Electromagnetic Principles

After selecting the electromagnetism part, two options will be available. They are-

1) Magnetic Field due to current and

2) Force due to Magnetic Field.

Magnetic Field due to Current

Steps to follow-

1. Upon selecting this option, the camera of the device will be open.
2. Please hold the camera on the target image for this module.
3. A set up with electric wire and current source will be seen (Fig. 1).
4. Press “Start” button to start the flow of the current. (Fig. 2)
5. In this module, users can determine the magnetic field by changing the values of current and radius.
6. By pressing the “Change direction of the current direction”, user can alter the positive and negative side of the source. Therefore, the current direction is changed.
7. The magnetic field around the current carrying conductor can be observed by circular arrows.

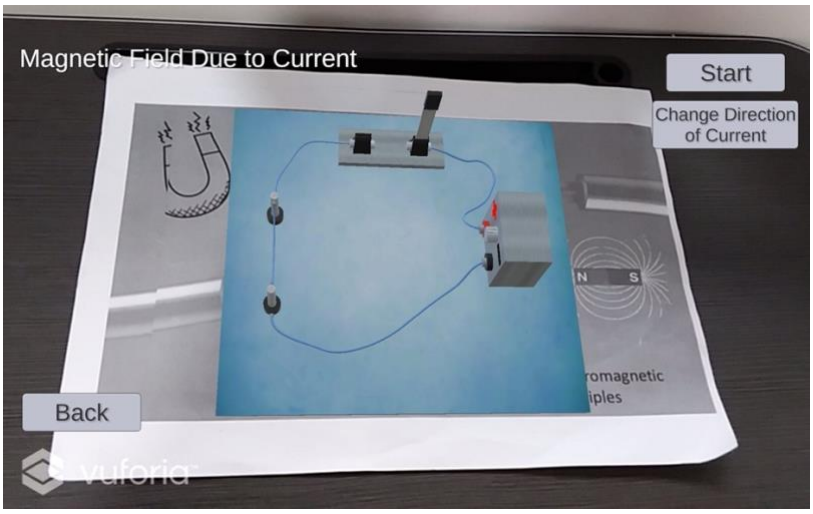

Fig. 1 Initial image of the Magnetic Field due to Current module.

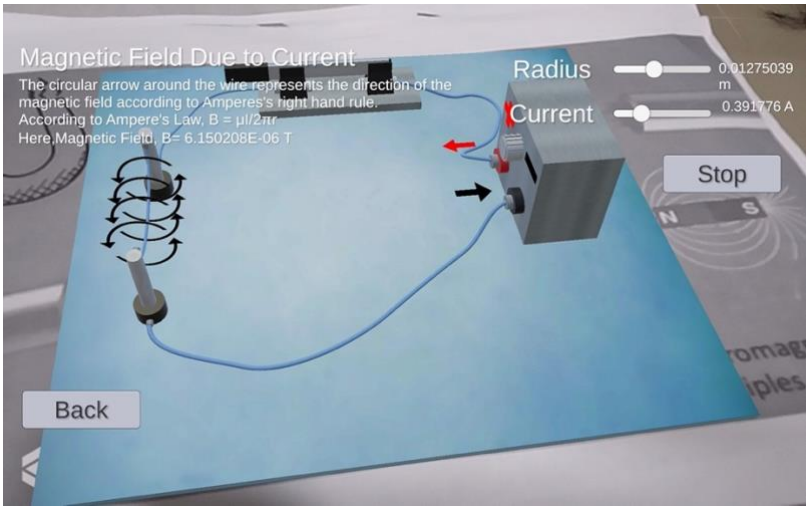

Fig. 2 After pressing "Start" option, Magnetic Field due to Current module.

Theory

The magnetic field is calculated using the Ampere's law (Equation 1). The law talks about the sum of the magnetic field across a closed loop which is carrying current.

$$\oint B\, dl \rightarrow = \mu \times I \qquad (1)$$

where, B is the magnetic field, L is the infinitesimal length, I is the current flowing through the closed-loop, μ is the permeability.

From the Ampere's law, the following equation of magnetic field along a straight wire can be derived-

$$B = \frac{\mu I}{2\pi r} \qquad (2)$$

where, B = magnetic field around a line of current, I = current passing through the wire and r = distance from the wire where the magnetic field is measured. In this module the magnetic field is being calculated using this formula. User can determine the magnetic field around a current carrying conductor by varying the I and r. Moreover, the direction of the arrow (defining the current direction) will change if the source's positive and negative sides are altered. Here, the magnetic field direction (based on the Ampere's right-hand rule) is shown around the current carrying conductor using several ring-shaped arrows.

Force due to Magnetic Field

Steps to follow-

1. After selecting this option, the camera of the phone will open.
2. Please hold the camera on the target image for this module.
3. A set up with a free electric rod, a horseshoe magnet and current source will be appeared. (Fig-3)
4. User can rotate the magnet to change the pole in opposite direction by pressing “rotate magnet” Button.
5. Magnetic field direction is shown by an arrow sign from north to south.
6. User can change the direction of the current by pressing “change current direction” button.
7. Press “Start” to start the current flow.
8. The wire will move towards the magnet or away from the magnet depending on the direction of the magnet and the current flow.

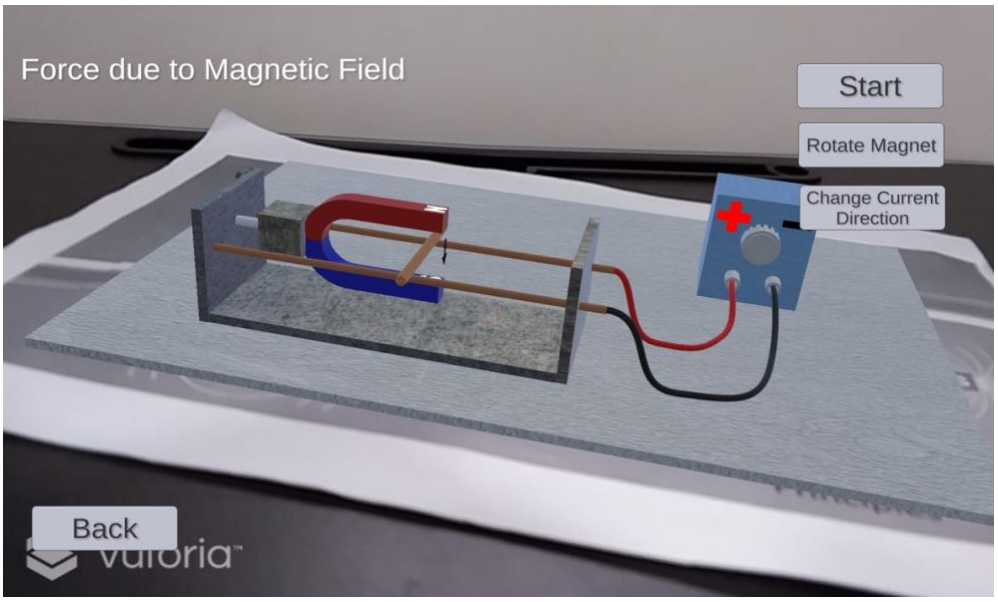

Fig 3: Force due to Magnetic field

Theory

A current carrying conductor produces a magnetic field around it. i.e., behaves like a magnet and exerts a force when a magnet is placed in its magnetic field. Similarly, a magnet also exerts equal and opposite force on the current carrying conductor. The direction of this force can be determined using Flemings' left-hand rule.

The direction of the magnetic field, force and current act mutually perpendicular to each other. The current carrying rod moves away from the magnet, when a repulsion is created due to the opposite direction of the current of the rod and the magnetic field lines of the magnet. Similarly, the current carrying rod moves towards the magnet because of the attraction created due to the same direction of the current of the rod and the magnetic field lines of the magnet.