RESEARCH ARTICLE

Electronic Gadget Detection Using Giant Magnetoresistive Sensor

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ABSTRACT: This work reveals the presence of an Electronic gadget where it is misused/restricted/prohibited in the premises. The objective of this work is to detect the electronic gadget, which is exhibiting magnetic field even when it is in Power off/Airplane mode. This detector concentrates only on some major parts which are used in the mobiles/electronic gadgets for the purpose of detection and then indicates to the alert system. We have many systems to detect the signals receiving or transmitting from the device i.e. in-active condition. By using this detection circuit which has magnetic field detecting sensors, we can identify an electronic gadget which exhibits the magnetic field. By using this sensor, the misusage of electronic gadgets in the prohibited areas can be restricted/ eradicated.

KEYWORDS: Sensor, Magnetoresistive effect, Gadget, Giant Magneto Resistance

https://doi.org/10.29294/IJASE.7.2.2020.1752-1755

1. INTRODUCTION

The development of technology and the invention of many new electronic gadgets had grown up vastly in the present era, which has many advantages and disadvantages. One among such disadvantage is the wide usage of the electronic gadgets in an inappropriate way, which leads to the accident as an end result. This work deals with the detection of electronic gadgets which exhibits magnetic field, normally the electronic gadget under working condition emits a wide range of signals and thus gives an easy way for detecting the signals which transmit/receive by the gadget [1, 2], but in no power mode, an electronic gadget does not exhibit any kind of active signals except the magnetic field produced by the magnets of the speakers. Identification of the magnetic field produced by the electronic gadget which is under power-off condition is the condition of this work. The detecting device which is used in this project consists of magnetic field sensors [1], which can be able to detect the magnetic fields produced from the electronic gadget at a certain distance. The detecting range (distance) of the detector system depends upon the detecting gadget we use i.e. Reed relays/ switches, Hall Effect sensors, anisotropic magnetoresistive sensor (AMR), Giant magnetoresistive sensor (GMR), in this (MR) detectors the value of resistance gets differs when they are subjected near to the sensitive magnetic field, these are the advanced magnetic field detectors which is used for the detection of the earth magnets for GPS systems in mobile or magnetometers. The GMR sensor is used in many sensitive applications as it highly sensitive when compared to HALL and AMR devices [3]. Figure 1 shows the circuit of detecting equipment. The components used in the circuit are power supply, GMR sensor, Resistor, LED. The objective of using the resistor 2kΩ is to limit the current through the GMR sensor from getting damaged as it is suitable to very low power operation and the usage of 330Ω is to protect the LED. The output of the GMR sensor is collected across the input and output of the GMR sensor. The LED starts glowing when the device with magnetic field exhibiting property comes near to the sensing device range. In this work the GMR sensor was been tested for the magnetic field of the mobile phone. The aim of the study is to prove the concept of detecting the mobile phones gadgets available in the area where the phones are prohibited for the safety purpose.

2. Experiment description and principle

2.1. Magneto resistive sensor

Magneto resistor is a type of resistor whose resistance changes when an external magnetic field is applied. In other words, the flow of electric current through the magneto resistor changes when an external magnetic field is applied to it. A magnetic field is the region present around a magnetic object within which other objects experience an attractive or

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Received: 10.09.2020 **Accepted:** 25.10.2020 **Published on**: 01.11.2020

repulsive force [4]. The magneto resistors that are placed in the magnetic field will experience a change in resistance. When the strength of the magnetic field is increased, the resistance of magneto resistors also increases. On the other hand, when the strength of the magnetic field is reduced, the resistance of magneto resistors decreases. This change in resistance is caused by the magnetoresistive effect. In the absence of a magnetic field, the charges carriers in the material move in a straight path. Therefore, electric current flows in a straight path. When the magnetic field is applied to the material, the magnetic forces cause the mobile charge carriers (free electrons) to change their direction from the direct path to an indirect path. This increases the length of the electric current path. Hence, a large number of free electrons collides with the atoms and loses their energy in the form of heat and only a small number of free electrons flow through the conductive path. The small number of free electrons moving from one place to another place carries the electric current. Therefore, the resistance of the material increases with increasing magnetic field. Compared with the other magnetic sensors, GMR sensors has more robust reaction to presence of magnetic field due to its best sensitivity, very minute in physical structure helpful to fit in small housing and low raw material requirement for its construction. The magnetoresistive effect is the property of some materials, which causes them to change their resistance under the presence of the magnetic field. This magnetoresistive effect occurs in materials such as semiconductors, non-magnetic metals, and magnetic metals. An Irish mathematical physicist and engineer William Thomson first discovered this magnetoresistive effect in 1856. He observed that resistance of the pieces of iron increased when the electric current is flowing in the same direction as the magnetic force or magnetic field and the resistance is decreased when the electric current is flowing at 90° to the magnetic field or magnetic force. After that, he performed the same experiment with nickel and he found that the resistance of the nickel is affected in the same manner but the magnitude of this magnetic field was much greater than before. This effect is called Anisotropic Magneto Resistance (AMR) [4].

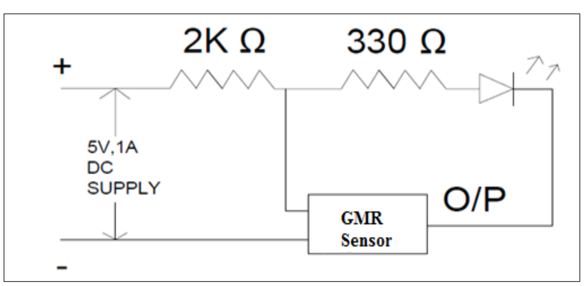

Fig.1: Circuit description

2.2. GMR technology

Albert Fert and Peter Grunberg discovered the Giant Magneto Resistance (GMR) in 1988. This effect is observed in the ferromagnetic materials. The resistance of the ferromagnetic material depends on, whether the magnetization of adjacent ferromagnetic layers is aligned parallel or anti-parallel. The resistance is high for the ferromagnetic layers with anti-parallel alignment whereas the resistance is low for the ferromagnetic layers with parallel alignment. Although the term "giant" in giant magnetoresistance (GMR) seems incongruous for a nanotechnology device, it refers to a large change in resistance (typically 10 to 20%) when the devices are subjected to a magnetic field, compared with a maximum sensitivity of few percentage for other types of magnetic sensors. GMR structures are ferromagnetic alloys sandwiched around an ultrathin nonmagnetic conducting middle layer. Figure 2 (a) shows the GMR characteristic when there is no external magnetic field. In this, 'A' is a conductive, nonmagnetic interlayer whereas 'B' is a magnetic layer, which faces opposite directions due to anti - ferromagnetic coupling. Resistance to current 'C' is high. The nonmagnetic conducting layer is often copper. Copper is normally an excellent conductor, but when it is only a few atoms thick, electron scattering causes copper's resistance to increase significantly. This resistance changes depending on the relative orientation of electron spins surrounding the conducting layer.

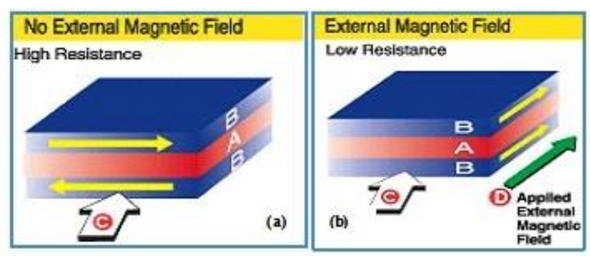

Fig.2: GMR characteristic [5] (a) when no external magnetic field (b) in the presence of the magnetic field

Figure 2 (b) shows the GMR characteristic in the presence of the external magnetic field. When applying an external magnetic field 'D', it overcomes anti-ferromagnetic coupling, aligning magnetic moments in alloy 'B' layers such exposure changes the device resistance so the structure can be used to sense an external field. Practical devices are often made of multiple layers of alternating magnetic and nonmagnetic layers to improve sensitivity. The selection of GMR for this work is based on its sensitivity of its detection.

3. Testing Results and Discussion

Figure 3(a) shows the detection of the strong magnetic field from the permanent magnet (10 Gauss) which is done from the distance of 3.5 centimeters, whereas the Hall-Effect sensor detected it from the distance less than 1centimeter. Figure 3(b) shows the detection of the weak magnetic field produced from the mobile phone (LENOVO 7000-A) (4 Gauss) is done by the GMR sensor from the distance of 1.5 centimeters, whereas the HALL-Effect sensor could not sense the same weak magnetic field produced from the same mobile. Table 1 shows the voltages at the respective terminals during the presence and the absence of the magnetic field, from the above table it is disclosed that during the presence of the magnetic field the resistance of the GMR sensor is low since the level of voltage increases and in the same way during the absence of the magnetic field the resistance of the GMR sensor is high since the level of voltage decreases. Table-2 shows the resistance of the GMR sensor when subjected to an external magnetic field and no external magnetic field, from this it is disclosed that the resistance of the sensor is high in the absence of external magnetic field and low in the presence of an external magnetic field.

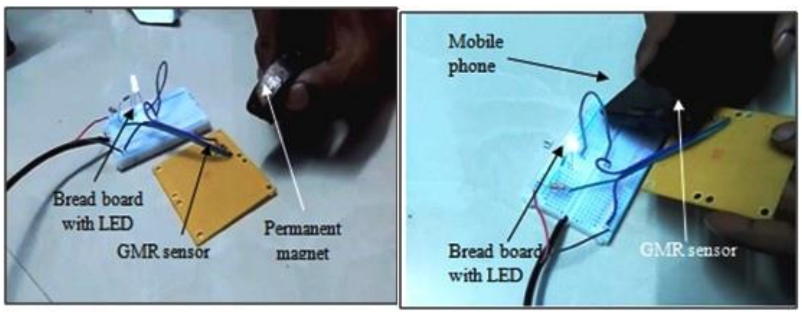

Fig.3: Testing with (a) Permanent Magnet, (b) Mobile (Lenova 7000-A)

Table 1: Voltage at respective terminals

S. No.	Checking parameters between terminals	Presence of magnetic field (V)	Absence of magnetic field (V)
1	Input – GND	3.75	3.5
2	Input - Output	3.84	2.98
3	GND – Output	0.69	0.69

Table 2: Resistance at respective terminals

Sl. No.	Checking parameters between terminals	Presence of magnetic field (Ω)	Absence of magnetic field (Ω)
1	GND – Output	854	938
2	Input-Output	680	714

4. CONCLUSION

In this study is mainly for concept proofing, a mobile phone was used as the testing gadget. This device can detect the gadget which exhibits the lower magnetic field with comparatively lesser working voltage. It detects the Mobile phone which exhibits magnetic field from a nearby distance and gives an indication or the alert to the required system for it can majorly reduce the accidents or other dangerous actions occurring due to the presence of the electronic gadget. This can be used as a safety device near security system for the detection process of electronic gadget, in industries or regions where the chances of occurring accidents due to the usage of the electronic gadget are more. It can also be used to detect the magnetic field producing electronic gadget when misplaced from its original position.

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