Embedding Secret Data in Html Web Page

Sandipan Dey,
Cogniant Technology Solutions
sandipan.dey@gmail.com

Hameed Al-Qaheri*
Department of Quantitative Methods and Information Systems
College of Business Administration
Kuwait University
alqaheri@cba.edu.kw

Sugata Sanyal,
School of Technology and Computer Science
Tata Institute of Fundamental Research,
Homi Bhabha Road, Mumbai - 400005, India
sanyal@tifr.res.in

Abstract

In this paper, we suggest a novel data hiding technique in an Html Web page. Html Tags are case insensitive and hence an alphabet in lowercase and one in uppercase present inside an html tag are interpreted in the same manner by the browser, i.e., change in case in an web page is imperceptible to the browser. We basically exploit this redundancy and use it to embed secret data inside an web page, with no changes visible to the user of the web page, so that he can not even suspect about the data hiding. The embedded data can be recovered by viewing the source of the html page. This technique can easily be extended to embed secret message inside any piece of source-code where the standard interpreter of that language is case-insensitive.

1 Introduction

Some techniques for hiding data in executables are already proposed (e.g., Shin et al [4]). In this paper we introduce a very simple technique to hide secret message bits inside source codes as well. We describe our steganographic technique by hiding inside html source as cover text, but this can be easily extended to any case-insensitive language source codes. Html Tags are basically directives to the browser and they carry information regarding how to structure and display the data on a web page. They are not case sensitive, so tags in either case (or mixed

*Contact Author
case) are interpreted by the browser in the same manner (e.g., \"< head >\" and \\
\"< HEAD >\" refers to the same thing). Hence, there is a redundancy and 
we can exploit this redundancy. To embed secret message bits into html, if the 
cases of the tag alphabets in html cover text are accordingly manipulated, then 
this tampering of the cover text will be ignored by the browser and hence it 
will be imperceptible to the user, since there will not be any visible difference 
in the web page, hence there will not be any suspect for it as well. Also, when 
the web page is displayed in the browser, only the text contents are displayed, 
not the tags (those can only be seen when the user does 'view source'). Hence, 
the secret messages will be kind of hidden to user.

Both redundancy and imperceptibility conditions for data hiding are met, 
we use these to embed data in html text. If we do not tamper the html text data 
that is to be displayed by the browser as web page (this html cover text is ana-
logical to the cover image, when thought in terms of steganographic techniques 
in images [1][2][3]), the user will not even suspect about hidden data in text. We 
shall only change the case of every character within these Html tags (elements) 
in accordance with the secret message bits that we want to embed inside the html 
web page. If we think of the browser interpreter as a function, \( f_B : \Sigma^* \rightarrow \Sigma^* \) we 
see that it is non-injective, i.e., not one to one, since \( f_B(x) = f_B(y) \) whenever 
\( x \in \{'A'\ldots'Z'\}, y \in \{'a'\ldots'z'\} \) and \( \text{UpperCase}(y) = x \). The extraction process 
of the embedded message will also be very simple, one needs to just do 'view 
source' and observe the case-patterns of the text within tags and can readily 
extract the secret message (and see the unseen), while the others will not know 
anything.

The length (in bits) of the secret message to be embedded will be upper-
limited by the sum of size of text inside html tags (here we don’t consider at-
tribute values for data embedding. In case we consider attribute values for data 
embedding, we need to be more careful, since for some tags we should think of 
case-sensitivity, e.g. \(<A HREF="link.html">\), since link file name may be case-
sensitive on some systems, whereas, attributes such as \(<h2 align="center">\) is 
safe). If less numbers of bits to be embedded, we can embed the information 
inside Header Tag specifying the length of embedded data (e.g. \(<\text{Header 25}>\) 
if the length of secret data to be embedded is 25 bits) that will not be shown 
in the browser (optionally we can encrypt this integer value with some private 
key). In order to guarantee robustness of this very simple algorithm one may 
use some simple encryption on the data to be embedded.

2 The Algorithm for Embedding

The algorithm for embedding the secret message inside the html cover text is 
very simple and straight-forward. First, we need to separate out the characters 
from the cover text that will be candidates for embedding, these are the case-
sensitive text characters inside Html tags. Figure 2 shows a very simplified 
automata for this purpose.

We define the following functions before describing the algorithm:

\[
l(c) = \begin{cases} 
\text{ToLower}(c) & c \in \{'A'\ldots'Z'\} \\
\text{other otherwise} & \end{cases} \]

where \( \text{ToLower}(c) = c + 32 \) 

2
Similarly, \( u : \Sigma^* \rightarrow \Sigma^* \) is defined by,

\[
u(c) = \begin{cases} 
\text{ToUpper}(c) & c \in \{\text{a'..'z'}\} \\
\text{c} & \text{otherwise}
\end{cases}
\]

where \( \text{ToUpper}(c) = c - 32 \)

Here the ascii value of ‘A’ is 65 and that of ‘a’ is 97, with a difference of 32.

It’s easy to see that if the domain \( \Sigma^* = \{\text{a'..'z'}\} \cup \{\text{A'..'Z'}\} \), then

\[
l : \{\text{A'..'Z'}\} \rightarrow \{\text{a'..'z'}\} \quad \text{and} \quad u : \{\text{a'..'z'}\} \rightarrow \{\text{A'..'Z'}\},
\]

implies that \( l(.) = u(.) = \Sigma^* - l(.) \).

Now, we want to embed secret data bits \( b_1b_2..b_k \) inside the case-insensitive text inside the Html Tags. If \( c_1c_2..c_n \) denotes the sequence of characters inside the html tags in cover text (input html). A character \( c_i \) is a candidate for hiding a secret message bit iff it is an alphabet. If we want to hide the \( j^{th} \) secret message bit \( b_j \) inside the cover text character \( c_i \), the corresponding stego-text will be defined by the following function \( f_{\text{stego}}:\)

\[
\forall c_i \in \{\text{a'..'z'}\} \cup \{\text{A'..'Z'}\}, \text{ i.e. if IsAlphabet}(c_i) \text{ is true,}

f_{\text{stego}}(c_i) = \begin{cases} 
l(c_i) & b_j = 0 \\
u(c_i) & b_j = 1
\end{cases},
\]

Hence, we have the following:

\[
\forall c_i \in \{\text{a'..'z'}\} \cup \{\text{A'..'Z'}\} \Rightarrow f_{\text{stego}}(c_i) = l(c_i).b_j + u(c_i).b_j, \quad \forall i
\]

Number of bits \( (k) \) of the secret message embedded into the html cover text must also be embedded inside the html (e.g., in Header element). The figure 1 and the algorithm together explain this embedding algorithm.

3 The Algorithm for Extraction

The algorithm for extraction of the secret message bits will be even more simple. Like embedding process, we must first separate out the candidate text (text
Algorithm 1 Embedding Algorithm

1: Search for all the html tags present in the html cover text and extract all the characters $c_1c_2\ldots c_n$ from inside those tags using the DFA described in the figure 2.
2: Embed the secret message length $k$ inside html header in the stego text.
3: $j \leftarrow 0$
4: for $c_i \in HTMLTAGS$, $i = 1\ldots n$ do
5: \hspace{1em} if $c_i \in \{‘a’\ldots ‘z’\} \cup \{‘A’\ldots ‘Z’\}$ then
6: \hspace{2em} $f_{stego}(c_i) = l(c_i).b_j + u(c_i).b_j$.
7: \hspace{2em} $j \leftarrow j + 1$.
8: else
9: \hspace{2em} $f_{stego}(c_i) = c_i$.
10: end if
11: if $j == k$ then
12: \hspace{1em} break.
13: end if
14: end for

within tags) that were chosen for embedding secret message bits. Also, we must extract the number of bits ($k$) embedded into this page (e.g., from the header element). One has to use ‘view source’ to find out the stego-text.

Now, we have $d_i = f_{stego}(c_i)$, $\forall i \in \{1, 2, \ldots , n\}$. If $d_i \in \{‘a’\ldots ‘z’\} \cup \{‘A’\ldots ‘Z’\}$ i.e., an alphabet, then only it is a candidate for decoding and to extract $b_i$ from $d_i$, we use the following logic:
\[
\begin{array}{c}
0 \quad d_i \in \{‘a’\ldots ‘z’\} \\
1 \quad d_i \in \{‘A’\ldots ‘Z’\}
\end{array}
\]

Repeat the above algorithm $\forall i < k$, to extract all the hidden bits. The figure 2 and the algorithm together explain this embedding algorithm.
Figure 2: Basic block-diagram for html data-hiding technique
Figure 3: Cover Html source before embedding the secret message
Figure 4: Stego Html source after embedding the secret message
Embedding Secret Message, can you see what it is

The Lena Image - we don't embed secret message inside Lena!!

Lena is an image that is used to test many of the classical image processing techniques and algorithms including histogram equalization, optimal thresholding, LOG Filter, DFT, DCT, DWT, Segmentation, JPEG, Compression.

Embed secret message inside cover text to get stego text and be happy. Since both the stego html and the cover html look exactly identical in the browser. No one can ever guess that there is some secret message already embedded inside it.

Finally, extraction of the secret message is also easy (just you need to do) view source (and extract the message). Just checking the cases of the html tags reveals the embedded message. Can make this simple technique even more robust by using some simple encryption technique in addition.

> Steganography examples

Figure 5: Cover & Stego Html
Algorithm 2 Extraction Algorithm

1: Search for all the html tags present in the html stego text and extract all the characters $d_1 d_2 \ldots d_n$ from inside those tags using the DFA described in the figure 2.
2: Extract the secret message length $k$ from inside html header in the stego text.
3: $j \leftarrow 0$.
4: for $d_i \in HTMLTAGS$, $i = 1 \ldots n$ do
5: if $d_i \in \{‘a’ \ldots ‘z’\}$ then
6: $b_j = 0$.
7: $j \leftarrow j + 1$.
8: else if $d_i \in \{‘A’ \ldots ‘Z’\}$ then
9: $b_j = 1$.
10: $j \leftarrow j + 1$.
11: end if
12: if $j == k$ then
13: break.
14: end if
15: end for

Figure 6: Cover vs Stego Html Histogram

Figures 3, 4 and 5 show an example of how our method works, while Figure 6 shows the comparison of the histogram of the cover html and stego html in terms of the (ascii) character frequencies. Classical image hiding techniques like LSB data hiding technique always introduce some (visible) distortion [5,10] in the stego image (that can be reduced using techniques [6,7,8,9]), but our data hiding technique in html is novel in the sense that it introduces no visible distortion in stego text at all.
4 Conclusions

In this paper we presented an algorithm for hiding data in html text. This technique can be extended to any case-insensitive language and data can be embedded in the similar manner, e.g., we can embed secret message bits even in source codes written in languages like basic or pascal or in the case-insensitive sections (e.g. comments) in C like case-sensitive languages. Data hiding methods in images results distorted stego-images, but the html data hiding technique does not create any sort of visible distortion in the stego html text.

References

[1] Neil F. Johnson and Sushil Jajodia. Steganography: Seeing the Unseen IEEE Computer, February 1998, pp. 26-34.

[2] W. Bender et al., Techniques for Data Hiding, Systems J., Vol. 35, Nos. 3 and 4, 1996, pp. 313-336.

[3] B. Pfitzmann, Information Hiding Terminology, Proc. First International Workshop Information Hiding, Lecture Notes in Computer Science No. 1,174, Springer-Verlag, Berlin, 1996, pp. 347-356.

[4] DaeMin Shin, Yeog Kim, KeunDuck Byun, SangJin Lee, Data Hiding in Windows Executable Files, Center for Information Security Technologies (CIST), Korea University, Seoul, Republic of Korea

[5] C. Kurak, J. McHugh, A Cautionary Note On Image Downgrading, Proc. IEEE Eighth Annual Computer Security Applications Conf., IEEE Press, Piscataway, N.J., 1992, pp. 153-159.

[6] F. Battisti, M. Carli, A. Neri, K. Egiazarian, ”A Generalized Fibonacci LSB Data Hiding Technique”, 3rd International Conference on Computers and Devices for Communication (CODEC- 06) TEA, Institute of Radio Physics and Electronics, University of Calcutta, December 18-20, 2006.

[7] Sandipan Dey, Ajith Abraham, Bijoy Bandyopadhay and Sugata Sanyal, ”Data Hiding Techniques Using Prime and Natural Numbers”, Journal of Digital Information Management, Volume 6, 2008.

[8] Sandipan Dey, Ajith Abraham and Sugata Sanyal ”An LSB Data Hiding Technique Using Natural Numbers”, IEEE Third International Conference on Intelligent Information Hiding and Multimedia Signal Processing, IHMSP 2007, Nov 26-28, 2007, Kaohsiung City, Taiwan, IEEE Computer Society press, USA, ISBN 0-7695-2994-1, pp. 473-476, 2007.

[9] Sandipan Dey, Ajith Abraham and Sugata Sanyal ”An LSB Data Hiding Technique Using Prime Numbers”, Third International Symposium on Information Assurance and Security, August 29-31, 2007, Manchester, United Kingdom, IEEE Computer Society press, USA, ISBN 0-7695-2876-7, pp. 101-106, 2007.

[10] R. Z. Wang, C. F. Lin and I. C. Lin, Image Hiding by LSB substitution and genetic algorithm, Pattern Recognition, Vol. 34, No. 3, pp. 671-683, 2001.