# RF Shielded Hat for Protecting Cameraman from EMF Exposure

**N. Hisham[1], H. A. Rahim[1], F. Malek[2], M. Jusoh[1], F. A. A. Fuad[1], F. S. Abdullah[2], and M. S. Mezan[2]**

[1]Embedded, Networks and Advanced Computing Research Cluster (ENAC)
School of Computer and Communication Engineering, Universiti Malaysia Perlis, Perlis, Malaysia
[2]School of Electrical System Engineering, Universiti Malaysia Perlis, Perlis, Malaysia

**Abstract**— This paper presents a new layer of absorber for RF Shielded Hat. The objective of this studied is to create and develop a new layer of absorber for RF Shielded Hat made from Microwave Absorbing Sheet that can protect the cameraman from electromagnetic field (EMF). The Microwave Absorbing Sheet is used because of super light weight, good microwave shielding, high absorption and no problem for skin contact. Three different types of protective hat are chosen: back of the hat with no protection to allow adjustment of size, rear hat that covers the neck and hat that covers head and thyroid region. All hats are sewn with microwave absorber sheet. The investigation was aimed to study whether the types of hat worn reduce the electromagnetic exposure to human head. The measurement campaign was carried out in the anechoic chamber to completely absorb reflections of either sound or electromagnetic waves. The wireless video camera operated in frequency of 1.9 GHz to 2.7 GHz. The position of the wireless video camera was fixed on the right of the cameraman shoulder where this position is much closer to our heads. The experiment will be investigated in two different situations, while being exposed in the sham condition and also 2.45 GHz signal. Both of the measurement will be undertaken during the pre, during and after the experiments.

## 1. INTRODUCTION

Recently, people always exposed to electromagnetic field (EMF) in their everyday life. The electromagnetic field (EMF) are present everywhere in our environment but are invisible to the human eye [1]. Both electric and magnetic fields are present around appliances and power lines. However, electric fields are easily shielded and weakened by walls and other objects, where as magnetic fields can pass through buildings, humans and most other materials [2]. The use of ever-rising cellular phones whether private or business communication has determined an increased concern for possible adverse health effects deriving from exposure to the electromagnetic field radiated by such devices [3–5]. When the cellular phone is working, the transmitting antenna is place very close to the user head, arise the question whether people using it could be exposed to hazardous levels of electromagnetic radiation [5]. However, protecting the health of workers has been one of the problems to be handled wisely. Therefore, the international association such as IEEE Standards Association (IEEE-SA) and independent scientific organizations both have developed international guidelines and issuing limits for a safe exposure with the scientific rationale for these guidelines [6, 7].

In particular, one of the jobs in which wireless technology has been deployed is cameraman. In fact, the requirement of mobility not only for external shots but also for studio programmes demanding quick and dynamic changes in the view point, has pushed towards the introduction of wireless cameras. This trend, accompanied by the transition from analogue to digital transmission, has made the use of wireless video-cameras become more important [4].

Because this research has not been done yet and there was a complaint from a cameraman on the symptoms of dizziness, headaches and fatigue that occurs when using a wireless video camera that may be caused by low levels of exposure to EMF in the workplace, therefore this research is taken. Thus our project is to help the cameraman from exposed to this symptoms is to create and develop a new layer of absorber for RF Shielded Hat made from Microwave Absorbing Sheet.

## 2. MATERIAL SELECTION

In this study, microwave absorbing sheet is the main material that will be used. Microwave absorbing sheet is from LessEMF Inc with main material from carbon. Carbon is conductive in some forms, and a very good microwave absorber using non-woven nearly-pure carbon fibers, to achieve good microwave shielding and high absorption. Microwave absorbing sheet is super light weight and better durability with estimated weight of 34 g/m$^2$, thickness of 0.445 mm, resistivity of $\sim 3$ Ohms per square and tensile of 47 N/15 mm. Fig. 1 and Fig. 2 show the microwave absorbing sheet and a shielding performance of this material according to the manufacture [8].

Figure 1: Microwave absorbing sheet.

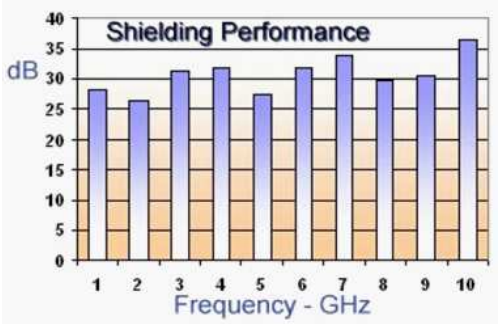


Figure 2: Shielding performance.

To measure absorption of the material using $S$ parameter,

$$A = 1 - S_{11}^2 - S_{21}^2, \tag{1}$$

where

$$\begin{aligned} A &= \text{absorption} \\ S_{11}^2 &= \text{reflection} \\ S_{21}^2 &= \text{transmission} \end{aligned}$$

## 3. METHODOLOGY

### 3.1. Wireless Video Camera

The standard wireless video camera used for this experiment. The position of the wireless camera was fixed on the right of the cameraman's shoulder. The wireless video camera operated in frequency of 1.9 GHz to 2.7 GHz.

### 3.2. RF Shielded Hat

This project is focusing on three types of protective hat. The hat was functioning for protecting cameraman from EMF exposure. Fig. 1 shows the types of hats that will be used when doing a research.

(a) (b) (c)

Figure 3: Types of hats (a) the back of the hat with no protection to allow adjustment of size, (b) rear hat that covers the neck (c) hat that covers head and thyroid region.

## 4. MEASUREMENT SETUP

The experiment was carried out in an RF Shielded room at Electromagnetic Hyper Sensitivity (EHS) Laboratory to eliminate multipath reflections from surrounding environment. Measurement was performed on a cameraman. Research will be done on the subject with the position of the camera is placed on the right shoulders by using three different kinds of hats: Back of the hat with

no protection to allow adjustment of size, rear hat that covers the neck and hat that covers head and thyroid region. The antenna on the video camera connected to a Rohde & Schwarz SMBV100A with frequency range 9 kHz to 3.2 GHz. 4 meter Huber + Suhner Multiflex 141 flexible and low loss coaxial cable were used in the measurement campaign. The cable were wrapped with Eccosorb Flexible Broadband Urethane Absorber model: FGM-U-20-SA microwave absorbing foams to minimize the spurious radiation from and coupling between the coaxial cable. The measurement setup for cameraman shows in Fig. 4.

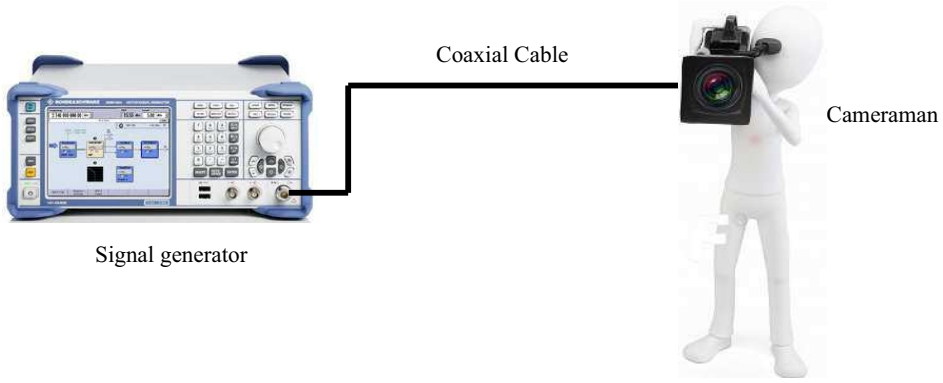


Figure 4: Cameraman measurement setup.

## 5. CONCLUSION

A light weight, good microwave shielding, high absorption and no problem for skin contact hats made from Microwave Absorbing Sheet that can protect the cameraman from electromagnetic field (EMF) is presented and discussed in this paper. Three different types of protective hat are chosen: back of the hat with no protection to allow adjustment of size, rear hat that covers the neck and hat that covers head and thyroid region. By using this shielded hat it will show a better performance to prevent the cameraman from symptoms of dizziness, headaches and fatigue.

## REFERENCES

1. World Health Organization (WHO), "Elctromagnetic field (EMF)," 2013, http://www.who.int/peh-emf/about/WhatisEMF/en/.
2. National Cancer Institute, "Magnetic field exposure and cancer," Apr. 21, 2005, http://www.cancer.gov /cancertopics/factsheet/Risk/magnetic-fields.
3. Bernardi, P., M. Cavagnaro, S. Pisa, and E. Piuzzi, "Specific absorption rate and temperature increases in the head of a cellular-phone user," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 48, No. 7, 1118–1126, 2000.
4. Bernardi, P., M. Cavagnaro, M. La Rosa, S. Pisa, and E. Piuzzi, "Power absorption in the body of a cameraman exposed to the electromagnetic field emitted from a digital radio-camera," *Proceedings of the 39th European Microwave Conference*, 882–885, Rome, 2009.
5. Bernardi, P., M. Cacagnaro, and S. Pisa, "Evaluation of the SAR distribution in tht human head for cellular phones used in a partially closed environment," *IEEE Transactions on Electromagnetic Compatibility*, Vol. 38, No. 3, 357–366, 1996.
6. IEEE Std C95.1-2005, "IEEE standard for safety levels with respect to human exposure to radio frequency electromagnetic fields 3 kHz to 300 GHz," New York, USA, 2006.
7. ICNIRP, "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)," *Health Physics*, Vol. 74, No. 4, 494–522, 1998.
8. LessEMF.com, "EMF shielding & conductive fabrics," 2013, http://www.lessemf.com/fabric.html.