Smart ATM Surveillance System

S.Shriram[1], Swastik B.Shetty[1], Vishnuprasad P. Hegde[1] , KCR Nisha[2], Dharmambal.V[3]
[1] Student, Department of Electronics and Communication,
[2] Associate Professor, Department of Electronics and Communication,
[3] Senior Assistant Professor, Department of Electronics and Communication,
New Horizon College of Engineering (NHCE),
Bangalore, India.

Email: shriramspark@gmail.com

***Abstract*— This paper presents an Automated Teller Machine (ATM) surveillance system which is a smart system based on embedded technology and incorporates various sensors to continuously monitor its surroundings for suspicious activities like physical attack, fraud and theft that might jeopardize the ATM and people nearby. Also discussed is the security and safety measures that can be implemented to prevent such raids by proper surveillance. This paper analyses the different forms of physical attacks on ATM's and discusses the methods that are used to detect the foray, commence proactive measures and tip-off officials through GSM network. We also discuss about the implementation of the proposed system, the sensors and the other supporting hardware that are being used to deploy this system. The proposed system thus heightens the security of ATM's against imminent attacks effectively.**

Keywords—Automated Teller Machine (ATM), Micro Electro Mechanical system (MEMS), Global System for Mobile communication (GSM), Microcontroller, Personal Identification Number (PIN), Passive Infrared (PIR), Force Sensitive Resistor (FSR)

I. INTRODUCTION

Automated Teller Machines (ATM) today have become areas of target due to their easy and readily available cash at everyone's convenience. The attacks on ATM's are steadily rising and this is a serious problem for law enforcement and banking sectors. So there has to be a system developed and put into place that will make sure the ATM is safeguarded and also gives customers the confidence when using the ATM.

Currently to provide protection to the ATM and to the customers using it, there are CCTV security cameras and emergency sirens. Other measures that are being researched includes a system that implements a low cost standalone embedded webserver, Machine to Machine (M2M) and RFID to implement an anti-theft system [1], in case there is an intruder in the ATM kiosk a system with image processing capabilities proves it's worth in identifying the intruder [2], but this kind of systems doesn't function up to expectations when the facial features extracted from the front face don't give us a proper ID of the intruder, in this case a system with image processing capabilities using silhouette image finds its application [3][4][5].

But the need of the hour is implementing a system which prevents the physical attacks made on the ATM which is rampantly increasing, using hardware devices [6]. Going a step further and implementing an Omni Directional Vision Sensor (ODVS) can provide high intelligence and robustness for preventing financial crimes in ATM's [7]. Biometrics like fingerprint watermarking can also be used to encrypt a numeric digit [8] [9].
Experimental results shows that the proposed system is efficient in tackling most forms of physical attacks on ATM and can deploy various methods to thwart the attacks.

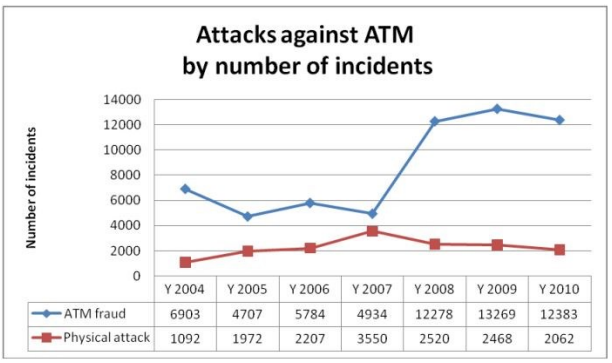


Figure 1. Reported ATM crimes in Europe [11]

II. ATM ATTACKS AND PROTECTION

There are a variety of ATM attacks because it is such an attractive target. We cannot list all the types, but highlights some popular ones. Basically, there are three basic types of ATM attacks which can be as follows.

- Physical attack: Brute force attack to ATM machines with intention of gaining access to cash within the safe
- ATM Fraud: Theft of bank card information
- Software Attack: Theft of sensitive information

978-1-5090-1277-0/16/$31.00 ©2016 IEEE

Physical attack: This kind of crime is active in most parts of the world, and is also showing a trend of escalation in Asia-pacific area. According to a recent report release by European ATM Security Team (EAST), a total of 2,062 physical attack incidents in Europe were reported in 2010 [11]

Ram-raid: The common method of physically removing ATM from premise with vehicle is shown in Figure 2, and then steal cash by opening safe with brute force.

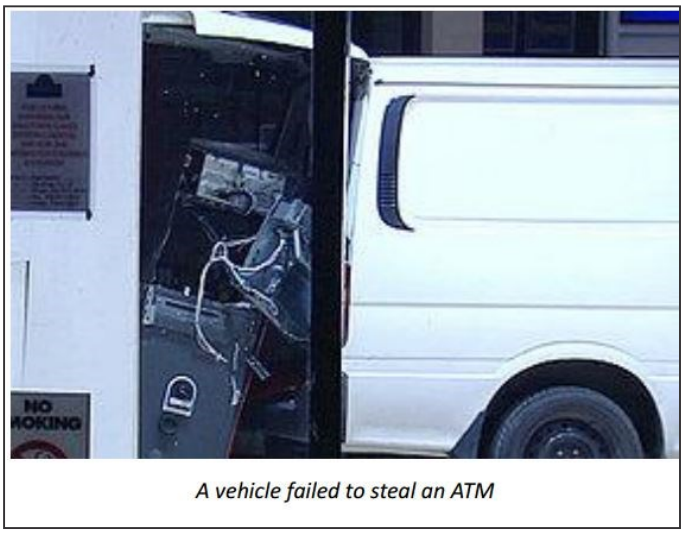


Figure 2. A vehicle failed to steal an ATM [11]

Cutting: Use rotary saw, blow torch, thermal lance, and diamond drill to brutally open safe gaining direct access to cash shown in Figure 3.

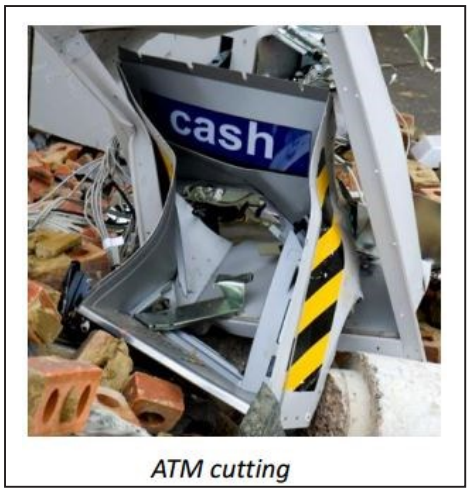


Figure 3. ATM cutting [11]

Protection: Audible alarm or siren could help dissuade a thief from following through with their ATM theft. This will be one of the most effective methods to thwart an attempt to burgle an ATM.

This system can detect if any suspicious event happens. Thermal sensors, vibration sensors, MEMS (Micro Electro Mechanical system) like accelerometers are the basic requirement in this system.

Installation: choose a safe place to install ATM, visibility from the road is main factor. Well-constructed base is very important which make ATM securely fixed to floor by a minimum of four anchor bolts.

Barriers: anti-ram bumpers or similar barriers can be installed in front of ATMs. Also some barriers that wrap around ATMs in order to make lifting the ATM more difficult shown in Figure 4

Figure 4. An ATM with barrier installed [11]

Lockers, known as anti-theft mechanism, could make physically removing ATM very difficult by being attached to the main body of the ATM, increasing the protection levels.

III. PROACTIVE MEASURES

The proposed system employs proactive measures to counteract the burglary attempt, here the sensors of the system act as first line of defense and detects the break-in and instigates the protective actions which will deter the burglars from continuing with their attack, thereby successfully thwarting the attack.
The proactive measures that are employed in the system are the siren, notification to officials using GSM and visual alert in the ATM kiosk. Once any of the sensors are triggered the blaring siren and the visual alert will deter the intruder and cause him to abandon the plot. By stopping the attack, the ATM is prevented from bearing any more harm caused due to the attack.

IV. THE PROPOSED SYSTEM

The proposed system unlike other systems uses a number of smart sensors to detect an attack and avert it, like PIR (Passive Infrared) Sensor, ADXL335 Accelerometer, FSR (Force Sensitive Resistor) to detect motion, heat, change in orientation, sudden acceleration, force, and vibration. The controller used here is the popular ATMEGA-328 from ATMEL.

This system is built around the ATMEGA328 microcontroller which belongs to the ATMEL family.

The system continuously monitors its surroundings by sensing temperature changes, force, and orientation of the ATM using the sensors. Here we can see the basic block diagram of the proposed system shown in Figure 5

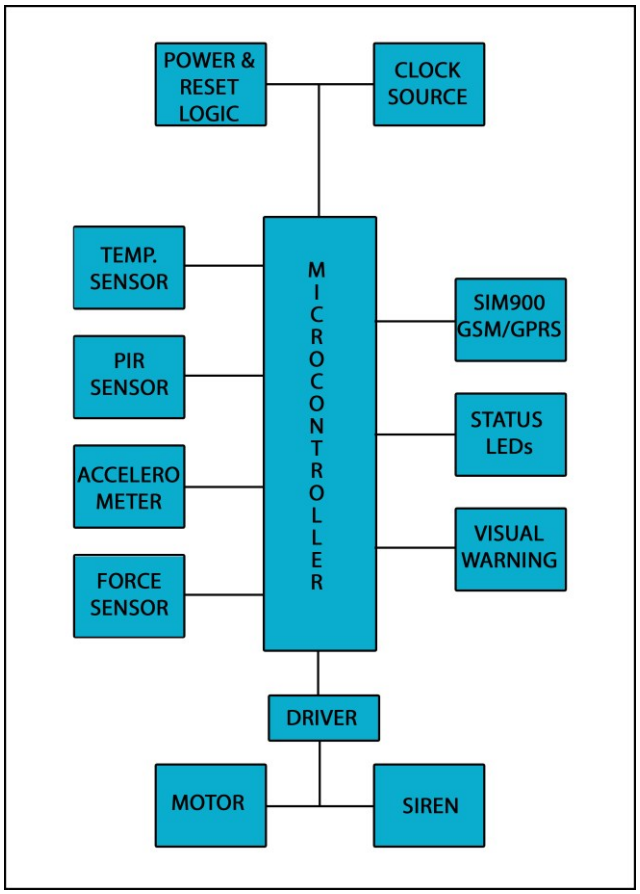


Figure 5.The basic block diagram of the proposed system

V. CHARACTERISTICS OF THE SYSTEM

1. Continuous monitoring of the sensors in the system so that any burglary attempt is detected.
2. Informing the controller that the sensors have been triggered and necessary safety actions are due.
3. Siren: The controller then activates the alarm system through the driver to dissuade the burglary attempt.
4. Warning: The controller then sends an SMS alert and call alert to officials informing the break in happening.
5. Shutter locking: The controller then activates the motor locking down the kiosk and the culprits are locked inside.

The flowchart for the proposed system is shown in Figure 6.

The ATM is safe when no sensors are triggered, and no action needs to be taken, but when any of the sensors are triggered then the ATM is vulnerable to attacks and necessary safety action should be taken. Here we activate the siren; visual warning and we alert the designated persons by SMS and call using the SIM900 GSM module.

VI. FLOWCHART OF THE SYSTEM

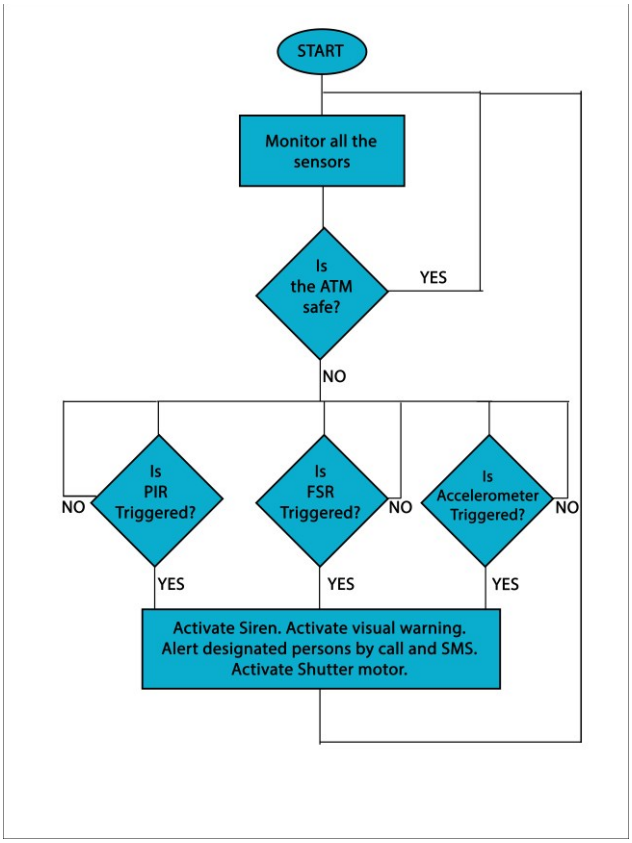


Figure 6. The flowchart for the proposed system

VII. HARDWARE USED AND ITS DESCRIPTION

Here we shall discuss the hardware used in this system briefly and its characteristics.

1. ATMEGA328 Microcontroller

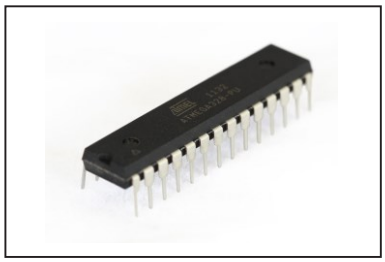


Figure 7. ATmega-328 [15]

The high-performance Atmel 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1KB EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, SPI serial port, 6-channel 10-bit A/D converter, programmable watchdog timer with internal oscillator, and five software selectable power saving modes, programmable brown-out detection. The device operates between 1.8-5.5 volts [15]. Shown in Figure 7.

2. PIR – Passive Infrared sensor

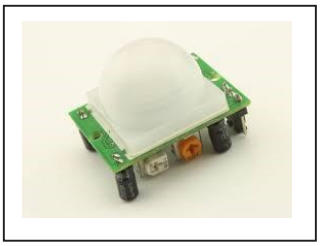


Figure 8. A PIR sensor [17]

Pyro electric passive infrared (PIR) sensors shown in Figure 8 are widely used in daily life. They are a key component in motion detection and can be used for security systems, automatic doors, or automatic light control. They are commonly used to detect humans

The PIR works on the principle that everything on earth has infrared (IR) energy. The IR energy of an object depends on different parameters such as its temperature, color, and texture. This energy is not visible with the human eye, but PIR sensors can detect it.

In case the ATM is cut open using gas welding, the temperature may easily touch 6000 degrees Fahrenheit, which could easily melt the sensor and damage the sensors if they are contact temperature sensors. We can exploit this feature of the PIR sensor and use it as a non-contact temperature sensor to detect the changes in heat.

3. FSR – Force Sensitive Resistor

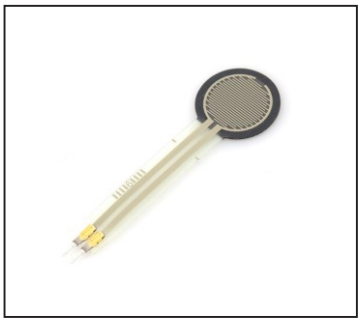


Figure 9. A Force sensitive resistor [16]

FSRs are sensors shown in Figure 9 that allow you to detect physical pressure, squeezing and weight. FSRs are basically a resistor that changes its resistive value (in ohms Ω) depending on how much it is pressed. The FSR's resistance changes as more pressure is applied. When there is no pressure, the sensor looks like an infinite resistor (open circuit), as the pressure increases, the resistance goes down.

By placing these sensors at appropriate locations in the ATM's body, we can use this sensor to easily detect large forces exerted on the body of the ATM, which might be one form of the attack

3. ADXL-335 Accelerometer

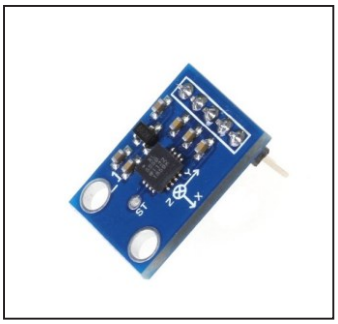


Figure 10. The ADXL335 accelerometer [18]

The ADXL335 shown in Figure 10 is a small, low power, 3-Axis ±3 *g* accelerometer MEMS Sensor. The ADXL335 has a measurement range of ±3 g minimum. The output signals are analog voltages that are proportional to acceleration. The accelerometer can measure the static acceleration of gravity in tilt-sensing applications as well as dynamic acceleration resulting from motion, shock, or vibration. It contains a polysilicon surface - micro machined sensor and signal conditioning circuitry to implement an open-loop acceleration measurement architecture. [18]

4. SIM 900 GSM Module

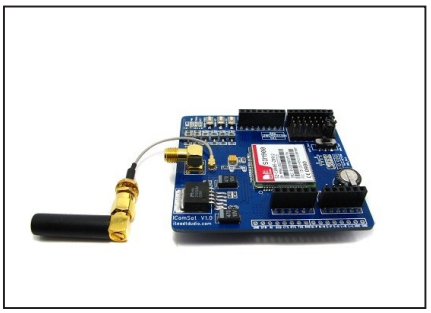


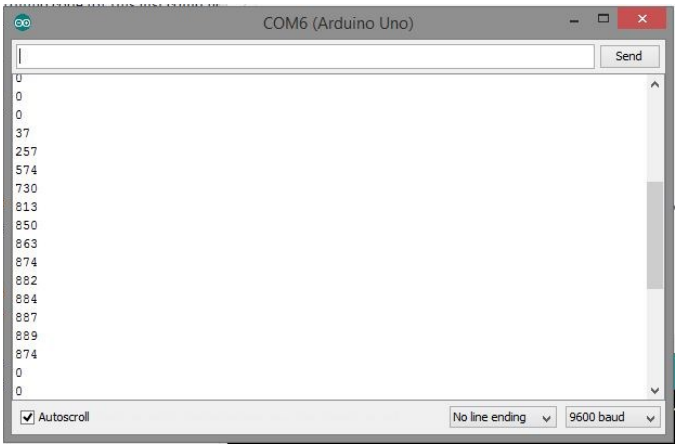
Figure 11. The SIM 900 GSM Module [19]

The SIM900 is a complete Quad-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications. Featuring an industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM900 can fit almost all the space requirements in your M2M application, especially for slim and compact demand of design. [19]

VIII. EXPERIMENTAL RESULTS AND OBSERVATIONS

1. Here is a screenshot of the data coming from the FSR sensor when the sensor is pressed shown in Figure 12.

Figure 12. Readings from the Force Sensitive Resistor



In Figure 12 we see that when the FSR sensor is pressed we are getting a reading proportional to the force applied, when no force is applied we get null readings.

2. Here is a screenshot of the data (in degrees) coming from the accelerometer when the sensor is placed on a levelled surface shown in figure 13

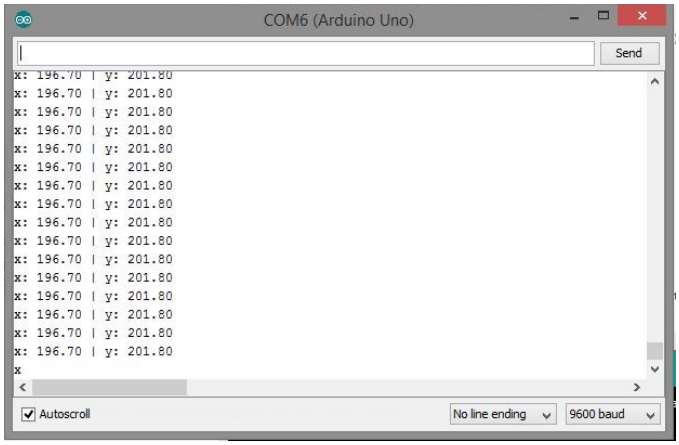


Figure 13. Readings (in degrees) from the Accelerometer when on a level surface

When its titled towards left shown in Figure 14

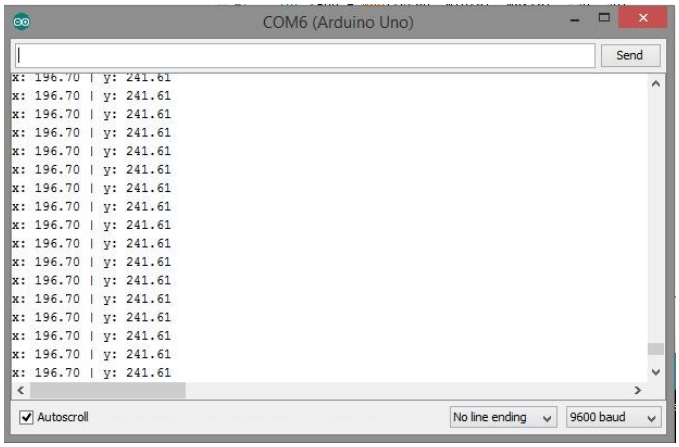


Figure 14. Readings (in degrees) from the Accelerometer when tilted left

When it's tilted towards right shown in Figure 15

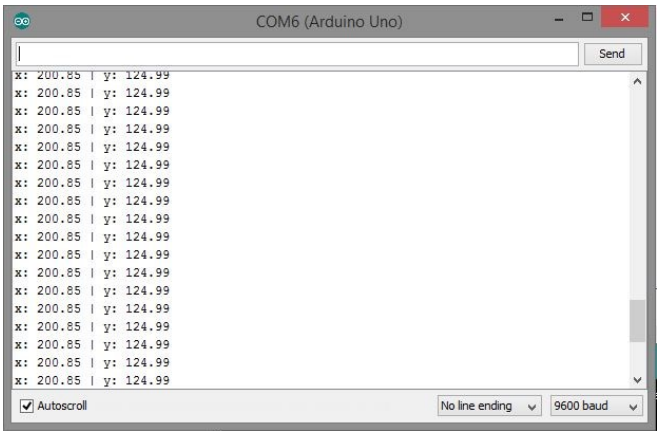


Figure 15. Readings (in degrees) from the Accelerometer when tilted right

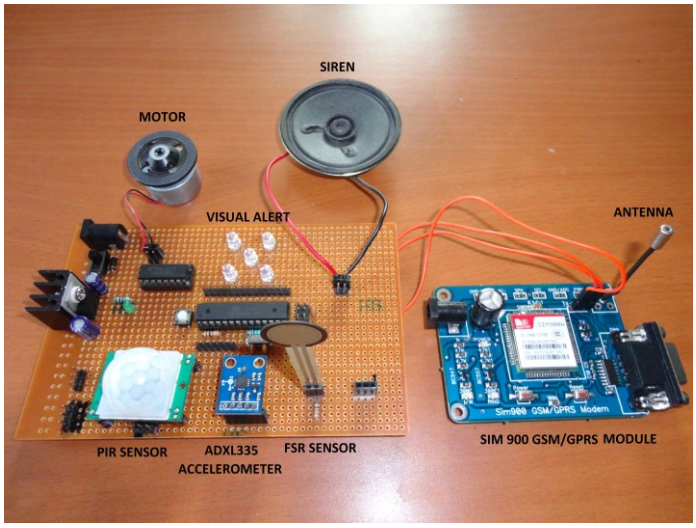


Figure 16. The final prototype of the proposed system

IX. CONCLUSION

The implementation of ATM surveillance by using smart sensors and GSM/GPRS modem took advantages of the stability and reliability of sensor characteristics. The security features were enhanced largely for protection of ATM's when compared to previous systems. The whole system will be built on the technology of embedded system which makes the system more safe, reliable and easy to use. Therefore the proposed surveillance system here utilizes the latest technology like smart sensors and GSM/ GPRS modem which as a system has a very good endurance in the long run, which makes it ideal for protecting the ATM. Thus this system will be able to thwart physical attacks on the ATM and alerts necessary people to take action at any time and save people from lot of hardships involved in the ATM attacks.

REFERENCES

[1] M. Raj and Anitha Julian, "Design and Implementation of Anti-theft ATM Machine using Embedded Systems," International Conference on Circuit, Power and Computing Technologies [ICCPCT], pp. 1 – 5, 2015

[2] Xihao Zhang, Lin Zhou, Tao Zhang, Jie Yang, "A Novel Efficient Method for Abnormal Face Detection in ATM," ICALIP, pp. 5 - 700 , 2014

[3] I-Pin Chen, Li-Kui Liu, Wei-Wei Hong, "Image Processing Based Burglar proof System Using Silhouette Image," ICMT, pp. 6394 – 6397, 2011

[4] Hiroshi Sako, Takashi Watanabe, Hiroto Nagayoshi, and Tatsuhiko Kagehiro, "Self-Defense-Technologies for Automated Teller Machines," International Machine Vision and Image Processing Conference IMVIP, pp. 177 – 184, 2007.

[5] Che-Yen Wen, Shih-Hsuan Chiu, Jiun-Jian Liaw, ChuawPin Lu, "The safety helmet detection for ATM's surveillance system via the modified Hough transform," International Carnahan Conference Security Technology, Proceedings IEEE 37th Annual 2003, pp. 364 – 369, 2003

[6] F. Puente, J.D. Sandoval, P. Hernandez, C.J. Molina, "Improving Online Banking Security with Hardware Devices," 39th Annual International Carnahan Conference on Security Technology, CCST, pp. 174 – 177, 2005

[7] Yiping Tang, Zuling He, Yaoyu Chen, Jinyi Wu, "ATM Intelligent Surveillance based on Omni-directional Vision," WRI World Congress on Computer Science and Information Engineering, pp. 660 – 664, 2009

[8] R. AshokaRajan, R.Angelinjosphia, Ms.PVS.Gayathri, T.Rajendran, P. Anandhakumar, "A Novel Approach for Secure ATM Transactions Using Fingerprint Watermarking," Fifth International Conference on Advanced Computing (ICoAC), pp. 547 – 552, 2013

[9] H. Lasisi and A.A. Ajisafe, "Development of Stripe Biometric Based Fingerprint Authentications Systems in Automated Teller Machines," 2nd International Conference on Advances in Computational Tools for Engineering Applications (ACTEA), pp. 172 - 175 2012

[10] Ning Ding, Yongquan Chen, Zhi Zhong and Yangsheng Xu , "Energy-Based Surveillance Systems for ATM Machines," 8th World Congress on Intelligent Control and Automation (WCICA), pp. 2880 – 2887, 2010

[11] Best Practice for ATM Security, GRGBanking Equipment (HK) Co.,Ltd,

[12] Jebaline, G.R, Gomathi, S, "A novel method to enhance the security of ATM using biometrics", 2015 International Conference on Circuit, Power and Computing Technologies (ICCPCT), pp. 1-4, 2015

[13] Shinde, A.S, Bendre, V, "An Embedded Fingerprint Authentication System", 2015 International Conference on Computing Communication Control and Automation (ICCUBEA), pp. 205-208, 2015

[14] Sugandhi, N.; Mathankumar, M.; Priya, V, "Real time authentication system using advanced finger vein recognition technique", 2014 International Conference on Communications and Signal Processing (ICCSP), pp. 1183-1187, 2014

[15] ATmega328 datasheet, www.atmel.com

[16] FSR – Force Sensitive Resistor datasheet, www.interlinkelectronics.com/FSR402.php

[17] PIR – Passive Infrared Sensor, www.parallax.com

[18] ADXL335 3-axis accelerometer datasheet, www.analog.com

[19] SIM900 GSM/GPRS module datasheet, www.simcom.us