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COSMIC RAY ELIMINATION USING THE WAVELET TRANSFORM

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RESUMEN

En este trabajo presentamos un método para la eliminación automática de rayos cósmicos en imágenes espectrales de una sola exposición, mediante el uso de la transformada Wavelet. El método propuesto elimina los rayos cósmicos sin importar su forma o tamaño. Con este método podemos eliminar más del 95% de los rayos cósmicos en una imagen espectral.

ABSTRACT

In this work, we present a method for the automatic cosmic ray elimination in a single CCD exposure using the Wavelet Transform. The proposed method can eliminate cosmic rays of any shape or size. With this method we can eliminate over 95% of cosmic rays in a spectral image.

Key Words: techniques: image processing

1. GENERAL

The most common way to eliminate cosmic rays in Astronomical images is to take several CCD images from the same field and then combine them. The cosmic rays elimination in a single CCD image becomes more complicated and is necessary to have an alternative method.

Some methods to eliminate cosmic rays in a single CCD image are the following:

• The task COSMICRAY from the IRAF package.

• van Dokkum (2001) proposes to make the elimination of cosmic rays based on detection of the edges with a Laplacian.

• Pytch (2003) passes a window (user defined) for the whole picture and analyze the histograms of the corresponding values of the pixels inside that window, he defines a cosmic ray as those that exceed a certain standard deviation.

1.1. *Objetive*

The main objective of this work is to develop and implement a method to eliminate cosmic rays in a single CCD image in an automatic way. Specifically, we want to know if the Haar wavelet transform can identified cosmic rays in a single CCD image.

2. METHODOLOGY

Wavelet analysis consists of decomposing a signal or an image in a series of approximations and details. This transform doesn't lose the spatial resolution, for a particular detail we can know its place in the image. This is the principle we use to find the cosmic rays in the spectral image.

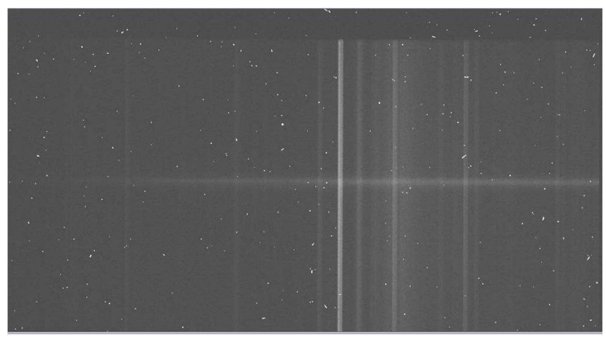

Fig. 1. Image before apply the cosmic rays elimination.

The steps for the detection and elimination of cosmic rays are the following:

• Apply the wavelet transform to the spectral image.

• Analyze the coefficients from the details decomposition and select those that are above a predefined threshold. These are the details that we think can be cosmic rays.

• Once we have been detected a cosmic ray, we define a region centered in the place where the cosmic ray was detected.

• Then, we analyze the region defined in the previous step, we do a statistical analysis calculating the mean for this region.

• For eliminate a cosmic ray, we replace the value of the pixels with the mean calculated.

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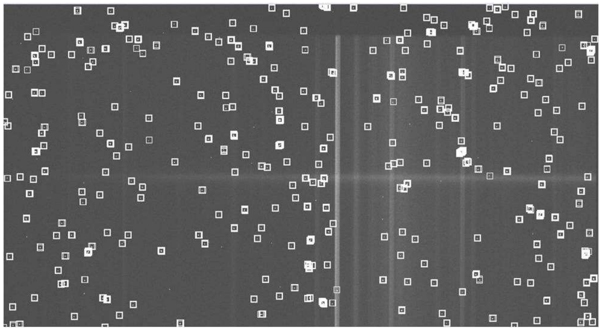

Fig. 2. Cosmic rays detected (boxes) by the Haar wavelet transform.

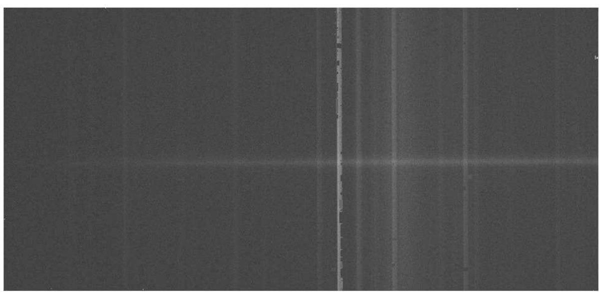

Fig. 3. Image after apply the cosmic rays elimination.

3. RESULTS

The experiments were performed with real images taken by Dr. Jose Ramon Valdes in the "Observatorio Astrofísico Guillermo Haro".

Figure 1 shows the images before applying our method for the cosmic rays elimination.

In Figure 2 we show in boxes the cosmic rays detected by the Haar wavelet transform.

In Figure 3 we show the resulting image after the process of removing cosmic rays using the Haar wavelet transform.

4. CONCLUSIONS

We could see that the wavelet transform was able to find cosmic rays of any shape or size in a spectral image.

A great percentage of cosmic rays (over 95%) in a single CCD image can be eliminated applying the method we propose in this work.

5. FUTURE WORK

There is a lot of work to do, some of the problems we have when we apply the method is that the coefficients of cosmic rays and emission lines are quite similar, that is why it is necessary to develop a mechanism to discriminate between cosmic rays and emission lines.

Another problem we found is when a cosmic ray fall within the signal or very close to it, the elimination of these cosmic ray is complicated and we need a more delicate process to remove it.

REFERENCES

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