

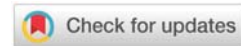


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Research Article

Providing a HSE system for intelligent temperature control of urban equipment (electrical panels) and fire prevention based on the integration of concept models and programming of AVR microcontroller (Case study of Mashhad) as a smart city implementation

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Abstract

Today, smart city approaches are considered as a key to solving the problems facing metropolises. However, using this approach, the costs of investment, operation, and maintenance of infrastructure in cities will be significantly reduced. In this study, a system for intelligent temperature control of urban equipment (electrical panels) and fire prevention based on a combination of concept models and programming of AVR microcontroller was designed. Then, the data obtained from the sensors (installed in the aerial panel of one of the streets of Mashhad) were analyzed by the SPSS software model. The results of the analyzes showed that the highest accumulation of data was at temperatures below 30°C and statistically, the normal distribution was skewed to the right. The temperature data received from the sensors for phases one, two, and three have a median of 26, 29 and 29°C, respectively, which indicates; Temperatures of 75 to 81°C are selected correctly as warning values. Considering the results of this study, it became clear that the present system can be very effective in monitoring, controlling, and monitoring the health of urban electrical panels.

Introduction

One of the main requirements for the operation of urban equipment is to pay attention to the principles of maintenance and repairs, and failure to pay attention to this issue annually causes extensive financial losses [1]. At the same time, field

studies show that the maintenance process for small equipment is very difficult and complex and requires a lot of manpower [2]. Therefore, the use of inexpensive sensor equipment can fill this management gap and lead to maintaining the safety and health of the equipment [3]. Implementation of sensor networks and consequently analysis of collected data for optimal

management of urban facilities is one of the main goals of the smart city. In fact, with the help of integrated telemetry, in addition to reducing human error, it is possible to help increase the efficiency of the equipment [4]. Switchboards are one of the main components of electrical monitoring systems, which are generally divided into home, air, and street types. However, with the help of analyzing the temperature information of electrical panels, it is possible to measure the consumption in different urban areas (even separately for subscribers), possible breakdowns of current transformers (to control power losses), and fire prevention (especially in peak times) [5-7]. Moghavvemi et al. (2001) Using AVR microcontroller system programming, designed a low-cost remote control system for temperature and humidity in municipal facilities and developed its applications [8]. In another study, Coopmans and Chen (2008) designed a monitoring package and low-cost, low-volume data loggers using AVR microcontroller programming [9]. Simić (2014) designed and developed sensor systems for measuring temperature and humidity in servers using an AVR microcontroller system [10]. In this study, the main goal is to create a system for intelligent temperature control of urban equipment (electrical panels) and prevention by using conceptual modeling methods (to determine the logic of management programs and performance of the smart city-based system) and AVR microcontroller programming.

Materials and methods

Case study

All the studies conducted in this research are related to home, weather, and street signs in Mashhad. Meanwhile, based on face-to-face interviews with the Mashhad City Distribution Company, large costs are incurred annually due to the fire of electrical panels in infrastructure and urban facilities (Figure 1). Especially in peak consumption conditions, in addition to the heat generated by the flow of current, the high temperature of summer (peak consumption period) is caused by more and leads to financial losses to the electrical panels. It can also cause casualties in acute cases due to violation of HSE principles.

Alarm management algorithms

One of the main goals of the smart city is to stabilize urban resources, property, and assets. This conservation of resources in electrical infrastructure is done in the form of an intelligent structure based on the principles of alarm management. The warning logic in this system is shown in Figure 2.

In this algorithm, the threshold of the primary and secondary temperatures of the electricity (°C) are equal to 62 and 55 (for domestic), 70 and 65 (for street), and 81 and 75 (for air), respectively. A specific limit time of 5 minutes is also considered in this study. It should be noted that these numbers were selected based on trial and error method and based on the experience of operating urban facilities.

AVR programming and statistical analysis

In this study, all microcontroller programming was done to design electronic boards in the Code Vision environment and



Figure 1: Damage caused by rising temperature in electrical panels.

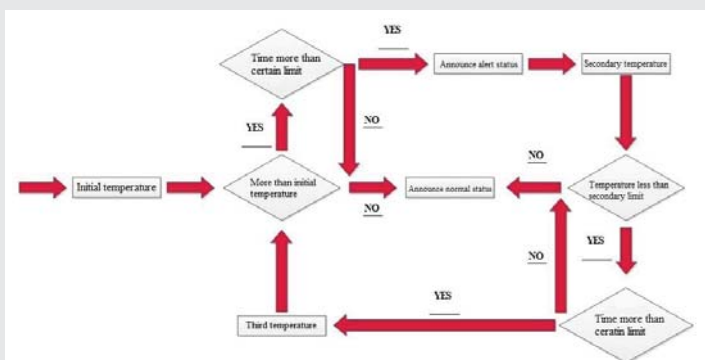


Figure 2: Alarm management logic in switchboard temperature control system.

electronic simulations in the Proteus environment. However, all the results in this study will be based on the aerial table. Also, all descriptive statistics analyzes were performed in the SPSS software environment.

Results and Discussion

After designing, manufacturing, and programming the temperature control system of electrical panels (in Code Vision environment), the mentioned system should be installed in the aerial panel of one of the streets of Mashhad. The results of the statistical analysis of temperature changes are shown in Figure 3 and Table 1. It should be noted that the relevant results are in the peak of electricity consumption (summer of 1998) and conditions of temperature crisis and the probability of fire is higher than ever.

As shown in Table 1, The maximum, minimum, average, average, and temperature modes of the aerial switchboard for all three phases of the output bus are equal (47, 62 and 61), (10, 13 and 12), (26, 29 and 29), (26.33, 30.8 and 30.7) and (25, 26 and 25) degrees Celsius. Also, the normal temperature distribution curve has a skew to the right, which indicates a high accumulation of data in values below average.

Considering Figure 3, it can be seen that the maximum amount of data is accumulated in values less than 30°C.

However, it should be noted that data above 60°C make up a small percentage of the data received. As shown in Table 2, the number of data above 70°C in phases 1, 2 and 3 has been reported as 1, 23 and zero, respectively. Preliminary analyzes show that the received data (more than 70°C) is related to the peak consumption in summer and are realized cross-sectionally in some periods.

Conclusion

One of the main problems of urban management is the maintenance and repair of existing infrastructure in cities as potential assets. However, the maintenance and repair

Table 1: Results of descriptive statistics of aerial electrical panel temperature.

Title	Phase 1	Phase 2	Phase 3
Mean	26.33	30.8	30.7
Standard Error	0.046	0.058	0.06
Median	26	29	29
Mode	25	26	25
Standard Deviation	6.61	8.44	8.73
Sample Variance	43.77	71.37	76.36
Kurtosis	0.11	0.31	0.25
Skewness	0.36	0.72	0.73
Range	37	49	49
Minimum	10	13	12
Maximum	47	62	61
Sum	544364	636845	634683
Count	20673	20673	20673
Largest	47	62	61
Smallest	10	13	12
Confidence Level	0.09	0.11	0.12

Table 2: Results of histogram analysis of temperature data.

Phase Num.	Cumulative %	Frequency	Bin
Phase 1	55.96%	11568	30
	97.27%	8540	50
	100.00%	564	60
	100.00%	1	70
	100.00%	0	0
	100.00%	0	80
	100.00%	0	More
Phase 2	Cumulative %	Frequency	Bin
	56.38%	11655	30
	97.72%	8546	50
	99.89%	449	60
	100.00%	23	70
	100.00%	0	0
	100.00%	0	80
Phase 3	Cumulative %	Frequency	Bin
	74.59%	15421	30
	100.00%	5252	50
	100.00%	0	0
	100.00%	0	60
	100.00%	0	70
	100.00%	0	80
	100.00%	0	More

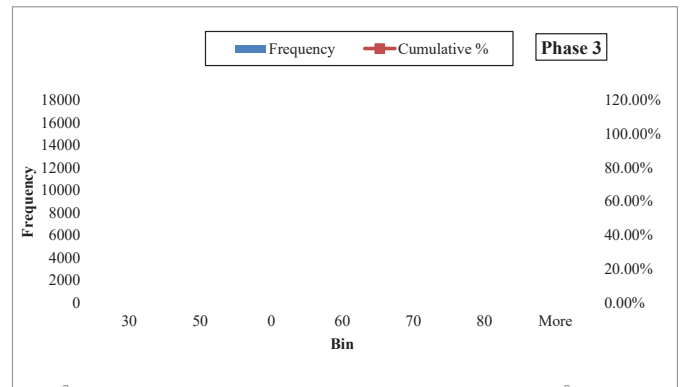
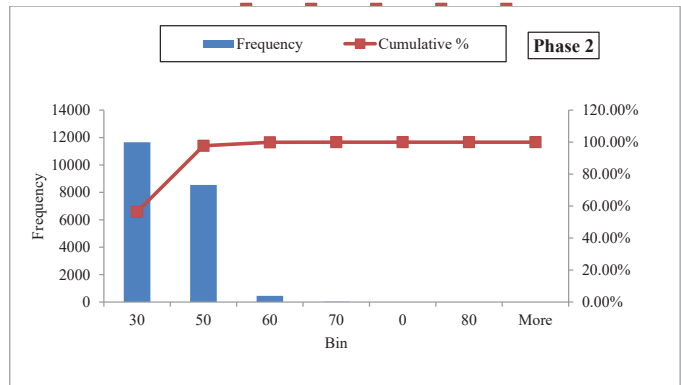
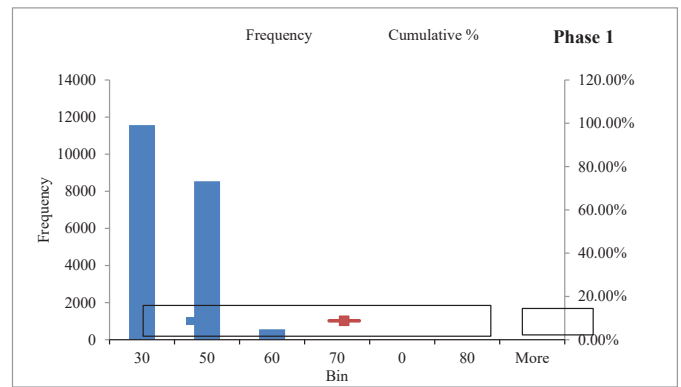


Figure 3: Frequency distribution of temperature data in electrical panels; (a) phase 1 (b) phase 2 (c) phase.

of urban equipment in the traditional way is very expensive and not easy. Therefore, the results of scientific and practical research showed that the use of smart tools (in the smart cities approach) can increase the life of urban equipment and devices. In the meantime, this study introduced a system for intelligent temperature control of urban equipment (electrical panels) and fire prevention based on a combination of conceptual models and programming of AVR microcontroller. The results of the analysis showed that by using the mentioned system, all the temperature data of the electrical panels can be observed, and by observing a series of requirements of operation and urban management, it can control the breakdown and fire.



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