A TOOL FOR ALL ASTRO SENSOR RECORDINGS
FUSION INTO COLOR COMPOSITE IMAGES

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SUMMARY: A method of various sensors integration into color fusions, which, although quite simple, has not been seen elsewhere, is described. The method is implemented in the user friendly visual environment packed into a single program that is running on all PC platforms starting with Win 98/NT. Basically, it is transportable to other platforms and the authors would expand it and transport it to other platforms, if the need arises.

Key words. Techniques: image processing

1. INTRODUCTION

Our goal was to produce an efficient and comfortable work in environment that would provide for "false color fusions" of all astronomic sources, with ease and necessary input preprocessing. Existing software on the market did not meet all needs an average researcher would have, and this was sufficient for us to decide developing such a piece of software ourselves. Inspired by early astronomical uses of the image fusion techniques - false colors, our product was primarily aimed at CCD-microscopy (Jovanović 2002), where it enabled user to combine CCD images obtained in all standard and nonstandard wavelengths in visual and UV - microscopy, combining disjoint techniques into easy and comfortable fusions, that allowed clinics and researchers to see assess hidden relations in the examined preparations, with user controls of all segments in production of final composites. After success with CCD microscopy, we realized that there are no reasons we should omit the astronomers from the list of users of our software. The work on the described product was carried out in the Group for Intelligent Systems at the Faculty of Mathematics of the University of Belgrade. Our demo software and slide shows depicting its performance and the groups potential are available at our web site http://www.giss.com (GIS 1997). This software provides for fusions of data obtained with visual, IR, all radio, X and gamma recordings prepared as standard monochrome image inputs. Software described here is still under development, and is expected to expand the number of features and to incorporate in future other specificities, especially virtual optical components - spectroscopic lensing, based on our method of image spectroscopy, applied to the corrections of defects present in the microscopy at high magnifications. Similar approach must have been applied in the Hubble Space Telescope image processing, report of which was published in the August, 2002, issue of Sky and Telescope magazine, though all interesting details on the software were not described, nor the software made publicly available (Feinberg 2002).

2. METHOD

Suppose that the recordings of astronomic data, originating in all perceptible windows, are prepared in the form of .bmp inputs, i.e. made available in some sort of standard visual format. Let us designate these windows as
$W = \{ w_{s_1,1}, \ldots, w_{s_1,n_1}; \quad w_{s_2,1}, \ldots, w_{s_2,n_2}; \quad \ldots \quad w_{s_k,1}, \ldots, w_{s_k,n_k} \}$

with source type domains $\{s_1, s_2, \ldots, s_k\}$. Let us allow for the preprocessing operations on the separate domains that would provide for filtering, noise reduction, sharpening, some features enhancing, centering (so that the objects are positioned at the same coordinates), aiming finally to the linear combinations that will integrate one output for each source type

$$o_i = \sum_j \lambda_j w_{s_i,j}, \quad \text{for } i \in \{1, 2, \ldots, k\}. \quad (1)$$

Type representatives obtained in this way are further processed, individually and commonly, and centered before they are entered into final precolor monochrome fusion:

$$m_i = P_j(o_{il}, \ldots, o_{iq}), \quad i \in \{1, 2, 3\}. \quad (2)$$

Both initial and final centering consist of combined translations, rotations and zooming. The coordinate system transformations are not integrated yet, but are experimented with, to provide for unification of diverse prevailing standards. In such a way, comfortably and efficiently, a gallery of color composites

$$cc_j = (\rho_j m_1, \gamma_j m_2, \beta_j m_3), \quad j \in \{1, 2, \ldots, n\} \quad (3)$$

is generated in real time, giving the researchers a potentially rich insight into the investigated phenomena and underlying physics.

The operation with the software is simple and needs practically no training at all, with all tools and choices offered in the friendly and logical manner. User interfaces of the software are presented on Figs. 1, 2 and 3.

The Figs. 4 and 5 show the final monochrome centering and integration operation for this example of fusion of radio 1420 MHz and 408 MHz, together with X-ray sky. In this way the whole color composite gallery is generated in minutes, with color balance selection suitting diversity of visualizations as shown for this beautiful example on Figs. 6 through 11.

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1. All the figures in full colors are available on WEB site http://saj.matf.bg.ac.yu.
Fig. 4. Centering of preprocessed input monochromes.

Fig. 5. Composite image fusion.

Fig. 6. Composite with dominant X-sky, subdominant 408 MHz, and strongly reduced 1420 MHz.

Fig. 7. Composite with dominant 408 MHz, reduced X-sky, and strongly reduced 1420 MHz.

Fig. 8. Composite with dominant 408 MHz, subdominant X-sky, and strongly reduced 1420 MHz.

Fig. 9. Composite with dominant 1420 MHz, subdominant 408 MHz and strongly reduced X-sky.
Fig. 10. Composite with dominant 1420 MHz, sub-dominant X-sky and 408 MHz.

Fig. 11. Composite with dominant 1420 MHz, sub-dominant X-sky and strongly reduced 408 MHz.

In the absence of rich of fusible sources, here we offer another well known object, recorded with 3 CCD short monochrome exposures, together with the easily generated gallery of color composites, in order to illustrate a little more the method and software potential. We definitely did not perform the best possible preprocessing, but the main purpose here was to show that the concept is practical and useful. Access to more exciting source recordings will definitely pull more attraction towards best possible preprocessing efforts and, hopefully, proportional benefit in final results. This work on Trifid nebula images is shown on Figs. 12 through 17.
The method presented here of various sensor integrations into color fusions, presented herewith, though quite simple, has not been seen elsewhere by us. The method is implemented in the user friendly visual environment packed into a single program that is running on all PC platforms starting with Win 98/NT. It is easily transportable to other platforms, and it would be a pleasure for the authors to expand it and to transport it to other platforms, if the need arises.

REFERENCES

У раду је приказан метод интеграције снимака добијених из различитих сензора који су у употреби у савременој астрономији у колор фузије. Мада је метод доста једноставан, слично нисмо видели другде. Метод је имплементиран у пријатно визуелно окружење, упаковано у јединствен програм који ради на свим платформама, полазећи од Win 98/NT. Лако је преносив на друге платформе и аутори ће са задовољством да га прошире и пребаци на друге платформе ако се укаже озбиљна потреба за истим.