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Intelligent Campus Implementation For Smart Cities

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Abstract

Digital transformation has provided the decision-making infrastructure needed to produce custom solutions for each person. Traditional decision support systems have begun to evolve into intelligent systems and mass customization has begun to be applied in many areas of life, such as education, transportation, health, and production. In order to achieve digital transformation in teaching, it is necessary not only to focus on the teaching process but also to focus on environmental factors. The provision of digital content and the performance of the student are carried out in the digital environment with education technologies. It is aimed to maintain sustainability of the environmental quality by following the digital environment by means of digital transformation and to improve the teaching processes with intelligent systems that will interfere immediately in emergency situations.

Keywords: Cyber-physical Systems, Education, Industry 4.0, Artificial Intelligence

1. INTRODUCTION

Digital transformation is an important factor in ensuring mass customization as well as providing flexibility in processes. Providing special content to students is an important factor in increasing the success of teaching by defining individual needs, especially in education systems [1]. The increase in the quality of education is not only about personal content, but also about the quality of educational tools and the environment. Class and campus environment must be monitored in order to follow the environmental conditions in which teaching activities are carried out and to ensure the safety and security of the students. In this process, the classrooms participated by the students and the working environment will be evaluated and a proposal for the determination of the work accidents or emergencies that may occur in the teaching environment or the management of autonomous emergency is proposed.

2. LITERATURE SURVEY

Although different terms such as smart city, digital city, and intelligent cities are used in the literature, different definitions are also made. Albino et al. [2] made firm that concepts such as technology,

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infrastructure, knowledge management, connectivity, sustainability, quality of life, and participatory governance have come forward in defining intelligent cities. The key components of urban development for smart cities are smart technology, smart industry, smart services, smart management, and smart life [3]. IoT technology is widely used in smart city implementations all over the world. The main objective of the business partnership between these objects and objects that send data to the cloud computing system via wireless networks is to perform the combined task assigned to them [4]. Wireless sensor networks are one of the most effective tools to use in creating smart cities because of its ease of use and low cost according to Dener and colleagues [5].

These tools are used in a wide range of environments, from emergency training to education. While the use of technology improves productivity, especially the benefits provided in education are greater. The intelligent systems to which human logic is transmitted can provide better performance and metric values than traditional classical approaches [6]. Because education is a process in which people are involved, Mostar University has switched to an intelligent teaching system in education and a digital learning environment for students to reduce administrative costs and save time in education [7]. Infrastructure as a Service (IaaS) is emerging as the most important and fastest growing area in this digital environment [6, 8].

Quality in teaching systems should be improved not only by the process but also by managing emergencies. There are many works in this field. For example, image processing techniques [9, 10, 11], distributed sensor systems [12], object and motion tracking [13, 14, 15], color classification [16] are some of the works in this field. Töreyin and colleagues classified the video data by visualizing fire motion, vibration and irregularity of the video, and increased the fire detection performance [10]. To handle the fire, it is necessary not only to detect the fire, but also to detect its motion. Laugraud and colleagues developed a background subtraction algorithm called LaBGen [15]. In the system developed for this study, these issues were not addressed separately, because various factors like building design, sensor design, and system design affect the digitalization[17].

There are many studies in the literature to solve for single problem. In this study, the knowledge in the scientific literature is transformed into a complete framework. Contribution of the proposed system is that it operates with low cost algorithms, and decrease both network and hardware complexity. By monitoring the teaching environment, a hybrid system has been created that monitors both the emergency management and the quality of the environment as well as the teaching process.

3. INTELLIGENT CAMPUS MODEL

Intelligent campus is an environment in which person-specific data is produced, analyzed and reported in a high-populated environment in order to enable student-specific teaching processes to be maintained. In order to achieve this, it is aimed to follow the operations of working environment by the cloud computing system, to understand the environment with artificial intelligence, and to report with big data systems. Those systems are the main components of Industry 4.0.

3.1. Cloud computing services

The cloud computing system is an important tool for students to follow their work, their connections and the software they use. In addition, the communication infrastructure required for students to be connected to the campus is provided via the cloud system. Cloud model developed for intelligent campus includes:

- Infrastructure as a service (IaaS),
- Software as a service (SaaS).

Because the platform service (PaaS) is effectively used to develop software, the intelligent campus system is not considered as a general part of the cloud. However, it is anticipated that the open platform services will be used independently of the campus cloud system within the scope of the programming lessons.

3.1.1. Infrastructure as a service (IaaS)

IaaS is a cloud service that allows a person or organization to rent infrastructure such as servers and data storage. Within the scope of the infrastructure service, students are provided with a virtual desktop via campus accounts, reporting how long they spend on the virtual desktop and how long they have been using applications. Student accounts have been integrated with the operating system through the Lightweight Directory Access Protocol (LDAP), and it has been determined how long the user remains connected for the specified software. This information is obtained by gathering process information by Power Shell in Windows environment and by Terminal in Linux and Unix environment. How efficiently the application is used can be determined by assignments, but it can be easily measured whether the application is used as much as necessary and how long the given work is performed by the student. For this reason, it is necessary for the instructor to define the minimum usage periods of the applications, to match the applications and assignments, to integrate the student's homework grades into the system and to integrate with application use information.

An advantage provided by the infrastructure service is the sharing of course content, announcements and important information. Information sharing is carried out via web services. Access to the cloud system from any platform is possible. Especially in emergencies, cloud infrastructure is needed to direct people. Two models were designed to guide campus members with cloud service.

- In the first model, the emergency warning will be sent for everyone, and will be redirected if the user accepts it. In this model, floor and partition information will be selected by the user.
- In the second model, the campus member known by face recognition, fingerprint recognition or Radio Frequency Identification (RFID) tag will be directed immediately and no message will be sent to everyone.

Hybrid use of these two models is predicted in terms of application efficiency. This is because the system has to work when there is no tracking system.

3.1.2. Software as a service (SaaS)

Software service differs from infrastructure service in which the software can be run on the students' computers and there is less load on the system. In such a structure there are 2 important issues for students to follow. The first is licensing the software with a server license. Because, the usage times of the software can be reported by a license manager like OpenLM in such a structure. The second important issue is identity verification. This is because the matching of the IP provided by the license manager and the student information is possible. The processes after these operations will continue similar to the infrastructure service.

3.1.3. Internet of things

Monitoring of the conditions in the environment is essential both in terms of teaching quality and management of emergencies. The reports needed in these two processes can be obtained in various and different ways. The data requirements of the model were determined as air quality, ambient temperature, ambient light intensity, noise, RFID tags, fingerprint data, infrared human detection, and image. Air quality, ambient temperature, light intensity, and noise data should be monitored to ensure sustainability in the teaching environment.

RFID tags, fingerprint data, and facial image processing on the image are important for identifying the environment in which campus members are located. Especially in the laboratory environment, it is essential to prevent unauthorized access and to detect casualties at the time of accident. It is also necessary for the detection of activity and direction over the image, the identification of people in the environment, the understanding of human presence with infrared sensors, and the realizing of the priority of intervention in emergencies.

Fire detection via picture and infrared sensors is required for emergency identification. The determination of the activities within the campus and in the building is important for emergency situations in order to evacuate the buildings as soon as possible and with minimum loss. There is a need for a cloud system to be guided in emergencies.

3.1.4. Sharing sensor data

Data will be collected in different formats from different sensors for realization and reporting ambient conditions. The data will be uploaded to the servers via web services so that the collected data is not saved directly to the server. In particular, high-dimensional data such as images will not be loaded directly to the server, but only the points detected on the image will be stored on the servers. Therefore, all data to be collected for reporting on the server will be text or numbers. Images received are stored on a separate server via the Realtime Streaming Protocol (RTSP) and are mapped to the reporting server. In this way, it is possible to collect data not only from embedded systems, but also from IP cameras. Since the images obtained from the IP cameras will be automatically deleted some time later, the images of the detected exceptional cases are stored in a separate server disk space. In this respect, both disk space saving and evidence relating to the determinations made are stored.

3.1.5. Detection of motion

In-campus motion is analyzed on embedded systems or with images obtained from IP cameras with the RTSP protocol. As the analysis method, background subtraction and image subtraction are used. As a threshold value, the difference between the values of red, green and blue is expected to be at least 10. Two frames of succession taken from the imagery were investigated for difference from each other and background. The midpoints of the points on the binary images obtained are calculated and the closest midpoints are mapped. The amount of slip and direction between these points were determined as the amount and direction of motion. The difference data is normalized by a regression model so that the amount of motion can be understood correctly. Figure 3.1 shows the detection of motion by the system.

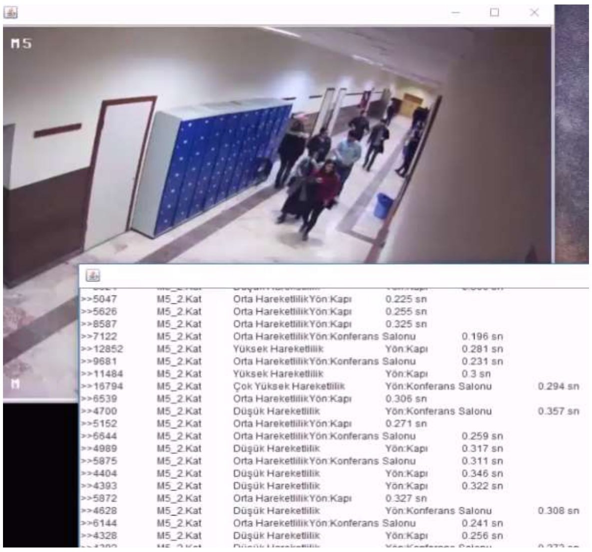

Figure 3.1 Detection of in-building motion

3.1.6. Fire detection

Fire detection and measurement of the fire size were carried out on color and realized by color filters. The neighboring points between the points obtained by filtering the red, green and blue (RGB) and brightness values in the image are determined and the neighboring points are grouped. The size of the fire is interpreted according to the number of points grouped. Detection of fire by image is shown in Figure 3.2.

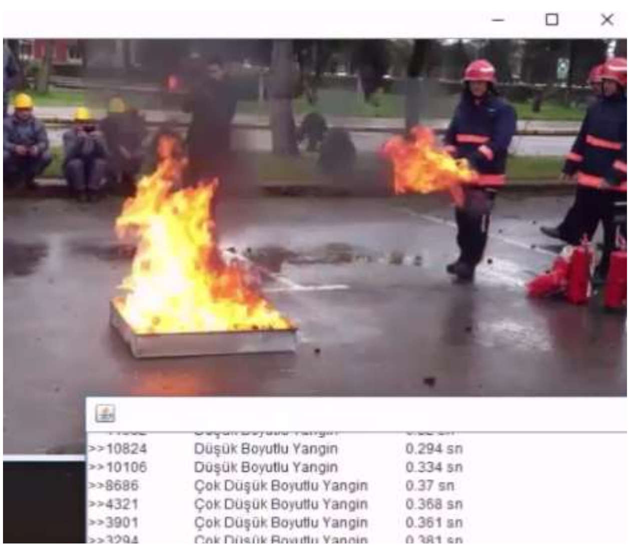

Figure 3.2 Fire Detection

3.2. Flow of system

The developed system integrates the data collected with student scores related to the learning process through cloud computing. At this point, it is possible to determine how long the students are adapting and their learning speed. The quality of the teaching environment is monitored by sensor data. In emergencies, data collected from the sensors are analyzed and campus residents are guided by an intelligent system via cloud computing.

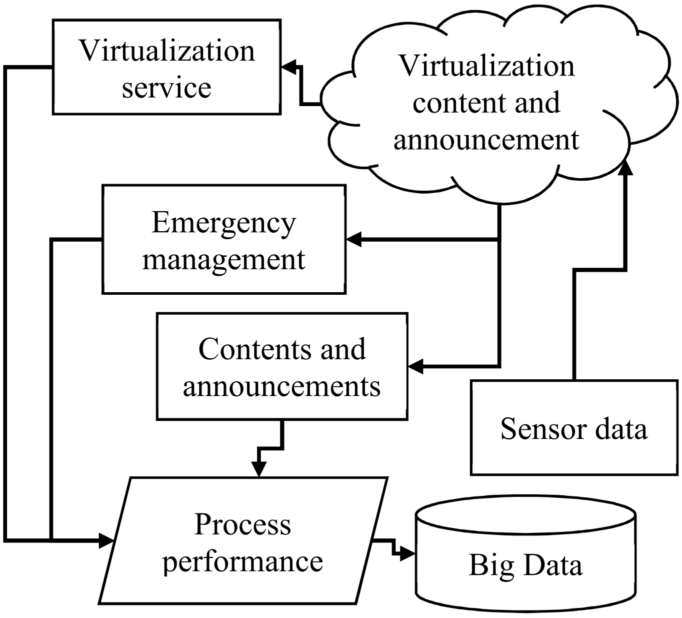

Figure 3.3 Detection of in-building motion

3.3. Mathematical model of the system

Three phases of the system have different objectives, and different performance measures regarding to the objective function. However, there is no need to develop a multi-objective mathematical model to achieve the maximization of the system performance. We develop a cost oriented model with the efficiency and effectiveness constraints, instead of developing a multi-objective model. The objective function of proposed model consists of the setup (SC_h) and maintenance (MC_h) costs of each hardware "h" given in Equation 1. Total cost is calculated by multiplying unit cost with number of each type hardware used "$N_{h,o}$".

$$Min\ (SC_h + MC_h) \sum_{o=1}^{o\in O} N_{h,o} \quad (1)$$

Each hardware will be operated for a specific number of people or a particular zone, which is the operating target of hardware. The index of operating target is noted as "o". Each target must be assigned for at least one hardware, given in Equation 2 and Equation 3.

$$\sum_{h=1}^{h\in H} N_{h,o} \geq 1 \quad (2)$$

$$\sum_{o=1}^{o\in O} N_{h,o} \geq 1 \quad (3)$$

Each system in a zone must satisfy the needs. To actualize it, an effectiveness matrix ($E_{h,o}$) is used for each target and hardware in Equation 4.

$$\sum_{h=1}^{h\in H} E_{h,o} N_{h,o} \geq 1 \quad (4)$$

Efficiency parameter depends on the type of hardware and the process. For instance, the ratio of system timeout to respond time is the efficiency of one emergency sensor. The multiplication of efficiency and the ratio of total area that the sensor covers is the effectiveness. If the effectiveness is smaller than one, we need to use more than one sensors.

4. RESULTS

In order to measure and increase the quality of teaching processes, a model consisting of three phases has been developed. The first part of the developed model follows the learning process through the cloud system. In this process, the students' time to use the software was measured and the learning speeds were revealed together with the scores they have taken from the related assignments. The quality of the teaching environment was measured by sensor data and the identification of possible work accidents for emergency response was determined. When an emergency condition occurs, the cloud system is used to direct the people around and to minimize the losses.

5. RESULTS

The proposed system aims to measure the educational environment to gather the data related to the education process. To manage it, the system is designed as collecting the studying data, environmental conditions, and emergency data.

We proposed a model to minimize the cost, while keeping the effectiveness of the system at a certain level, which we presume that the system will increase the quality of the education process. In the future study, we will try to find out the correlation between the quality of the education process and contribution of the system.

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