10th Hel.A.S Conference
Ioannina, 5-8 September, 2011
CONTRIBUTED POSTER

Hiding Information in Astronomical Images

Eleni E. Varsaki[1], *Nectaria A. B. Gizani*[2], *Vassilis Fotopoulos*[1] *and Athanassios N. Skodras*[1]
[1]Digital Systems & Media Computing Laboratory, School of Science and Technology, Hellenic Open University, Patra, Greece
[2]Physics Laboratory, School of Science and Technology, Hellenic Open University, Patra, Greece

Abstract: Astronomical Image Processing Software (AIPS) is used for radio astronomical data reduction of extended radio sources. It saves the output map, together with 'history' of the production of the image into Flexible Image Transport System (FITS) file format. The flux, the noise of the map and any other information is lost, once the image of the radio source is extracted from AIPS. As a consequence, any other discipline astronomer, interested in such information, would have to get familiarized with the radio data reduction. In this work, a data hiding method is proposed able to embed any necessary information into the radio map, in order to be able to extract it even when FITS is converted to a TIFF format.

1 Introduction

Hiding information in digital images refers to the technique of embedding additional data into an image in a way that no human eye can notice. Data Hiding is used extensively in authentication, copyright protection and communication applications [1]. In this study we propose a data hiding technique that embeds information into FITS astronomical radio images. The embedded data concern information of the source (e.g. radio flux) and the quality of the data reduction which produces the astronomical image (e.g. the noise of the final map known as root mean square). This information is lost after the image (map) is extracted from AIPS in a FITS or other format (e.g. postscript).

The method we propose will help another discipline astronomer, who would like to extract these simple but important data. It does not require knowledge of the AIPS software. Additional information is embedded into the FITS image. This information can be acquired from the FITS map and remains unchanged even when FITS is converted into TIFF file format. TIFF supports high dynamic range images. Such application that converts FITS to TIFF image format is the standalone ESA/ESO/NASA FITS Liberator 3 [2]. The proposed data hiding algorithm is based on the discrete Walsh-Hadamard Transform (WHT). The WHT is a non-sinusoidal, orthogonal transformation that decomposes a signal into a set of orthogonal, rectangular waveforms called Walsh functions [3].

We have thoroughly examined the change of the coefficients so that the produced stego-FITS map is visually identical to the original one.

2 Description of the Procedure

The proposed scheme consists of the embedding, format conversion and the extraction parts. The input is the original FITS image and the embedded information, i.e. the message. The output is the extracted message, which is received from both the FITS and TIFF image formats. In order to hide information, selected WHT coefficients are changed according to the bits to be embedded. For the embedding the original image is divided into 4×4 non-overlapping blocks and the WHT is applied to every block. The last diagonal element of the 4×4 WHT coefficient matrix is read together with the message bit. One message bit is embedded into every block of image. *'1'* requires a positive WHT coefficient, while *'0'* requires a negative one. If this is not the case, then the coefficient's sign is changed and its value is shifted by a constant value d, which is experimentally chosen. The produced stego-FITS image is saved and converted into 16-bit TIFF format, using ESA/ESO/NASA FITS Liberator 3. The stego-TIFF image is entered into the extractor, which reads its WHT coefficients and extracts the message bits equal to *'1'*, if the coefficient is positive or *'0'* otherwise [4].

3 Results and Discussion

Test results were conducted in a Matlab 2010 environment, using the 16-bit double precision floating point real numbers' map of the radio source Cygnus A extracted from the NASA Extragalactic Data Base (NED). Image format conversion was done via the ESA/ESO/NASA FITS Liberator 3, into 16-bit depth TIFF, by only using the linear stretch function with white and black levels equal to the maximum and minimum values of the produced stego-fits image. As a result, the complete dynamic range of the FITS image was retained and the embedded information could be extracted from the image. The message size was 42976 bits, equal to the image's capacity, i.e. to the maximum amount of data that can be embedded into the image map. The constant value d, according to which the WHT coefficient was shifted, was experimentally chosen to be 0.0001. The embedding procedure produced no visual artifacts and therefore the statistics and the good quality of the image remained unchanged.

Acknowledgements: Eleni Varsaki would like to acknowledge the Greek State Scholarship Foundation (IKY).

References

[1] Sencar, H., Ramkumar, M., and Akansu, A., 2004, Data Hiding Fundamentals and Applications, Elsevier Academic Press, San Diego

[2] The ESA/ESO/NASA FITS Liberator v3: `http://www.spacetelescope.org/projects/fits_liberator/`

[3] A. K. Jain, 1989, Fundamentals of Digital Image Processing, Prentice-Hall, New Jersey

[4] Varsaki et al., 2011, 'Data hiding in astronomical FITS images', *SPIE Journal of Electronic Imaging*, submitted