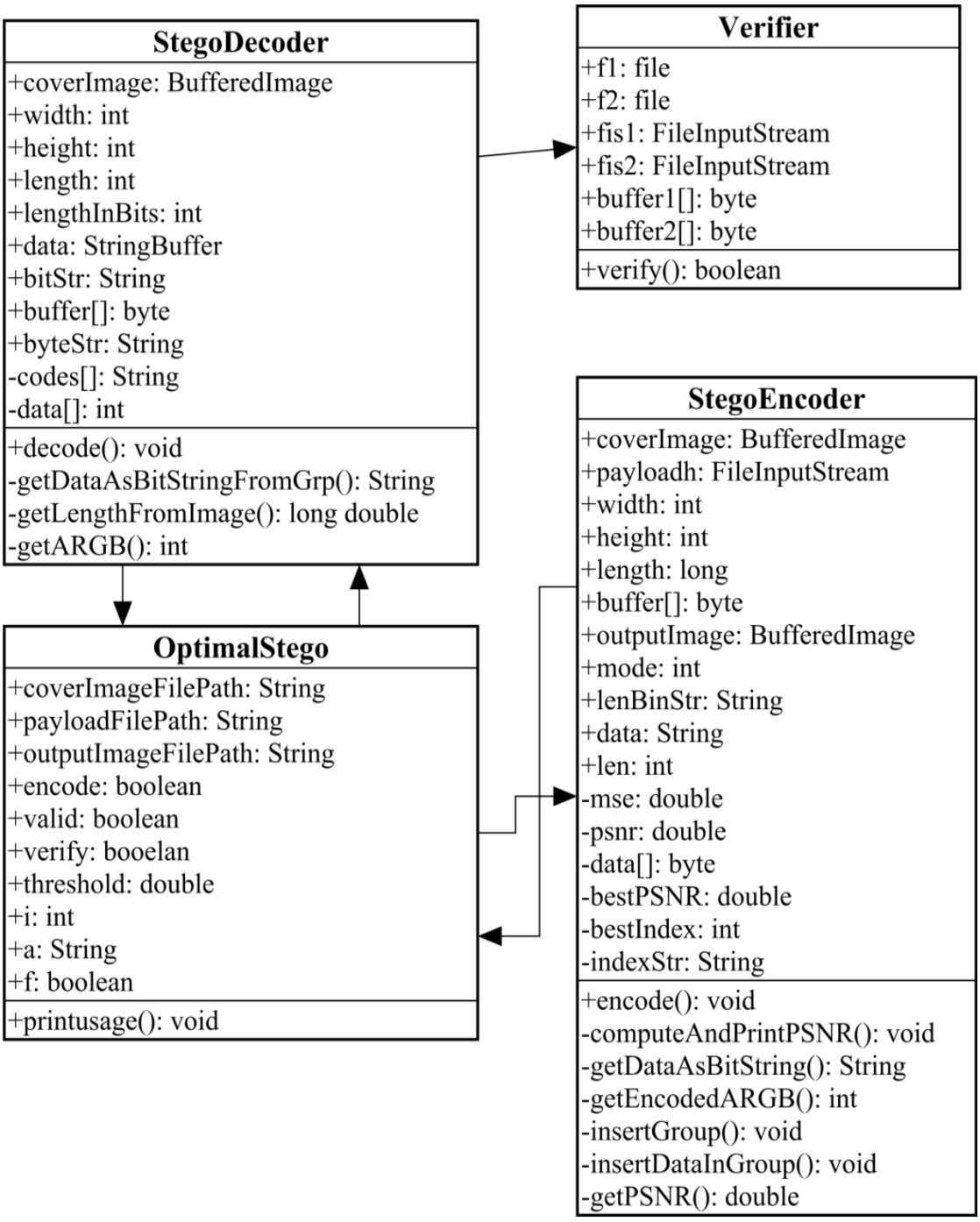

Figure 3.4. Class diagram of Optimal LSBS model

