Hong Kong Student Science Project Competition 2022

Template of Extended Abstract (Investigation)

(Word Limit: 1,000 words, Pages: 2 pages only)

Team Number: SBPE223

Project Title: IDefended

Project Type: Investigation

To our best knowledge and after thorough literature research, as at 30/6/2022 , there ~~are~~ / are no* similar works. If there are, the reference links are as below:

The enhancement our project has made for the existing related products or research is summarized as below:

***Please delete if not applicable. HKSSPC values the originality of works. Students must conduct literature research thoroughly to ensure that their works are unique, and to list relevant reference materials to complement the research or invention.**

I. Background

The Hong Kong government issued a new version of the Smart Identity Card in 2018, adopting the RFID method for the first time, which allows the card holder's personal information to be read at a certain distance without contact with the reader. This brought up heated debates regarding the level of information security of the RFID technology. To prevent personal information from being leaked, people turned their heads to RFID wallets which could block the signals out to a certain extent.

However, the use of RFID wallets has brought up new problems: cards that people use daily, like Octopus Cards (with a frequency of 13.5MHz) are now unable to be detected by readers. These cards must be taken out of the wallet before tapping, which is very inconvenient. Meanwhile, the RFID mechanism in our student ID cards (with a frequency of 125kHz) remains unaffected by the RFID wallet. Therefore, we decided to test the properties of the RFID wallet and come up with solutions for variable detection of RFID-implemented cards.

Literature Review:

https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=RFID&btnG=

https://www.nitta.co.jp/en/product/sheet/magnetic_sheet/

II. Objectives

- To investigate the ways to protect personal information on ID cards and other RFID cards, and evaluate the methods to correct the current flaws of RFID wallets
- To create a method of RFID card detection without opening the wallet, based on the results of our experiments

III. Hypothesis

If the strength of the EM waves transmitted by the RFID reader is directly related to its distance from the RFID card, with a shorter distance transmitting weaker EM waves, and the voltage measured from the self-made coil is related to the strength of the EM waves, when the RFID card and the RFID reader reaches a certain distance, the RFID card will not be detected.

IV. Methodology

Materials: Octopus card, Student ID card, card reader, CRO, signal generator, self-made coil, Al sheets
Experiment 1.1: investigating the detection of a vertically placed Octopus card at the centre axis
Experiment 1.2: using a self-made coil to simulate the Octopus card to record the induced EMF in the coil when it is held perpendicular to the card reader's surface
Experiment 2: investigating the maximum height for the card to be read and the voltage measured by the CRO at this position
Experiment 3: measuring degrees of voltage reduction from using different materials
Experiment 4: finding the optimum thickness of sheet of aluminium foil used to block magnetic waves
Experiment 5.1 and 5.2: measuring the maximum distance of protection between an 8-time folded aluminium card and Student ID card and Octopus card respectively // exploring the relationship between received voltage of RFID cards and distance between aluminium foil and RFID cards
Experiment 6: exploring the effect of Eddy Current on the prevention of RFID card detection

V. Results

Experiment 1.1: a vertically placed Octopus card cannot be detected at the centre axis, but it can be read if moved slightly to the side
Experiment 1.2: When the Octopus card is at the centre of the card reader, the magnetic field lines from the card reader are parallel to the coil in the Octopus card. The coil does not cut the magnetic flux. Thus, an EMF is not induced in the coil
Experiment 2: 5.1 cm is the maximum vertical reading distance and 0.28 V is the minimum voltage measured by the CRO
Experiment 3: The voltage recorded by the search coil connected to the CRO is smaller than the original voltage when metal is placed between the reader and the card as metal can absorb electromagnetic waves
Experiment 4: The minimum number of times the sheet of aluminium foil needs to be folded is 8 times. Even if the aluminium card is placed above the RFID card, it can still protect the RFID card.
Experiment 5.1: The maximum distance of protection between the aluminium card and Octopus card is 3mm; while it is 2mm for the Student ID card
Experiment 5.2: When the aluminium foil is closer to the card, the induced voltage decreases, while the weakened percentage increases. However in Experiment 5, the octopus card cannot operate even though the voltage received by the card is larger than the voltage of 0.28V recorded in experiment 2. Therefore the reason why the octopus card cannot operate is not due to the lack of voltage
Experiment 6: The high frequency signal generator causes an A.C. to flow in the self-made coil 1 and produce a rapidly changing magnetic field. According to Lenz's Law, this rapidly changing magnetic field induces an Eddy current in the aluminium card. The Eddy Current flowing in the aluminium card will then produce another magnetic field which cancels the magnetic field produced by the self-made coil 1, as a result the induced voltage measured by the self-made coil 2 is greatly reduced.

VI. Conclusion

We discovered that an 8-time folded aluminium card is approximately 0.1 mm thick, which provides a rate of protection of 97% for RFID cards. This is sufficient for protecting 125 kHz and 13.56 MHz RFID cards, namely our Student ID cards and Octopus cards. We also found out the protection is still existent when the 8-time folded aluminium card is within 2-mm distance from an RFID card. Ultimately, through numerous experiments, we have figured out a way to protect RFID cards from detection while providing convenient access to them when needed. By incorporating it into our tested product, we are able to reach the aim of our experiment──creating a wallet with variable detection of RFID cards with different frequencies.

☐ **Our project is developed based on our school's previous project and the enhancement is as below:**