Solar-based Home Surveillance System

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***Abstract*— Thefts, including loss of personal property in the domestic space, amount to over 50 percent of crimes committed in the developing world. In urban areas, the crime rate is esp. higher than that in rural areas. This problem can be addressed using Information and Communication Technology. In this work, a rechargeable probe with sensor-based technology is designed. Recharging can be done using solar energy and the sensors monitor households. On detecting an intruder, probe activates and directs an SMS alert to the users on their mobile phones. The usefulness of the work is proven in urban and rural households, esp. in monitoring agricultural practices including dairy farming. The work also draws attention to upcoming opportunities in Human-Computer Interaction for studying sensor-based technologies.**

Keywords— SMS, Sensors, HCI, ICT, Solar, Microcontroller

1. INTRODUCTION

In households, break-ins and burglary is a persevering problem. Criminal offences cause physical as well as mental distress to the people directly affected and also to their friends and family. In urban areas, where the rate of crimes is higher, burglary victims fail to feel a sense of safety and security. Therefore, the focus is needed on domestic security to help resolve this problem. Information and Communication Technologies (ICTs) can be used to detect and identify thefts.

Preliminary research shows that homes are not similarly designed everywhere, neither is it easy to implement the ICTs into the households due to varying family size, geographic divisions and cultures. The aforementioned was also concluded in the study on the localities in parts of America and Europe by Desjardins et al. [1]. The incorporation of non-digital materials along with digital materials in the home is explored by Crabtree and Tolmie [2]. Similarly, the experiences with sensor-based applications can help resolve the user's requirements for their households [3]. It, however, must be noted that the said technology-probe turns the user-family into designers, but it does allow the users to be active partners in the designing process [4]. George Hope Chidziwisano and Susan Wyche [5] led a two-stage study, based on surveys and data logging methods, to discern household happenings. The designed system consisted of a main stage, including meetings and technology probe implementation, while the second stage included follow-up meetings and perception. Erete [6] looked into burglars' behaviors and concluded that the burglar-detecting mechanization, such as alarms, were not practical in preventing them from stealing. The research suggested that a "neighborhood chession" would be beneficial in preventing burglaries. Therefore, in rural areas, where neighborhood households are close to one another, this problem of theft can be solved through community policing. Further, the said technology can play a vital role in encouraging civil liberties for people with varying socioeconomic backgrounds around the globe [7, 8]. Hence, an important role is played by the probe in dissuading and sidetracking thieves from breaking into the house. Visa M. Ibrahim et al. [9] proposed a home security system designed using a microcontroller, a Passive Infra-Red (PIR) motion sensor, a camera for capturing images, a GSM module for delivering SMS alerts and a buzzer for the alarm. It made the intruder panic by activating the buzzer, when trespassers were detected in the surrounding area. Omorogiuwa Eseosa et.al. [10] proposed a system for catching intruders, using a GSM intelligent home security system. It consisted of intrusion detector sensors, wireless sensors, a programmable microcontroller, relays, a GSM modem, data-

acquisition node, and an interface program development for real time observance and monitoring of intruders.

In this work, we developed a technology probe which is rechargeable through solar energy and employs sensors to monitor households. As motion is detected, the probe gets energized and an SMS alert is redirected to the user on their cellular phone. The study is also an extension of the initial work on home security to strengthen neighborhood-watch scheme practices, as the neighbors also get alerted when an intrusion takes place. The findings helped to present design implications which were tangible, while offering a fresh perspective on the use of technology to deter crime. The developed technology probe is extremely helpful for monitoring valuables in households where a theft is a common issue. The proposed approach is found to be feasible and to possess a wide range of applications.

2. SYSTEM DESIGN

Appropriate software platforms and hardware components were selected to develop a simple, reliable, cost-effective and user-friendly system. The major components used are:

A. *Arduino Uno microcontroller* (see Fig. 1) is an open-source electronic prototyping platform having 32 KB of flash memory for storing the code used to build our home surveillance system. Arduino Uno consists of a physical programmable circuit board along with an Integrated Development Environment (IDE) software. The microcontroller is based on a single-chip ATmega328. It runs at a clock speed of 16MHz and comprises of two types of memories - program memory and data memory. It has many types of applications, such as controlling motors, GSM module, depending on the input received from the sensors.

Fig. 1. Arduino microcontroller

B. *PIR sensor* (see Fig. 2) is used to detect motion made by humans or animals. It can detect up to an angle of 120-degree and up to a distance of 20 ft, depending upon the amount of infrared light radiated from the surrounding. When a modification in the amount of infrared radiation is detected, the sensing element detects and differs from its threshold. This triggers a signal which activates the buzzer and the GSM module. Hence, the sensor conveniently helps the users to move around the probe anywhere during evaluation.

Fig. 2. PIR sensor

C. *Solar module*: A 12V, 2W solar module (see Fig. 3) plays a significant role in ensuring the effectiveness of the design and convenience of the user as it energizes the sensors and the Arduino microcontroller system using only the natural light from the sun, thereby making the probe self-sustaining.

Fig. 3. Solar module

D. *SIM900 GSM shield:* GSM architecture (see Fig. 4) is used for mobile communication and network and comprises of a GSM modem along a with power supply circuit and correspondence interfaces for the Arduino microcontroller. A SIM card is incorporated in the GSM shield to activate communication with the network.

E. LM7805 IC (see Fig. 5) is a voltage regulator whose function is to regulate the variable voltage received from the solar panel, to get constant dc supply to charge the batteries. The input voltage range is 7-35V, with an output voltage of a maximum of 5V.

Fig. 4. SIM900a GSM module

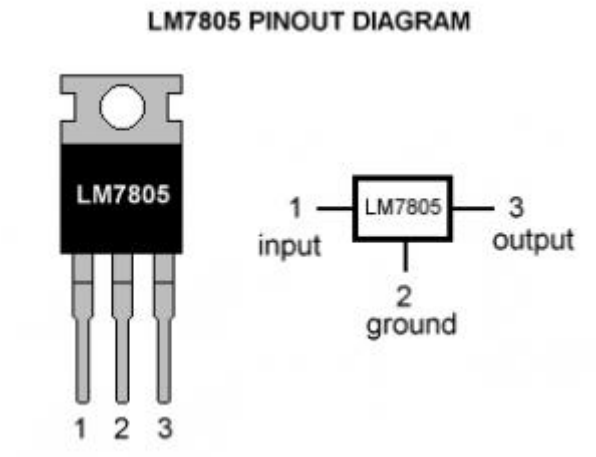

Fig. 5. LM7805 IC

F. *TP4056 IC* (see Fig. 6) is specially designed to charge the 3.7 V single cell lithium-ion batteries. It is a linear battery charger controller with a constant current and constant voltage output. The IC can automatically cut-off the charging current when the battery is fully charged, thereby reducing the risk of permanent damage to the battery. Further, it can also work with a micro USB or a wall adapter.

The proposed framework (see Fig. 7) is an SMS-operated GSM-based home security system design, and is structured and tried with the smart mobile network. It is cost effective and allows the user to move anywhere through the GSM innovation in this manner, thus making the framework area autonomous. The correspondence with the test is through an SMS, which has been tried with the mobile networks and is required to chip away at any portable system.

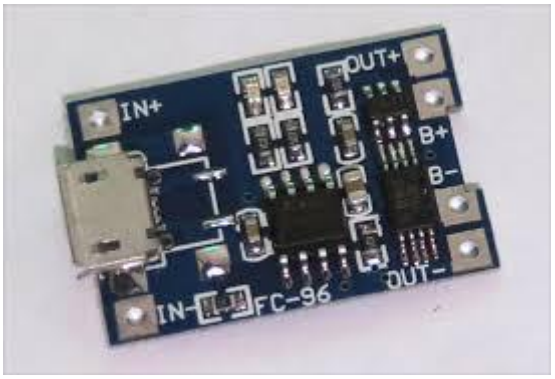

Fig. 6. TP4056 IC

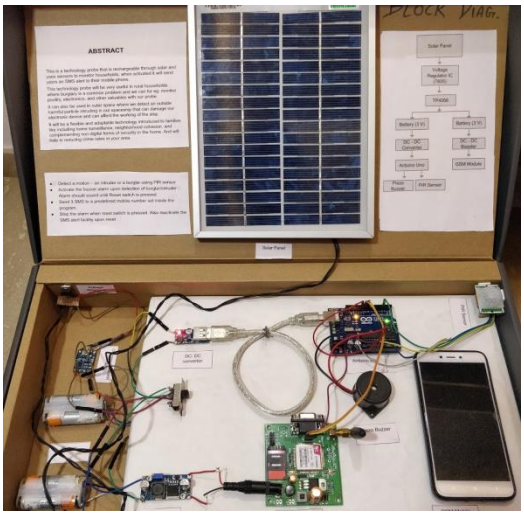

Fig. 7. Project Setup

3. METHODOLOGY

Figure 8 shows the flow chart of the proposed technology. The solar energy obtained is not constant throughout the day. Hence, it needs to be regulated using the LM7805 regulator IC. The constant dc supply charges two pairs of 3V batteries, which are connected in parallel with the help of the TP4056 IC chip. A DC-DC converter converts the 3V input supply to a 5V output, providing supply to the single-board microcontroller Arduino Uno. A DC-DC booster is required to boost the 3V input voltage to 12V so that the GSM module can be activated when needed. The Arduino is coded such that when an intruder is detected, the PIR sensor senses the activity and sends a signal to the microcontroller board. The microcontroller in turn sounds the buzzer and activates the GSM module, which then sends an SMS alert to the owner's mobile phone.

4. FUTURE SCOPE

The proposed framework can be coordinated with the web to remotely screen the user's home. It will enhance the user's security and help in the conservation of energy of the household. The proposed solar-based home surveillance system probe can be manufactured easily as it integrates generic components which are inexpensive and perform at par with their respective commercial counterparts. Due to flexibility in design as well as concept of the proposed probe technology, many modifications and improvements are possible to make the presented framework suitable for a variety of other applications. Air-quality-detector sensors can be included and programmed with Arduino microcontroller to monitor PM 2.5 levels inside users' homes. Similarly, fire sensors and gas sensors can be incorporated in the design to alert the user about fire and gas leakages, respectively, via an SMS. With further addition of LCD touch-screen, phone numbers for SMS alerts can be conveniently re/set. The GPRS capability of SIM900 GSM module can be used to access the internet. Finally, the probe can also be used in outer space to detect harmful particles intruding a spaceship.

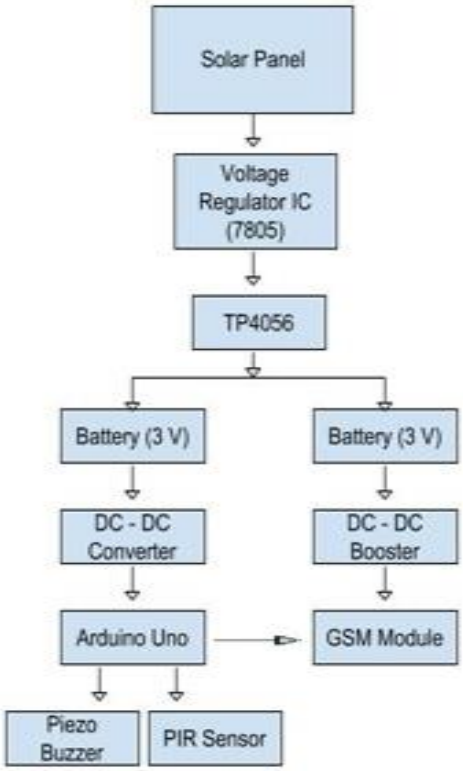

Fig. 8. Project flow chart

5. CONCLUSION

A solar-based home-surveillance system with a GSM module and sensor technologies was developed. The probe was successfully tested in households to ensure the highest level of security using minimal hardware, while being

user-friendly and cost-effective. The usage of the designed probe, in urban and rural areas, can open doors for people to explore the realm of various functionalities of sensor-based technologies in their households.

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