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Construction of a Simple Periscope Using Plane Mirrors for Use as a Security Surveillance Instrument for Preventing Face-to-Face View of People Around Houses.

[1]Tortondo Elias Ahuah, [2]Nathaniel Muwa Shawhatsu

[1&2]School of Science and Technology, Department of Science Laboratory Technology, Federal Polytechnic Bali, Nigeria
Email Address: eliastor241@gmail.com

ABSTRACT

A periscope is an apparatus consisting of a tube attached to a set of mirrors or prisms by which an observer can see things over, around or through an object that stand as an obstacle or condition that prevents direct line-of-sight observation from an observer's current position. A periscope operates on the principle of reflection of light. Primarily, periscopes are used in submarines to view objects floating on the surface of the sea such as, ships, boats, icebergs and logs of wood for security and prevention of accidents due to collision with such objects in its way. In this project the aim was to construct a simple periscope using plane mirrors that can be used as a surveillance equipment in a walled house in the day time to watch the people passing outside the environment of the walled house before they come to the house or pass to their destinations for security purposes. Two plane mirrors have been used in the construction of the equipment. The mirrors were inclined at 45° to the horizontal at both ends of the pipe. Beams of rays of light from the passers-by are reflected at the two mirrors according to the laws of reflection and the images of the people can be seen by the observer. Two of such instrument could be placed at strategic places in the house for use by a watchman for security purposes. Wooden materials were used for the construction and the plane mirrors were placed in the right position for optimal reflection by the two mirrors in order to obtain a clear view of passers-by outside the home environment.

Key Words: Simple periscope, Plane mirrors, Security surveillance instrument, Rays of light, Beam of light, Reflection of light.

1. INTRODUCTION

Generally, a periscope is an instrument used for observing over an obstacle or condition that prevents direct line-of-sight observation from an observer's current position. Periscopes technology are employed in submarines, armoured tanks in the military warfare and in clinical instruments to view hidden objects and anatomy of human beings. Periscopes are also employed in optical flight (Charles, Lawrence & Elwin, 2021). Different types of optical instruments such as lenses, prisms and mirrors are used in the construction of a periscope (en.wikipedia.org).

Basically, there are two types of periscope, commonly in use include: Simple periscope and Complex periscope (Collegedunia.com).

The simple periscope uses plane mirrors to see objects hidden from direct view (Nelkon, 2007). Such objects include: People outside a walled house, a football match event where spectators obstructs direct view, a dancing masquerade obstructed by a crowd. While constructing the periscope, the plane mirrors were fixed at 45° to the horizontal at opposite ends of a hollow straight object such as a tube or a square ended cylindrical object. The periscope will not function well if the mirrors are not inclined at the proper angles of inclination. The parallelism and the 45° inclination between the mirrors must be maintained for correctness of the result. This enables the beam of light rays from the object to strike at the required angle. Light rays are propagated rectilinearly. While Complex periscopes use prisms too for the reflection of light

It is worth to understand plane mirror as an optical instrument made of glass material with one surface or side coated with silver or gold paint. Plane mirrors have several applications in science and for domestic purposes. They are used in:

i. Shaving and decorations of our body.

ii. Commercial meters to overcome the error of parallax.

iii. Construction of simple periscope.

iv. Measurement of the small angle of rotation of the coil in a micro galvanometer. This meter measures very small electric currents.

v. Construction of the Kaleidoscope for use by engineers in building.

Earliest inventors of the periscope

The periscope has been in use for quite a long time. History about the invention of the periscope dates back to more than a thousand years ago. The following people were mentioned about the invention of the periscope in the early times.

Hippolyta Marie-Davy designed the periscope in 1854 (testbook.com).

Louis Barbier invented the periscope in 1861. He sold his patent rights to the Tuttman Company in London, who released the first commercial model in 1896.

Midspman was said to invent the periscope in 1868.

The history of the invention of the periscope has been varied from different reporters. However the dates do not part from each other in many years as can be seen above. This means that the invention of the periscope took place in almost close periods of time from the inception. The technology of the periscope is as a result of the idea of reflection of light rays on plane mirrors and smooth metal surfaces.

Reflection of light

Reflection of light is the bouncing back or changing of direction by a light ray when it approaches a smooth polished surface. The incident light ray that land on the polished smooth surface is reflected off the surface. The ray that bounces back is called the reflected ray. If a perpendicular were drawn on a reflecting surface, it would be called normal. We see our image in a plane mirror because of reflection of light. Light waves, sound waves and water waves can undergo reflection. Experimental researches have shown that incident light rays on plane smooth surfaces undergo certain laws that govern the reflection of light. The laws of reflection determine the reflection of incident light rays on reflecting surfaces such as plane mirrors, smooth metal surfaces and clear water.

Laws of reflection

Law i: The incident ray, the reflected ray and the normal at the point of incidence all lie in the same plane.

Law ii: The angle of incidence is equal to the angle of reflection.

These laws of reflection however do not apply in a diffused reflection of light on unpolished and unsmooth surfaces. Generally, light rays are produced rectilinearly. The phenomenon of rectilinear propagation of light means that light rays travel in a straight line. Light doesn't travel round corners. Objects are seen by reflection of light rays that incident on the objects from sources of light such as sun, stars, torchlight and light from other luminous objects.

A ray of light: is the path or direction on which light energy travels. When several rays of light travel together, they form a beam of light.

A beam of light: is a collection of light rays. Beams of light could be in different forms. These include:

i. **Parallel beam of light**: the rays in a parallel beam do not meet.

ii. **Divergent beam of light**: the rays in a divergent beam diverge from a point outwards.

iii. **Convergent beam of light**: the rays in a convergent beam converge at a point.

In the simple periscope, light rays travel from points on the surface of the object being viewed in parallel and enter the first hole of the periscope and incident on the objective mirror at an angle of 45^{o} and reflects at an angle of 45^{o} towards the second mirror which is the image mirror and strikes it through an angle of 45^{o} and reflects through an angle of 45^{o} to the eye of the observer who views it through the second hole of the periscope. The images of the objects in this construction are seen to be upright. Clear images of people can be seen and identified through this technology which incorporates plane mirrors and laws of reflection in plane mirrors. A periscope do not produce magnification of the image unless facilitated by magnifying instruments.

Several applications of periscopes

Apart from its use for the purpose of this project as a security surveillance instrument for exploring places without revealing ones presence by minimizing face-to-face view of people outside the walls of our houses,

i. Periscopes are used in submarines to determine the distance of a torpedo and helps in deciding the right time for launching pads for bombs attack (Unacademy.com).

ii. It is used in a nuclear reactor to observe the chemical reactions in test tubes or to measure the level of liquid in a container that is not easily accessible (www.toppr.com).

iii. In military, periscopes are used to observe from their hiding place to avoid enemies from ambushing it (byjus.com).

iv. Tanks and other armoured vehicles use it to inspect the surrounding of where they are for military surveillance to avoid enemies attack.

v. It is used by kids to look at a parade over the heads of a crowd considering their limited height compared to that of the crowd.

vi. Periscopes are used for inspection in architecture and construction.

Difference between Telescopes and Periscopes

i. Telescopes are primarily used for astronomy and provide the clearest view at night in viewing celestial bodies.

ii. The periscopes are used to see over, around or through an obstacle. Moreover, Periscopes are used in trench warfare, submarine navigation and viewing nuclear reactions (www.telescopenerd.com).

iii. A telescope is a monocular optical instrument that has the magnification capacity of distant objects.

iv. The periscope do not produce magnification.

v. Telescopes invert your image flipping your view upside down while periscopes do not. Periscopes display an undistorted view from the top mirror so you can see beyond your field of view.

vi. Telescopes allow us to view extremely distant objects within your line of sight. They have stronger magnification because they are used to view objects at extreme distances at a range of 30x to more than 90x (Will, 2022).

vii. Periscopes are used in trench warfare, submarine navigation and viewing nuclear reactions (www.telescopenerd.com).

viii. Periscopes are used to view objects not directly in your line of sight and have much weaker magnification.

While these optical instruments are different, they use similar processes to display your view. They both use mirrors to reflect an image.

Statement of the problem

The challenge of in security and the cost of affording CCTV demands exploration of different means for a house owners to have a means of checkmate suspicious movement around their houses. Periscope with wider view of objective mirror or wider objective prism can help least privilege people to have a security surveillance instrument mounted at a strategic to preventing face-to-face view of people around houses. The device is cost effective to the affordability of common man.

Aim and Objectives

Aim: Construction of a simple periscope using plane mirrors.

Objectives

i. To construct a simple periscope using plane mirrors.

ii. To provide a simple periscope for surveillance of people moving around the outside surrounding of the walls of our houses for security purposes.

2. MATERIALS AND METHOD

Materials

The following materials were used in the construction of the periscope in this project: Two circular plane mirrors, PVC Pipe, Hack-saw, Putty, Nails, Masking-tape, Compass and Wrapping paper.

Method of construction

Two circular plane mirrors of the same size were fixed at 45^o to the horizontal at opposite ends of the long PVC pipe. The saw was used to cut the tube at a slanting position for fixing the two circular mirrors at both ends of the pipe. The compass was used to measure an angle of 45^o to the horizontal as required, as it is cut on the PVC pipe. The Putty and nails were used to keep the circular mirrors in stable and static position so that light rays that reflect on the objective mirror from the object can reach the observer mirror in the right position. The wrapping paper was used to give the constructed periscope a befitting look. The angle of incidence (i^o) and the angle of reflection (r^o) at the objective mirror which is the first mirror are each 45^o. In the same way, the angle of incidence and reflection at the observer mirror which is the second mirror are each 45^o. This means that the angle of incidence plus the angle of reflection at the point of incidence on the plane mirrors at each end sum up to 90^o. $I.e$: ($i^o + r^o = 90^\circ$). This is the total angle through which the incident ray from the object turns towards the second mirror and reflects towards the observer's eye with the same angle size.

3. RESULTS

The materials mentioned above for the construction of the periscope were used and the periscope was constructed and tested and it worked perfectly as described for the purpose for which it was constructed. The constructed periscope is shown in figure **C** below.

Fig 1: Photograph of the Constructed Plane Mirror Periscope

4. SUMMARY/CONCLUSION

The security of life is so necessary that the means for a secured environment which we live in is very important. This project is geared towards finding a way to look at visitors before they enter the house. In the same way, passers-by at our houses can be seen from the constructed periscope. Two plane mirrors and a long tube were used in addition to other materials listed above for the purpose of the project of the periscope. This equipment will prevent a face-to-face contact with people in close proximity with our house environment. The periscope was constructed and tested and it worked effectively. One of the disadvantages of the constructed periscope is that the final will not be as clear as expected because, light energy is absorbed due to the two reflections on the plane mirrors. Furthermore, if there is dust and moisture, the images will be blurred.

5. RECOMMENDATIONS.

The researcher recommends that the following should be done on the results of the project:

i. The finished project on constructed simple periscope should be used for security purposes in our houses because it has been tested and found to be effective for the purpose for which it has been meant to serve.

ii. Further constructions of the periscope should be carried out on larger mirrors to compare clarity and functionality between the small mirror periscope and larger mirror periscopes.

iii. Prisms or lenses should also be used in construction of a periscope to compare the clarity and functionality between the two periscopes.

iv. Further research should be done to enable use of the periscope for surveillance at night by employing means that will enable such an action.

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