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Magnifying Lens of Telescope Using Object Distance

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Abstract: This study presents the design of a C program aimed at calculating the magnification by the lens based on object distance and image distance of the object and vice - versa. The working principle behind a telescope is that when an object that is to be magnified is placed at a large distance from the lens of a telescope, magnified, inverted images are formed at the least distance when held close to the eye piece. Leveraging the fundamental principles of optics, the program computes the magnification using the magnification formula corresponding to the provided inputs. Through this implementation, users can conveniently determine the magnification of a lens for various optical systems, facilitating applications in fields such as physics, engineering, and optics research. The program's modular structure and intuitive interface offer a practical tool for educational purposes and real-world optical analysis scenarios.

Keywords: Magnification, Object distance, Image distance.

I. INTRODUCTION

A telescope is an optical instrument designed to gather and magnify light to observe distant objects. It works by utilizing a combination of lenses or mirrors *(or both)* to collect and focus light onto a focal point, where it can be viewed directly by an eyepiece or captured by camera or other imaging device. It is widely used in astronomy to explore celestial bodies such as stars, planets, galaxies. Telescopes can also be used for terrestrial observations, surveillance and various scientific applications. There are various types of telescopes utilized in astronomy, each with its unique design and functionality [2]. Refracting telescopes employ lenses to gather and focus light, exemplified by the renowned Hubble Space Telescope. Reflecting telescopes, on the other hand, use mirrors to capture and concentrate light, such as the ones found in observatories like the Keck Observatory Telescopes. Compound telescopes combine both lenses and mirrors to achieve a compact design with the advantages of both refracting and reflecting elements, including the Schmidt-Cassegrain and Maksutov-Cassegrain Telescopes. Additionally, radio telescopes play a crucial role in detecting radio waves emitted by celestial objects, employing large parabolic dishes for signal collection. Furthermore, space telescopes like the Hubble Space Telescope, orbiting above Earth's atmosphere, provide distortion-free observations across various wavelengths, offering invaluable insights into the cosmos for astronomers.

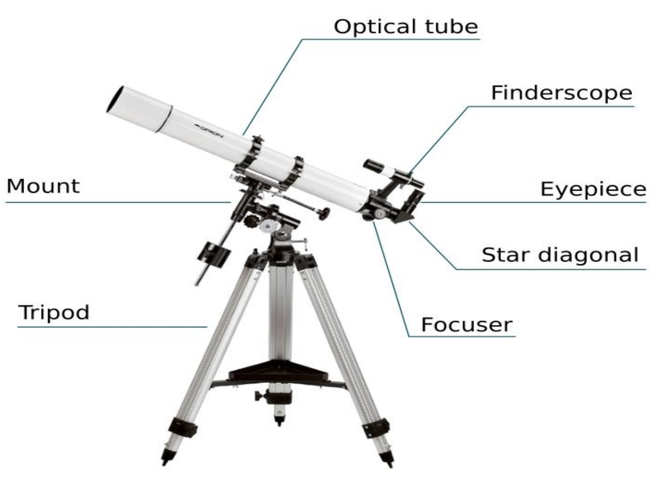


Figure - 1: Different parts of telescope

As shown in figure - 1, telescopes are equipped with several key components to enhance observation experiences. The eyepiece, closest to the observer's eye, magnifies images for clearer viewing. A focuser enables precise adjustment of focus by moving the eyepiece closer to or farther from the primary optical element [4]. Star diagonals facilitate comfortable overhead viewing with angled mirrors or prisms. Telescopes are typically supported by tripods for stability and ease of use. Mounted on sturdy structures, telescopes can track celestial objects as the Earth rotates [5]. Additionally, finder scopes aid in locating objects before observing through the main telescope, featuring aiming aids for alignment.

II. METHODOLOGY

As shown in the below figure - 2, Telescopes are defined by several critical parameters. Object distance refers to the distance from the object to the lens, while image distance indicates the distance from the formed image to the lens. Aperture, measured in millimeters or inches, determines light-gathering capability. Focal length, also measured in millimeters or inches, dictates magnification and field of view. Mount type, whether altazimuth or equatorial, supports and aligns the telescope [3]. Optical design, whether refractor, reflector, or compound, influences image quality and size. Additionally, magnification, field of view, and accessories such as eyepieces and filters enhance observation versatility and experience.

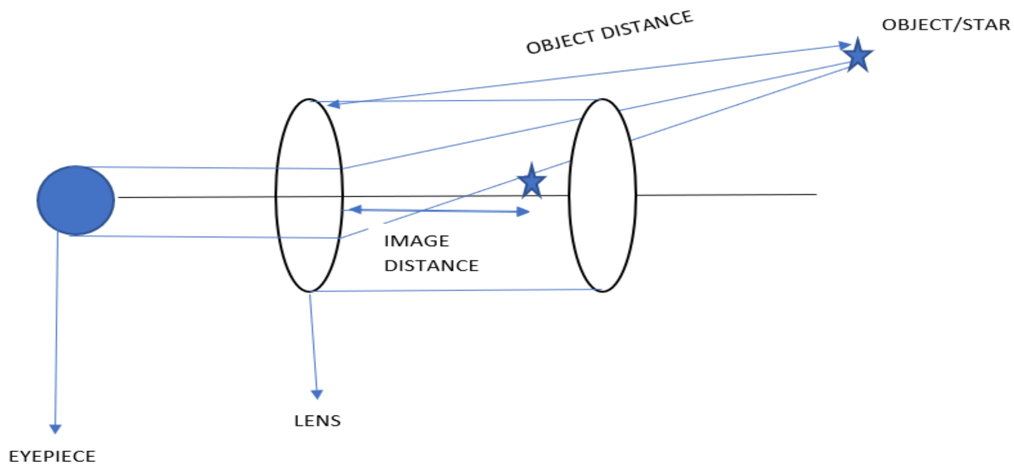


Figure - 2 : Block diagram for image formation in a telescope

Relation Between Magnification, Object Distance And Image Distance :

$$M = -v/u \tag{1}$$

From the above equation 1 , Magnification refers to the process of enlarging an object, image or phenomenon in order to make it more visible or easier to analyze. Let “M” be the magnification produced by the lens, “u” be the object distance and “v” be the image distance. The negative sign indicates that the image formed is inverted [1].

As shown in the below figure - 3, To compile the program, navigate to the directory containing the source code file using a terminal or command prompt. Use the GCC command with your chosen C compiler to compile the source code file and generate an executable named telescope. Once compiled successfully, execute the program by running the generated executable file. In the terminal or command prompt, enter the command to execute the telescope executable, initiating the program to find the approximate distance of a given star using a telescope. Interacting with the program involves following its functionality instructions. Depending on the program's design, you may need to input parameters such as star distance and lens magnification to calculate image distance, or provide image distance and magnification to determine the star's distance. Follow any provided instructions for inputting data or selecting options. The program should handle the required calculations based on user input and display the results accordingly. After completing the desired tasks, exit the program as instructed. This may involve specific termination commands or closing the program window. Pay attention to any error messages displayed during compilation or execution for troubleshooting. After execution, validate the program's correctness, reliability, and efficiency through testing different input scenarios and evaluating its performance under various conditions. Refer to the program's documentation or usage instructions for comprehensive guidance on features, output interpretation, and troubleshooting procedures.

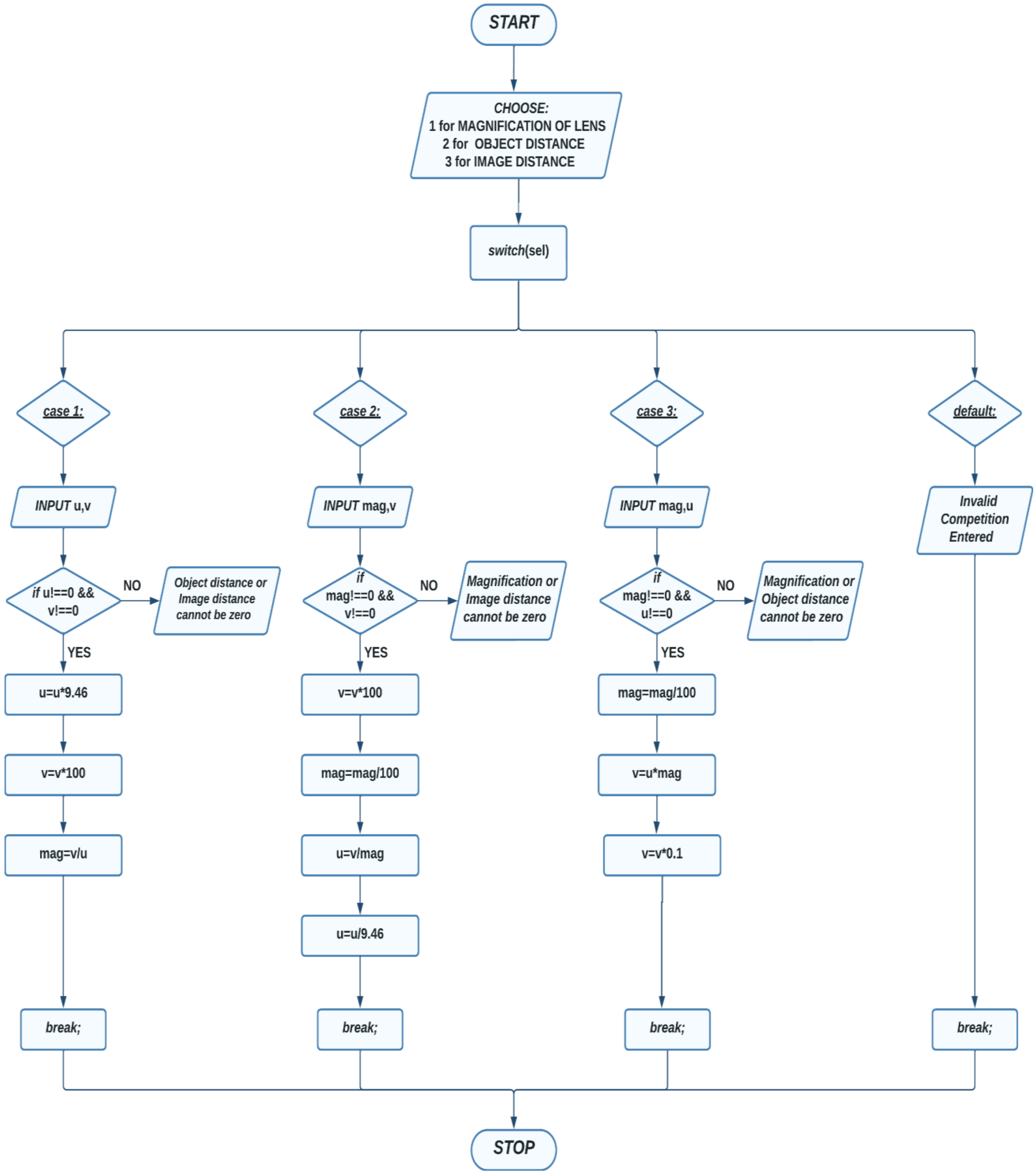


Figure - 3: Flowchart to find magnification of the lens of telescope

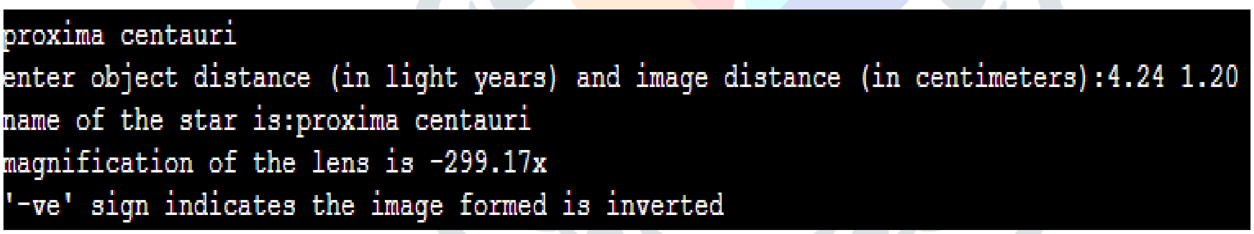
III. RESULTS

As mentioned in the below table - 1, the magnification of the lens with object distance (i.e. distance from earth to one particular star in light years) and image distance (approximate values) as input values and we got the appropriate magnification values is calculated with the help of c program.

Table - 1 : Finding the magnification of few stars

Serial No.	*Name of the Star*	*Distance from Earth (light years)*	*Magnification (X)*	*Image Distance (in cm)(approx.)*
01.	Proxima centauri	04.24	299.17	1.20
02.	Alpha centauri – A & B	04.37	314.46	1.30
03.	Barnard's star	05.96	319.25	1.80
04.	Wolf 359	07.78	326.09	2.40
05.	Lalande 21158	08.29	331.53	2.60
06.	Sirius A and Sirius B	08.60	344.17	2.80
07.	Ross 154	09.69	349.09	3.20
08.	Ross 248	10.30	359.20	3.50
09.	Epsilon eridani	10.49	362.77	3.60
10.	Lacaille 9352	10.74	363.19	3.69

The below figures - 4(a) and 4(b) are examples for calculation of magnification of lens to view two nearest stars to the earth i.e. , proxima centauri and Alpha centauri - A & B



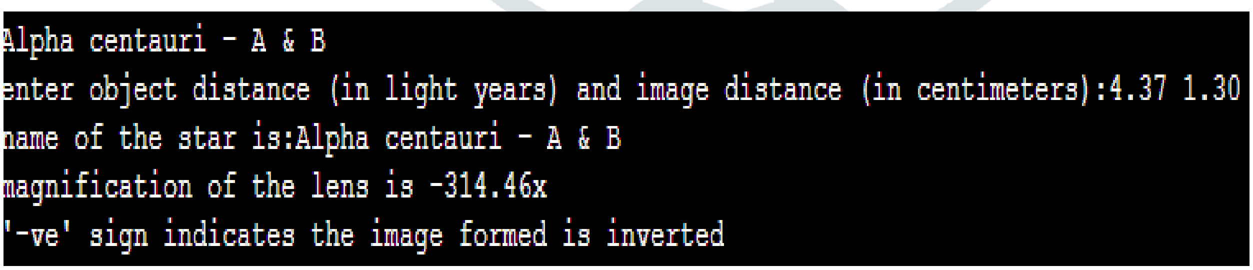


Figure - 4(a) and 4(b) : Output for magnification of lens to view the above stars

IV. CONCLUSION

This paper presents a meticulously designed C program tailored for calculating lens magnification based on object distance, image distance, and vice versa. By harnessing the principles of optics, particularly those governing telescopic magnification, the program efficiently computes magnification utilizing established formulas. This implementation offers users a convenient means to ascertain lens magnification across a spectrum of optical systems, with potential applications spanning fields such as physics, engineering, and optics research. The program's modular structure and user-friendly interface not only make it a valuable tool for educational purposes but also render it applicable in real-world optical analysis scenarios. Through this endeavor, the study contributes to the accessibility and practicality of lens magnification computation, thereby enhancing understanding and utilization within relevant disciplines.

V. REFERENCES

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