

DESIGNING AND IMPLEMENTATION OF OUTDOOR TRANSFORMER SECURITY SYSTEM

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Abstract: In agriculture, quality and high productivity depend on irrigation of crops in dry months. Pressurized irrigation methods are preferred due to both natural water resources more efficiently as well as better quality agricultural production. This situation brings with it the demand for electricity at irrigation. For this reason, the farmers are in need of transformers supplied with their own resources owned or state. During unirrigated winter months, states cut the energy of electrical transformers to eliminate or minimize energy losses occurred in transmission lines. However, this condition has created serious problems in the transformer security. In the previous studies, it is seen that many products have used GSM / GPRS communications technology taken their energy from network or solar panels connected to transformer. But, common feature of these products is a system that triggered by latching of lid in the protection provided region and then generating alarm. In this study, it is focused on the designing of security system triggered in the case of unauthorized persons to start approaching or leaving the transformer pole and this is the only possible by using system integrated outdoor PIR (Passive Infrared Sensor) sensors. In addition, developed Transformer Security System (TSS) uses both GPRS and MMS infrastructure. In sleep mode, TSS register the GPRS network in 4 seconds by receiving from the Passive Infrared Detector (PIR) and taking 5 seconds during video recording with audio and visual stimuli. After then, with alarm status information and image recording is transferred to the central monitoring software. As a result, security in the field of medium voltage electrical transformer is provided by using M2M technology and the continuity of the structure of interconnected power lines are protected.

Keywords: Agricultural Irrigation, Electric Transformer, M2M, GSM/TCIP

Introduction

Agriculture is among the most important source of income for many countries in the world are located in the first row. In agriculture, the quality and high yield depends on irrigated crop in arid last month (Schultz, 1964). In agricultural irrigation systems, pressure irrigation methods are preferred due to both more efficiently in natural water using and more quality in agricultural production (Nakayama, 1991). This situation brings with it the demand for electricity for irrigation. For this reason, the farmers are in need of transformers supplied with their own resources owned or state. During unirrigated winter months, states cut the energy of electrical transformers to eliminate or minimize energy losses occurred in transmission lines (Patterson, 1996). This situation is created serious security holes in the transformers. In addition, harm is not just to stay with stolen material, but also it leads to an explosion of the transformer when it is energized (Bisak, 1991). Considering the studies conducted on the subject, short message services provided by the GSM operators are used in the study for remote monitoring of transformer substations to security purposes (Bekiroglu, 2009). The general characteristics of security system using GSM/GPRS communication are products taking their energy from connected to the network or solar panels and it works with the snapping of a cover in the provided protection region (Korkmaz, 2007). Eventually, in the case of attempt to steal the system becomes active and provides notification center or person. But if the transformer is reached the system is disabled by cutting the cables connected to latch. The limited capabilities of existing solutions and not respond to the needs required different solution approaches. In this study, it is focused on the design and implementation of a system triggered in case of the approach to non-authorized persons transformer pole and start out directly. This is the only possible by using system integrated outdoor PIR (Passive Infrared Sensor) sensors. Developed transformer Security System (TSS) uses both GPRS and MMS infrastructure. The purpose of this study is to provide the ensuring security in the field of medium voltage electrical transformer using M2M technology (Wu, 2011) for agricultural purposes and protecting the sustainability of the interconnected structure in power lines.

Materials and Methods

Passive Infrared Sensor (PIR) Sensor

Passive Infrared Sensor (PIR) is a kind of sensor can detect infrared radiation depending on the body temperature and translated into an electrical signal with the helping of lens. Physically, all objects having a temperature greater than absolute zero point (-273 centigrade degree) radiate energy according to their temperature. These rays moves strongly up to a certain distance and when entered the sensor's detection distance these emissions are converted into an electrical signal detecting by pyrocell (Hong, 2013). These sensors (general operating principle is shown in Figure 1) are categorized as two main groups; open and indoor area motion sensors. The indoor motion sensor has less sensitivity, detection angle and distance according the outdoor motion sensors. Outdoor motion sensors are commonly used in military border security system, fire alarm / warning systems and open area security systems. Considering the usage areas, it is appears to be important because of their properties such as the sensitivity of detection distance, animal distinguish and energy consumption. The sensing distance and operational stability of PIR sensors depend on the geometric shape of used Fresnel lens, focus distance between the lens and IR filter, the quality of IR filter, pyroelectric material and the stability of the amplifier and comparator circuit. The stability and distance of sensor is provided by the distance and placement angle between the Fresnel lens and pyroelectric sensor is adjusted in accordance with lens law.

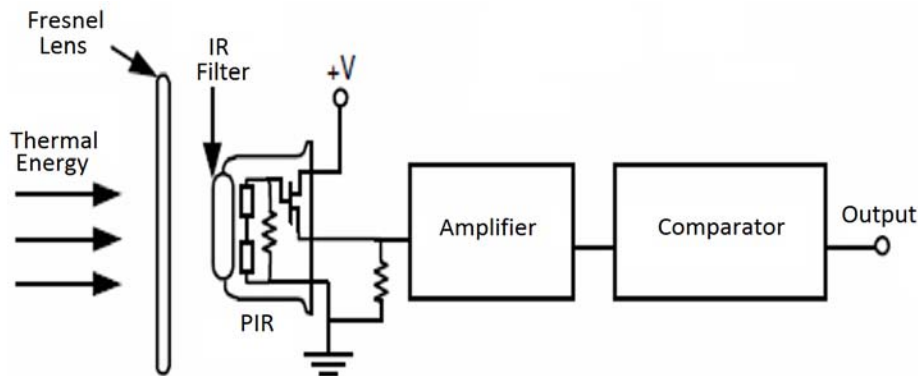


Figure 1. Operational principle of PIR Sensor

Transformer Security System

In the transformer security system (Figure 2), non-authorized persons input to the transformer pole when PIR sensor generates a warning sign. With taken this signal, video or photo of environment is taken and stored in external memory unit. Thanks to the communication unit on the system, the information is transmitted to main server locating in the monitoring center by establishing TCP/IP links over the GPRS/GSM line. The work integrity of the electrical transformer is checked using central monitoring unit or mobile devices by police and private security firms with individual users.

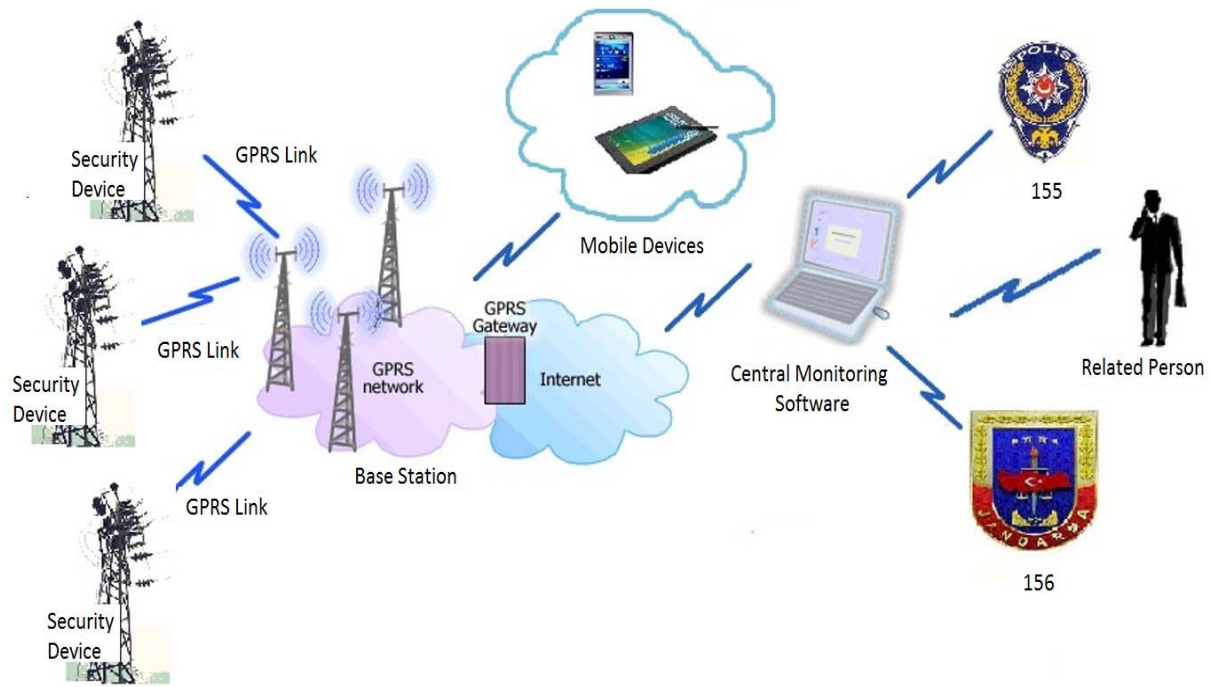


Figure 2. Transformer Security System

The working principle of Transformer Security System

The flow diagram of microcontroller software of TSS software is shown in Figure 3. After energizing the device, all elements included in the motion sensor and communication units are activated. Using GPS system device transmits information to monitoring center by taking information of coordinates and so ready for use. When alarm signal is came from the PIR sensor, videos / photos of environment are taken by activating IR illumination. The captured video or photo is stored in the external/internal memory unit. Then taken alarm information and video or photo is transmitted to server over the GSM/GPRS transmission line by connecting TCP/IP connection. When data transmission is performed successfully, the check information send by server is received and do not sent back. If data transmission is not performed successfully the error information is sent to the device by server. The device taken error information repeats transmission processing three times until it completes successfully. Alarm information received by successful software is displayed on the map in accordance with the coordinates of device. Alarm sending device can be controlled by an operator controlling system in the monitoring unit. In this control, it can be activated or passive by checking lighting on the device, audio devices or any mechanisms that can be added later. Alarm sending device without active or becomes inactive is also passed to state to produce a new alarm whether sleep mode taken out of event of alarm. As soon as the alarm generated by device is transmitted to center, if the connection has trouble for any reason, alarm information is stored in internal/external memory unit. When the device can also connect with the center, it transmits stored alarm information to center and a defined GSM number as MMS message.

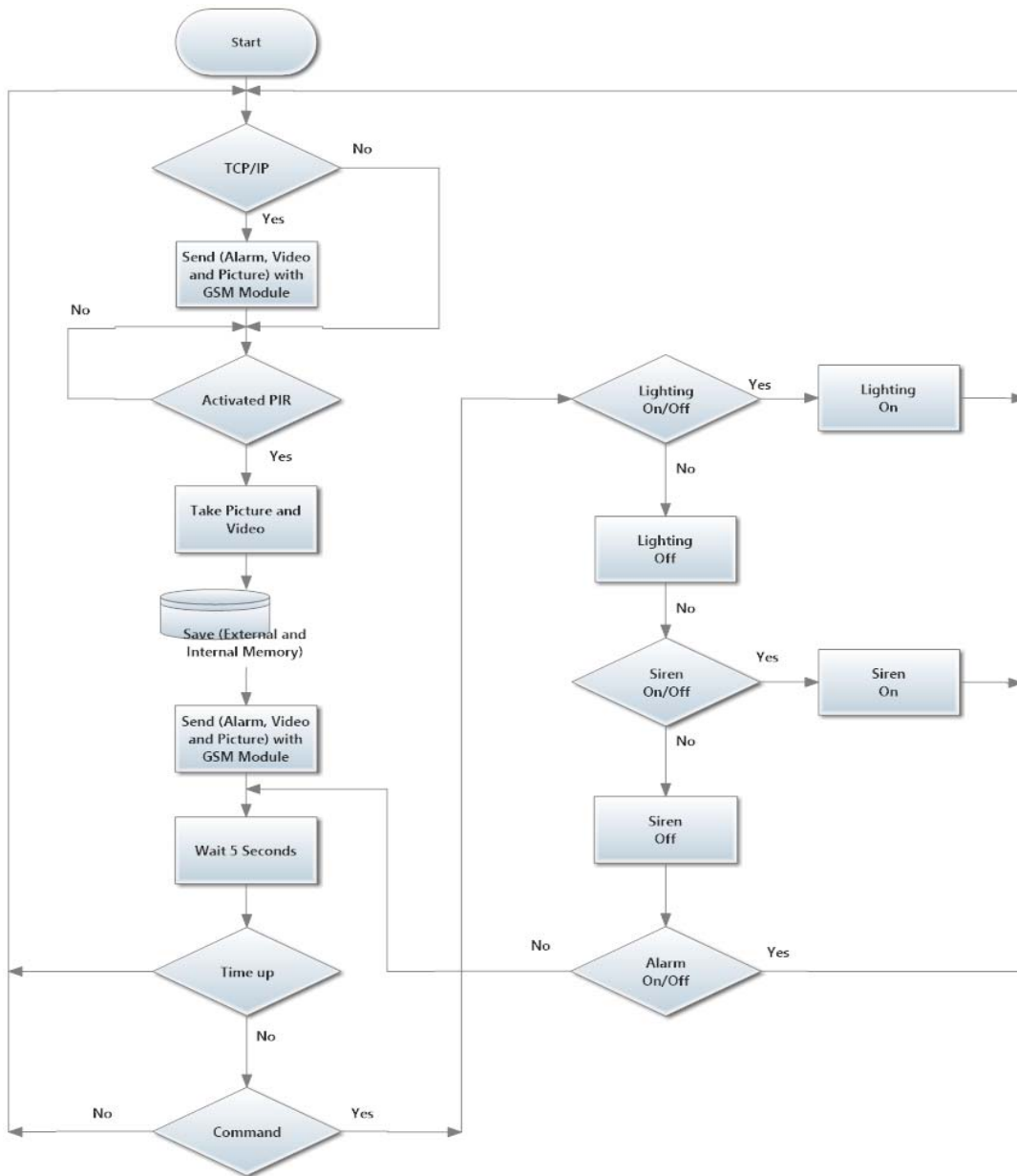


Figure 3. Flow diagram of system.

Results and Discussion

The features and hardware of designed outdoor security system are shown Figure 4. The device can be positioned in one or more points, produced alarm/warning and alerts with the helping of battery, taken photos or videos of environment and it is ready to communicate to introduced or will be introduced GSM number obtained all information via MMS. After energizing device, all elements on device are activated. After performing the task, device goes into sleep mode until the next warning sign. In this way, the device can be operated continuously for 3 years without being connected to any source of energy.

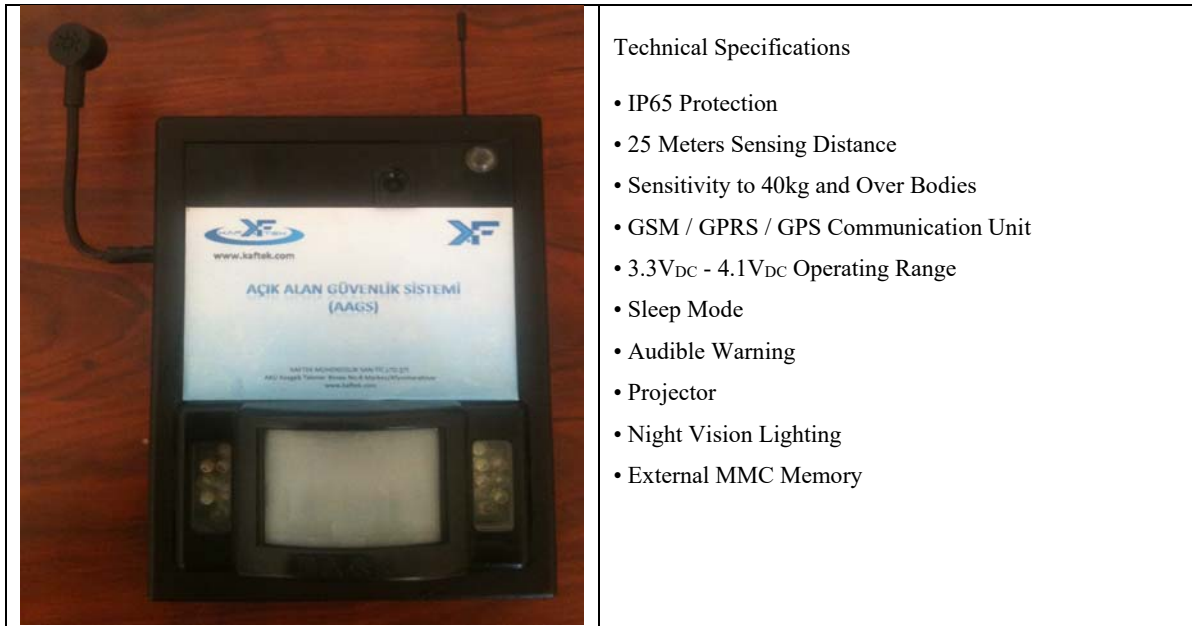


Figure 4. Outdoor Security System

The interface of central monitoring software monitored devices from hardware is shown in Figure 5. At the point where the device is located when its position is changed or theft, notification is given to individual users and central monitoring instantaneously and this notification has taken coordinates at the certain time intervals and moving device information 7/24 monitoring of electrical transformer is provided with the monitoring software within the visual and audio stimuli .

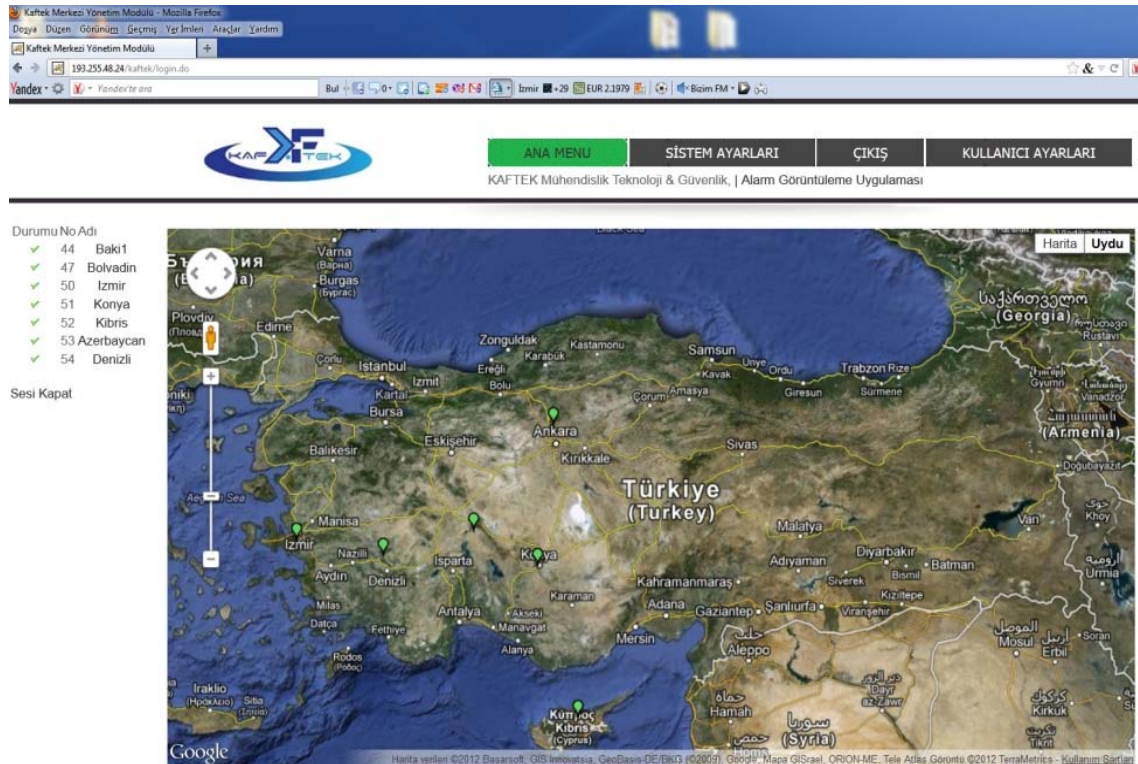


Figure 5. Central Monitoring Software

Alarm and images of performed system with taken data are shown in Figure 6. In sleep mode, TSS register on

GPRS networks in 4 seconds by receiving warn sign from Passive Infrared (PIR) detector and is taken video record of environment with visual and audio stimuli for 5 seconds. Status information with alarm and image recording are transferred to the software of central monitoring. In this process, if the fails to record the GPRS network it is provided uninterrupted transmission of the data to the monitoring center through SMS. When analyzed images, they have shown to be very successful to distinguish the environment and people. But at night times, it is not achieved the desired distinctiveness from the night images with IR illumination. Finally, it is determined that IR filter should be used in night to get quality image appropriate wavelength in camera.

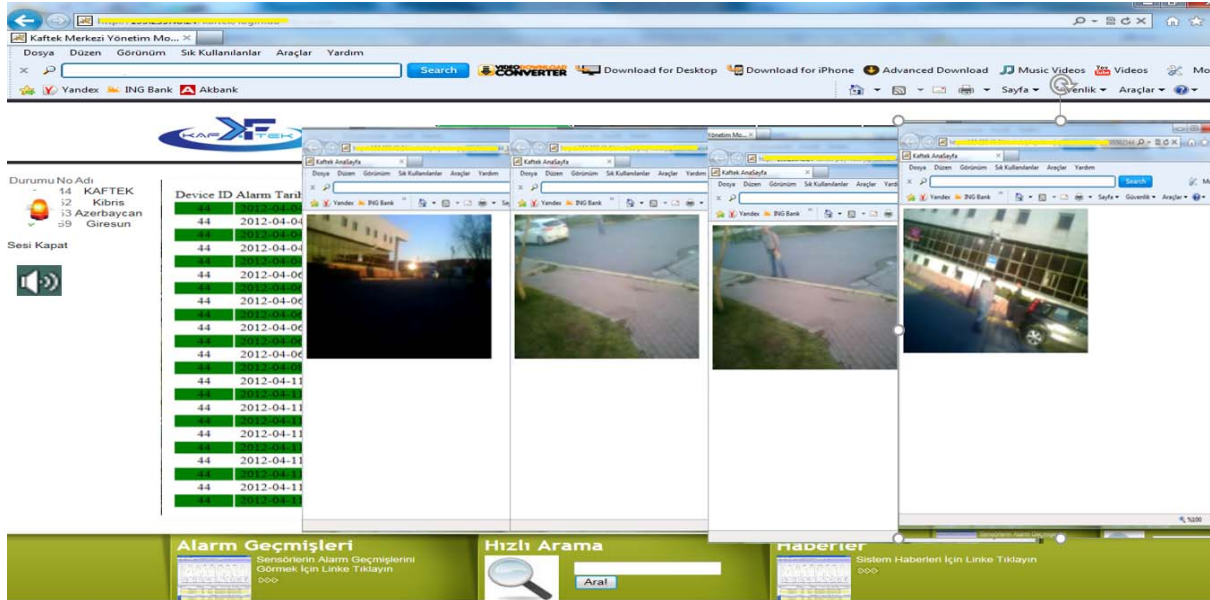


Figure 6. Integrated Test System

Conclusion

Agriculture plays a key role in many countries economy in the world. In agriculture effectively productivity depends on irrigation of crops in dry last month. For this reason, during unirrigated winter months, states cut the energy of electrical transformers to eliminate or minimize energy losses occurred in transmission lines. In this case, it has created serious vulnerability in transformers. The cooling oil and copper cables used in transformer attracts thieves due to higher selling prices. Performed transformer security systems use both GPS and MMS infrastructure. As a result, in this study a new monitoring system is realized for maintaining to continuity of the structure of interconnected power lines and security in the field of medium voltage electrical transformer used for agricultural purposes using M2M technology. The images are recorded in the server from the device that carries the distinction of being evidence in judicial review cases and with the lack of evidence, judicial process will provide the binding decisions faster. In the future studies, it will be continued in monitoring different species in their habitat and safety issues in the military field.

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