Detecting LSB Steganography in Grayscale and Colour images

Team Photons

Overview

Problem Description

Detecting whether an image contains hidden message, and estimating the length of the hidden message

Recent progress

1. Understanding of theory
2. Analysis of tools and creation of stego-images

Paper

Detecting LSB Steganography in Color and Grayscale Images (2001)

Jessica Fridrich, Miroslav Goljan, and Rui Du

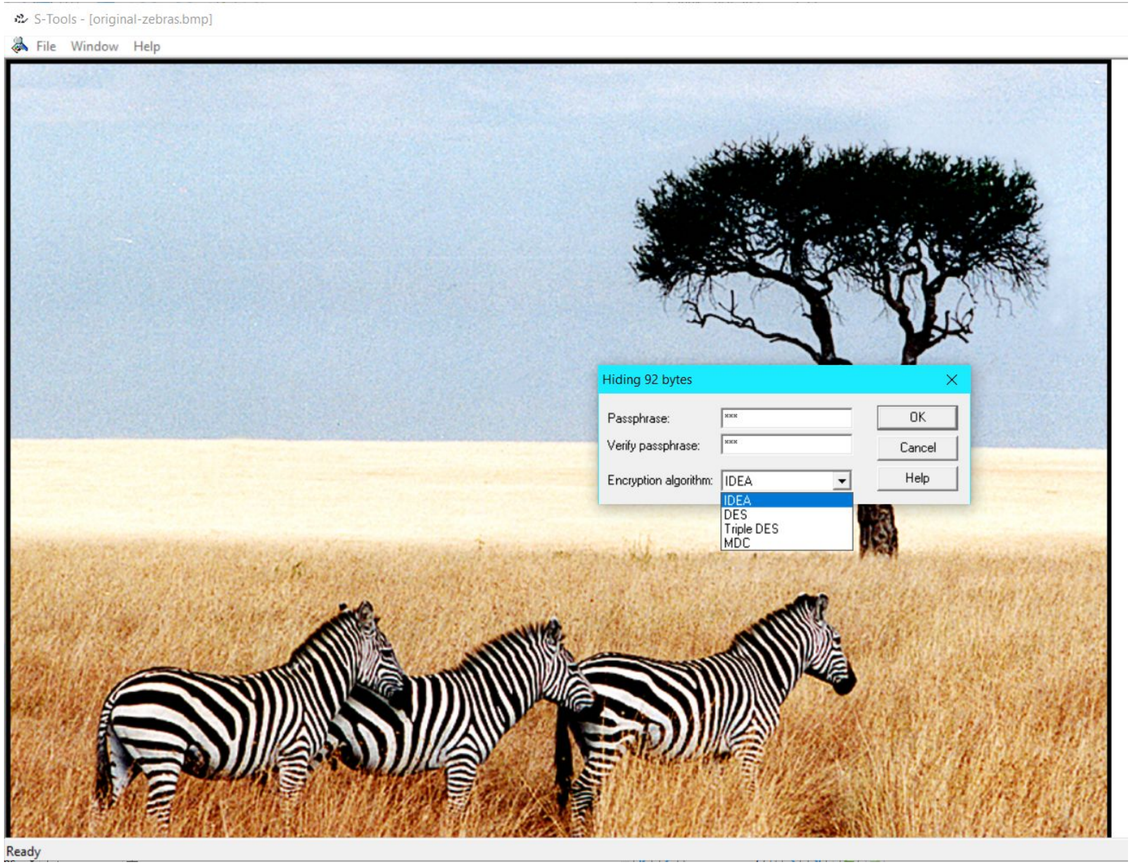
Scope

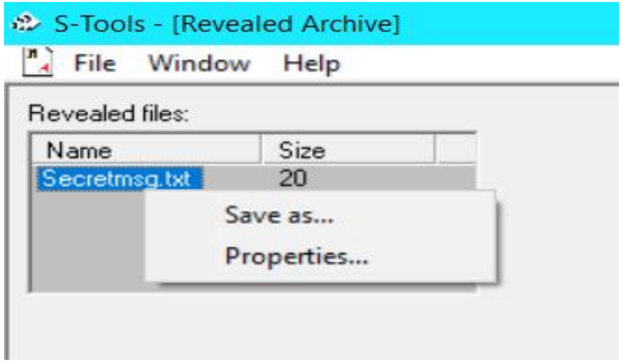
- Differentiating stego images from typical images
- Providing estimation of length of the hidden message
- **Not uncovering** the hidden message itself

  (If the hidden message is in the form of ciphertext, this would require cryptanalysis)

Theoretical Understanding

Steganography

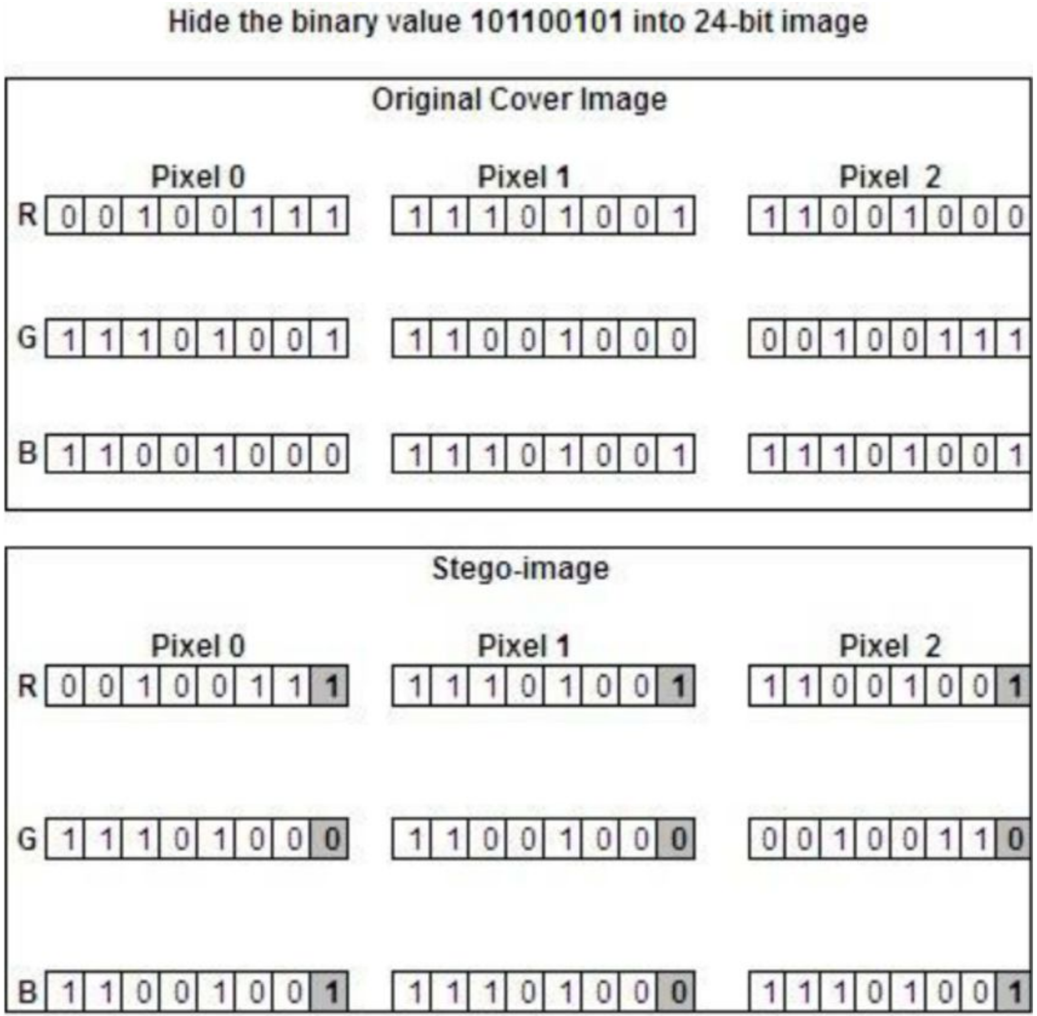




Example:
Using S-Tools to communicate secretly by encrypting and hiding the message in an image

Steganalysis

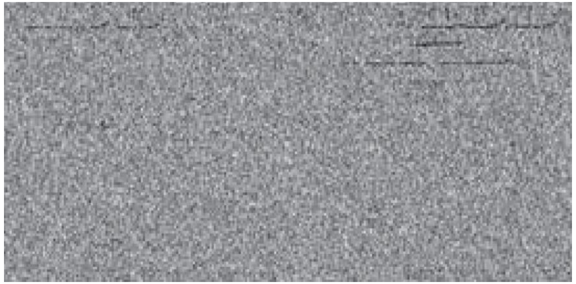
- Detecting the presence of hidden data in images or other multimedia files
- Using mathematical tools and statistical analysis for detection
- The technique described in the paper was developed mainly to detect messages scattered across the LSBs of randomly chosen pixels in a stego image
    - It is a generic technique, does not depend on the specific algorithm that was used for steganography



Why are LSBs usually used to hide the message?

The change in colour is undetectable for the human eye

Also, for most images, the LSB plane is essentially random and does not contain any easily recognizable structure



Approach

$$f(x_1, x_2, \ldots, x_n) = \sum_{i=1}^{n-1} |x_{i+1} - x_i|$$

An example of a discrimination function

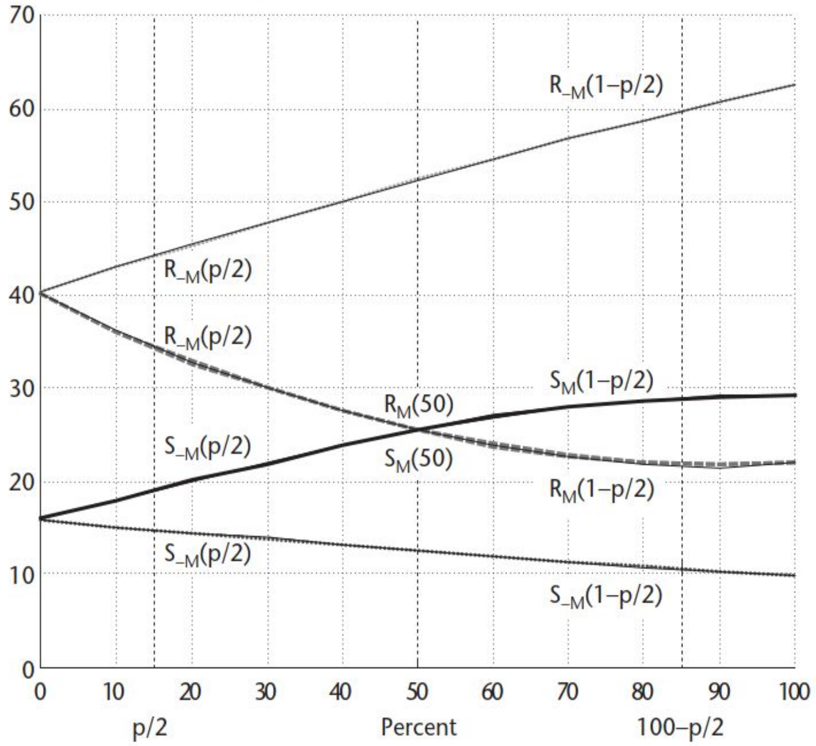
- Image is divided into disjoint groups of adjacent pixels
- Two functions : Discrimination function (f), Flipping functions
- Discriminaton function measures the smoothness of a group of pixels
  - Noisy group → higher value of discrimination function
- Flipping functions (F_0, F_1 , F_{-1}) flip the LSB of a single pixel
- Applying both the functions on all groups of pixels
  - A mask M is created to apply flipping functions to a group of pixels

Approach

- Based on the value of the discrimination function before and after flipping, groups are divided into
  - Regular (R), Singular (S) and Unusable groups
- Typical picture will have more regular groups than singular groups
- A negative mask -M is also applied to all the groups
- R_M = proportion of regular groups using mask M, S_M = proportion of singular groups using mask M
- For typical images, $R_M \cong R_{-M}$ and $S_M \cong S_{-M}$

Approach

- R_M, S_M, R_{-M} , and S_{-M} curves in the RS diagram are modeled by repeated experimentation
- Using statistical information of groups to predict whether image is a stego-image
- Calculating hidden message length
  - Estimated using point of intersection of R_M and S_M
- Noise estimation to calculate initial bias, message length is corrected accordingly
- Approach works when data is hidden in scattered pixels
- Fails for sequential or localized hidden data



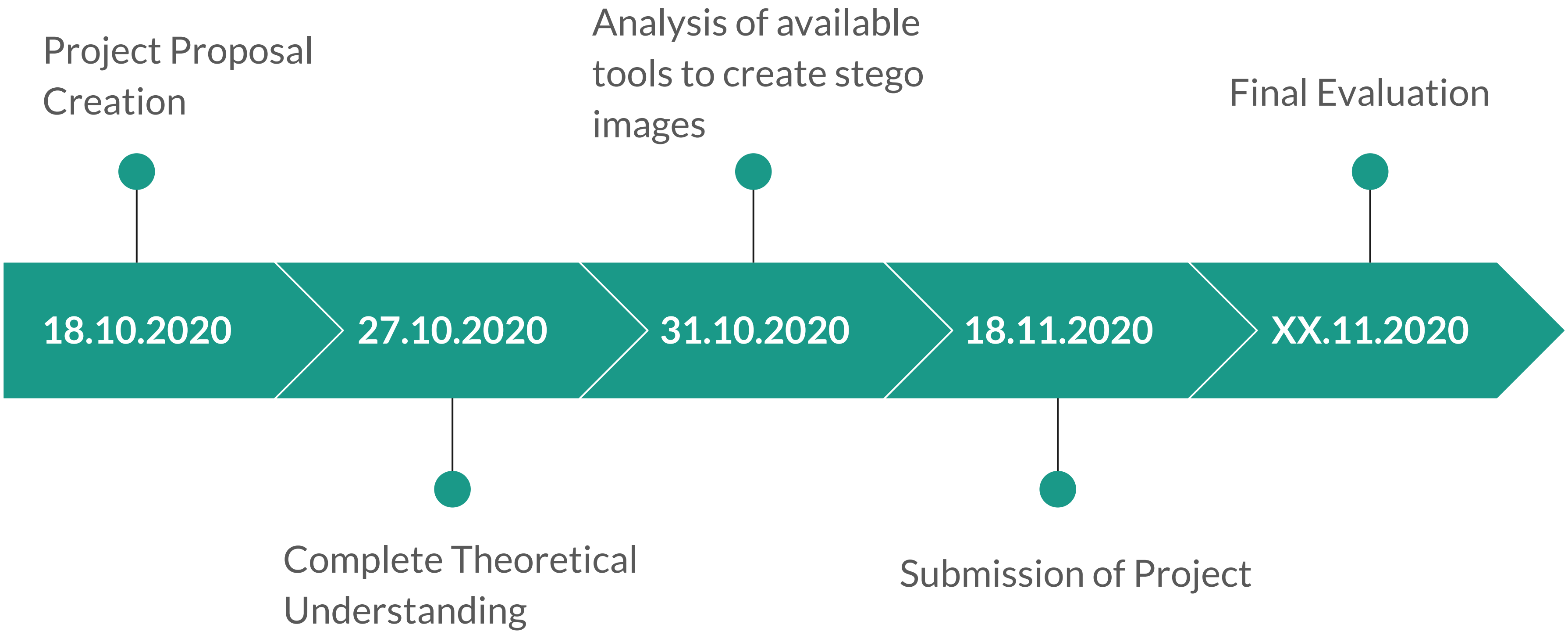
RS-diagram of an image. The x-axis is the percentage of pixels with flipped LSBs, the y-axis is the relative number of regular and singular groups with masks M and −M, M = [0 1 1 0]

Challenges

- Determining the size and shape of disjoint groups of pixels
- Determining the discrimination function to be used

- Current plan: Use the same group size and discrimination function that was used by the authors

Roadmap


Project Proposal Creation
Analysis of available tools to create stego images
Final Evaluation
18.10.2020
27.10.2020
31.10.2020
18.11.2020
XX.11.2020
Complete Theoretical Understanding
Submission of Project

Next steps

Implementation

Python is the preferred language for implementation

Testing

Running analysis on BMP and PNG images

Report

Reporting accuracy and other interesting findings

Final Submission Deliverables

1. Working Code
2. Report
3. Final Project Presentation