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Processing of data from innovative parabolic strip telescope.

This paper presents innovative telescope design based on usage of parabolic strip as objective.

Isaac Newton was the first one to solve problem of chromatic aberration, which is caused by difference in refractive index in lens. This problem was solved by new kind of telescope with mirror used as objective.
There are many different kind of telescopes.
The most basic one is lens telescope. This kind of telescope uses set of lenses.
The next type is mirror telescope. Objective of such telescope can be concave mirror, spherical parabolic mirror or hyperbolically shaped mirror. Lens speed is depending directly on surface of the mirror.
Both kinds can be combined. Such telescope composes of at least two mirrors and set of lenses. Light is bounced of the primary mirror to the secondary one and then to the lens system. This type has smaller sizes, but also smaller lens speed.

The telescope design presented in this paper have parabolic strip as objective.
Observed objects are projected as line in picture plane. Each line, which size is equal to size of strip, corresponds to sum of intensities of light coming perpendicular to objective from observed object. Series of pictures taken with different rotation and processed by special reconstruction algorithm is needed to get 2D pictures.
The telescope can be also used for fast detection of objects. The rotation and multiple pictures are not need in this mode, just one picture of mirror is needed.

The greatest advantage of the parabolic strip telescope is its simpler and cheaper construction. Just two holders with cut-out for parabolic strip and strip from reflective flexible material are needed to create the objective. Tension in the strip material guarantees stability and precision of the reflective surface shape.
Main idea of reconstruction is based on the same principle as CT (Computer Tomography); reconstruction of 2D image by usage of Radon transformation principle from 1D samples. Four algorithms were implemented and tested.
The most basic one is summation algorithm. It is based on sequential summation of projections (adjusted pictures taken during rotation of the telescope). It algorithm is very fast and very useful for verification of basic functionality of the whole setup.
Multiplicative algorithm is improved version of summation algorithm. It is based on mutual multiplication of picture matrixes. Main advantage of this algorithm is primarily in ability to easily clean dark point from final matrix and thus suppress noise in the reconstructed 2D picture. Disadvantage is complicated weighting of matrixes during multiplication.
The third one is iterative algorithm. This approach is base on multiplication in steps. Pictures are divided into subsets. These subsets are multiplicated and until the reconstructed image is created. Idea of subsets came from CT image processing.
The last algorithm, for processing of pictures from parabolic strip telescope, is Filtered Back Projection method. It is not possible to directly use inverse radon transformation despite the fact that telescope is based on principle of Radon transformation. It is mainly because radon transformation does not have guaranteed analytic solution, thus approximation of this algorithm is used. This approximation is known as Filtered Back Projection and was originally used for reconstruction of the picture from CT. Final picture processed by this method is usually of very good quality and algorithm itself is very well adjustable for particular problem thanks to wide variety of filters.

Construction of whole telescope is relatively simple. It composes of four parts. The base is multi-axis astronomical tripod with automatic Earth movement corrections. The second part is firm holder for servomotor. This servomotor is responsible for rotation of the objective of telescope. Furthermore the CDD camera is attached to the telescope in focal point. Image from objective is projected directly on the CCD chip without

any other optical elements. The support elements are made of aluminum and duralaluminum. Whole surface is anodized to black color to minimize light reflection. Mirror holders are made of hardened plastic.

The building of many observatories all around the world is possible thanks to low cost of this design. Observation of large part of the sky would be possible by such system of telescopes with big objective and angular freedom of about 15 degrees. This system is also fit for usage in satellite construction, thanks to the low weight. Best place for such telescope, is an orbit of the Earth, where all the adverse effects of the atmosphere are absent and construction of hundreds meters large objective can be made. Telescope of this magnitude can make observation of distant stars and search for exoplanets more precise and easier. Resolution of the 120 cm large parabolic strip telescope based on preliminary calculation, equal those of parabolic telescope with 150 cm diameter.
This design has yet another very unique usage. Telescope can be used for observation outside of visible spectrum, more precisely wavelength of X-Ray and gama, by exchange of parabolic strip material.

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