Smart Gun with Implantable RFid Match System – A practical approach

Gazziro, M.A.¹, Almeida, L.O.B.², Pedrazzani, C.D.³ (MD), Machado, C.G.C.F.⁴

¹University of Sao Paulo
IFSC – P.O. Box 369 – ZIP CODE 13560-970 – São Carlos – SP - BRAZIL
³gazziro@ursa.ifsc.usp.br
³lirio@ifsc.usp.br
³carolpedra@hotmail.com
⁴Company Korth RFid
Rua Antonio Carlos Ferraz de Salles, 95 – ZIP CODE 13563-420 - Sao Carlos - SP - BRAZIL
⁴c.machado@korth.com.br

Abstract— This paper presents a case study for Smart Gun Technology (SGT) based on radio frequency control. This system involves the use of a RFid tag implanted in the hand of the owner that will transmit its unique identification number to the electronic control inside the firearm. If the code in the hand of the user matches with the internal code stored inside the firearm then the electronic safety catch based on a solenoid device will be released, allowing it for firing. Besides it is a well know subject in the field of electronic weapons, here we present a case study of an operational system prototype, including detailed instructions for the RF coil design, power consumption reports and clinical instructions for the placement of the RFid tag inside the hand.

Keywords— Smart Gun Technologies, RFid, firearm security, unintentional firearm death, embedded electronics.

I. MOTIVATION

An United Nation's report show the world ranking for firearm-related murders of young people below 15 years [1], as presented in Fig 1.

Among teens ages 15 to 19 homicide and suicide are the second and third leading causes of death, respectively, after unintentional injury [2]. Firearms were the instrument of death in 85 percent of teen homicides and 43 percent of teen suicides in 2007 [3]. While almost one in four youth firearm injuries results in death, non-firearm injuries result in death in only one out of every 760 cases [4].

In the US unintentional firearm deaths were 5.2 times higher than in the other countries [5].

Incorporating safety devices into firearms is an important injury intervention, with the potential to save hundreds of lives each year [6].

Some researchers believe that the most important change that could be made in the design of handguns to reduce the incidence of gun-related injuries, especially to children, would be to personalise guns. A "smart" gun would rely upon a personal identification number (PIN), a magnetic ring worn by the user, a radio-frequency device on the user's clothing or person or fingerprint recognition technology to ensure that only an authorised user could actually fire the gun [7].

II. SMART GUN TECHNOLOGIES

The key issue surrounding the the inclusion of smart technologies is the reliability of the weapon system.

A. Tags and implicit enabling Layout

A tag is an item used to label, identify, or recognize an object or person which is tagged. The presence of the tag would imply that the firing mechanism should be enable [8].

B. Radio Frequency (RF)

Radio frequency controlled devices are all around us today, from cars alarms to doors bells. These devices transmit encoded signals to a receiver fixed to operated on the corrected signals.

C. Requirements

A requirement analysis about smart guns was performed by FN Manufacturing INC. according interviews of personnel from National Criminal Justice Reference Service [9]:
• looks like existing guns,
• work left or right handed,
• work if you are wearing heavy clothing or gloves,
• have a visible low-battery power indicator.

III. PROPOSED SYSTEM

RFid implants for humans have been used in a variety of contexts since their commercial inception in 2003. The product that typically carries a 16 digit number, was first marketed as an identification device (e.g. for emergency response), then as an access control mechanism (e.g. security), then as a payment solution (e.g. to purchase drinks at clubs) [10], and finally as smart gun security devices. The Fig. 2 shows the proposed functional system.

In order to attend the requirements informed in the previous section a mechanical diagram is presented in the Fig. 3.

IV. BASIC CONFIGURATION OF READER AND TAG ANTENNAS IN RFID

The magnetic flux that is passing through the tag coil will become maximized when the two coils (reader coil and tag coil) are placed in parallel with respect to each other.

Fig. 4 Basic configuration of reader and tag antennas in a RFid application.

The strength of the B-field generated by the reader decays in function of $\cos \alpha$ (Fig. 5) and is determined by reader parameters described in equation I.

$$B_z = \frac{NIu.a^2}{2.\left(a^2 + r^2\right)^{3/2}}$$ (1)

$B_z$=strength of the B-field (weber/m²)
$NI$=number of turns and current (ampere-turns) of reader coil
$u$=constant ($4\pi.10^{-7}$)
$a$=reader coil radius (cm)
$r$=read range (cm)

V. PROTOTYPE DEVELOPED AND PRACTICAL APPROACH

A. RFid TAG

The first author implanted a RFid tag microchip in himself, in his left hand. The chip was manufactured by BioBond company. The Fig. 4 shows a X-Ray indicating the position of the tag: under the skin, above the *abductor digit minimi* muscle. This place was chosen due to high concentration of fat tissue and absence of veins in the region.
X-Ray showing RFID tag after 18 days of the implant procedure. It is inserted under the skin, above the abductor digiti minimi muscle.

**B. Reader**

This RFID tag uses the protocol ISO 11784 FDX-B with frequency 134.2 kHz for communication (VLF band 100kHz-500kHz). A prototype reader was developed and tested in two conditions: with bare hands and with heavy gloves (figures 7a and 7b). This prototype uses a simple and reliable 8 bit microprocessor from Motorola company.

Fig. 7 Testing prototype above iron plate (a) Reading from 3 cm (b) Reading from 2 cm using heavy gloves.

The effective maximum distance for reading was about 3 cm and 2 cm from reader coil (with bare hands and gloves respectively). The angle was set up to normal direction (0 degree, cos α=1).

**C. Coil**

The coil have 60 spires (3 layers), with diameter of 3 cm using wire 29 AWG. The inductance is 390 µH and it’s Q is nearly 0.666. The voltage applied in the coil is 550 volts. The total current consumption in operation is 250 mA. The number of turns and current is 15 ampere-turns (NI=15).

**D. Experimental evaluation of the B-field generated**

The B-field generated by the prototype reader was evaluated. The minimal distance when the tag was effectively read is r=2 cm. From coil design section, we use NI=15 and a=3 cm. Using the equation I:

\[ B_z = 0.181 \, \text{µWeber / m}^2 \]

**E. Power Consumption**

The total power consumption of the system is 10 mA in waiting trigger operation and 260 mA in reading operation. Using high-end batteries the system can work for up to 4 hours of continuous utilization.

**VI. Discussions**

The main concern is about the placement of the chip inside the hand and the position of the reader coil inside the structure of the weapon. It needs to be very near from the implanted tag and adjusted in order to achieve a angle as most normal as possible.

**VII. Conclusions**

As conclusion for the present work we defined that use of RFID in Smart Gun Technologies is feasible, however the placement of the antenna is a critical factor.

**VIII. Acknowledgments**

The authors are thankfully to Nelson Margarido, Marcelo Rinhel, Lucas Dias, Alexandre Lima, Michel Belotti, Christofer Bertonha, Eduardo Faradezzo and Leonardo Costa.

**References**


