Web application as a support system for records of working time, monitoring business processes and activities of company employees

Milan Andric, Marko Arsenovic, Srdjan Sladojevic, Darko Stefanovic, Andras Anderla and Dubravko Culibrk
University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia
milan.andric@panonit.com, arsenovic@uns.ac.rs, sladojevic@uns.ac.rs, darkoste@uns.ac.rs, andras@uns.ac.rs, dculibrk@uns.ac.rs

Abstract - **In the contemporary business world, the usage of information technologies and all the benefit it offers is implied, regardless of the branch of business. This paper deals with the detailed description of the application that serves as a part of a system used for electronic recording of work hours, business activities of the employees, as well as the tracking of business processes. The application covers all types of businesses, and therefore has a wide usage in all companies, without limitations. The application was developed in the ASP.NET technology and relies on a Microsoft SQL Server database. The system was developed for Windows IIS server deployment. Besides the application, the system includes a device based on a general packet radio service (GPRS) module with a Radio Frequency Identification (RFID) module attached. The device sends information to the server that uses an analyzer to parse the data and to store them in the database. This paper contains the description of the RFID technology and a description of the technologies used for the development of the web application.**

Keywords - Work time acquisition; Evidence of business processes; Work reports; Web application; ASP.NET; SQL; GPRS; RFID;

I. INTRODUCTION

Business systems are complex structures, which are made first of all, from human resources, different components and processes. The goal of business systems is delivering certain goods to the buyers. Regardless of the size of the business system, it is necessary to keep various types of records about the elements of a business system. Generally speaking, the recording of work hours, business processes and activities can be realized in two ways:

- Manually – human resources are in charge of records that are usually done on printed forms or through electronic documents.
- Automated – usage of electronic system for records that can be constructed in some of the technologies suitable for the identification of a person or an object that needs to be recorded.

The manual way of recording is prone to errors when compared to the automatic. Security and safety of manual recording is not high because the job is done by a human. It is general knowledge that an automated system is more reliable than humans with regards to potential errors. Automated systems are more efficient, recording is done much faster and the employees are not losing time waiting to be recorded. If an error does happen, the process of locating and removing the error is simpler and easier.

RFID (Radio Frequency Identification) is an identification and tracking technology based on using the radio waves to send and receive data through RFID tags [1]. A tag is physically a small tile easy to install on different products, animals and even in the human body.

An RFID tag contains a chip used for data storage and the antenna is used for receiving and transmitting data over the radio waves. Every RFID tag has a unique, unchangeable number assigned during production. A transponder is the carrier for a tag, meaning that the tag is installed in a transponder that can have different forms, depending on the intended purpose. Some form factors are smart cards, labels, bracelets, etc. The second part of the system is the RFID reader (terminal) capable to spot the chip and read the information from its memory. The terminal uses radio transmission to send energy to the transponder, this is absorbed by the tag, wich then broadcasts the feedback information in the form of a unique identification code and/or line of data that has previously been stored in the transponder itself. The third element of the system is a computer information system that stores the required information about tags, readers and rules for issuing commands in its database [2]. At the moment, RFID systems are successfully complementing bar-code systems, but aim to completely replace the bar-code systems in the future [3].

Today, RFID technology is used in almost all sectors of economy and activities outside those sectors. RFID tags are used to track the property of a company (basic resources, goods in the warehouse, goods in stores, etc.), work hours of employees and physical control of access (which is the topic of this paper), identification of vehicles entering parking lots or passing pay tolls, charging of the tickets in city public transportation, charging of the tickets for different objects and events (sport, cultural , entertainment), recording of students' attendance of classes, records in libraries, identification of domestic animals, identification of a winner on athletic races, etc.

In this paper, we describe a system that can be used to manage the records of working time, monitor business processes and activities of company employees. The rest of the paper is organized as follows: Section II provides an overview of relevant published work. Section III describes the proposed system architecture which consists of RFID reader,

GSM modem and the web application. Section IV contains information about technologies that were used for application development. Finally, the last section holds our conclusions.

II. RELATED WORK

A review of literature dealing with the use of the RFID technology to keep various types of records reveals that the structure of the system does not change significantly. What differs, is the type of equipment that is used, depending on the category of the system that is recording or controlling, to smaller extent the choice of environment for the development of the user application, but they all fall into the category of web applications. This is because of the main characteristics of web applications: accessibility of application from remote locations at any time, releasing the user from installing the application and unnecessary taking of memory on user's computer.

Helmy et al. [4] performed a test of a system that consists of a mobile device with an application for attendance recording. They proved that such a system saves time, manpower and costs, and ultimately simplifies the examination procedure.

The authors of [5] demonstrated the use of RFID technology to record students' attendance of a class. The structure of the system contains transponders in the form of cards, a passive RFID reader, web server and a web application. The main motivation of the authors was to reduce the possibility of potential errors during the recording of attendance, as well as to eliminate the loss of time that was needed to manually record every student, individually. On a higher level, this made teacher's jobs easier, because the system of rewarding attendance to the class by points is automated and it also enabled them to follow attendance at any moment, from any computer through a web browser. Benefits exist for the management of the university as well, since they can use records of students for any relevant planning (reserving classrooms for lessons, increasing/decreasing the number of teachers).

Another study that uses RFID technology in educational institution for taking attendance was published by Lim et al. [6]. Their system has real-time clock capability and hence the taken attendance is more accurate because the time is also recorded. The system can be connected to the computer through a standard RS232 or Universal Serial Bus port.

Saparkhojayev and Guvercin [7] also demonstrated the use of RFID technology for recording students' attendance of the classes. The structure of the system is similar to the work previously discussed, but with an addition of a camera on the RFID reader. When the user puts the card to the reader, data is received and camera takes a picture of the user. After that, the data and the photograph are sent to the server and stored in a database. The teacher logs into the application with her username and password and should compare the new photograph with the existing photograph of the student, which is a part of the basic data in the database. The authors claim that this way they have achieved higher security of the system and they have reduced the time needed to record attendance of students.

Yadav [8] demonstrated the use of RFID technology for recording free spaces on a parking lot and the automated control of access to the parking lot. Using this software, they have shown that checking in and out goes much faster than manually, crowds are avoided, drivers do not have to wait for checking in and out because it is done automatically with the RFID tag and reports are created automatically. Also, maintaining records in the database is simpler. The problem of free parking space is solved through the program by comparing the information about the total number of parking spaces, and the number of car-users that entered the parking lot. Lifting and lowering of the ramp is implied in the program.

In [9] the authors proposed the use of RFID technology in order to eliminate wires that connect sensors with the control unit (microprocessor) in modern cars. The main advantage is the elimination of unnecessary wires and the low price of RFID elements needed to implement this system. The experiment has shown good results in terms of reliability and bandwidth while there were some flaws with respect to the placement of the RFID reader and tag, since the reader had to be placed in the vicinity of the motor. This led to the attenuation of the signal due to the distance between these two elements.

Another application of the RFID technology for modern cars is presented by Karbab et al. [10]. They proposed a scalable and low-cost car parking framework (CPF). In their work, a preliminary prototype was built and the experimental results show considerable reduction in cost and energy consumption.

In [11] the authors designed an automatic attendance system that uses fingerprint verification. They developed an accurate, fast and very efficient system relying on minutiae-based fingerprint technique. Maltoni et al. [12] also proposed a biometric system that uses fingerprint identification.

In order to keep allocation under control and take statistics of equipment more efficiently an RFID-based equipment management information system (REMIS) was proposed by Li et al. [13]. The authors described the components of REMIS and designed RFID application framework for equipment information management system.

III. SYSTEM STRUCTURE

A block diagram of the proposed system is shown in Figure 1.

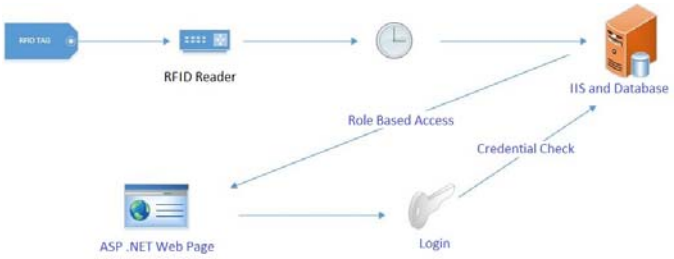

Figure 1: Block diagram of the proposed system

A. RFID characteristics

Recording of the employees entering and leaving the office is performed by pressing one of the entrance or exit buttons on the terminal and putting the card (transponder) in the vicinity of the device. When the button is pressed, there is a limited time period to present the card to the device. The data on the card is transferred to the reader that indicates the card has been read out by a sound and a light signal. The modem reads out the card (memory of chip in the tag) and uses GPRS to send data to a remote server. Reading of the card is instantaneous, and it is sufficient to put it five centimeters from the reader (terminal). The system stores every entrance and exit of workers from company. The remote server allows managers to access the data through the Internet in a safe way. The application generates daily and monthly statistics with records of sick days and leaves and flags instances of employees being late. The system enables the control of the access to specific segments of the company and can be adjusted to the specific needs of a company.

The reader device can remember up to 50.000 events. After every 100 memorized events, the data is sent to the remote server where it is stored in a database and then deleted from the device. The basic carriers of communication in the system are contactless RFID Mifare cards. Unlike magnetic or smart cards, these cards are not damaged by use and they have an unlimited expiration date. The cards can be used without being taken out from the wallet or pocket, because they can be read from a distance of up to 5 centimeters from the reader. In addition, RFID contactless card enable storage of data about users in the card itself.

Figure 2 presents the elements of the RFID system, transponder in form of contactless RFID Mifare card and terminal (RFID reader).

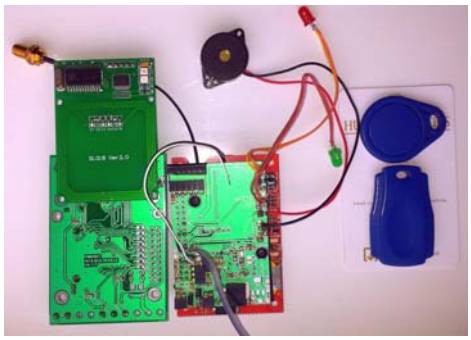

Figure 1: *RFID elements in the system for the recording of work hours and the control of access*

B. GSM modem

A Global System for Mobile Communication (GSM) modem sends the data to the server and the server receives, parses and stores the data. The Server runs a Windows operating system with the IIS web server option activated. The server receives packages through the appropriate TCP port and redirects them to a parser implemented as a separate Internet page. The parser first checks whether the package is in the appropriate form and if it is, parses it and saves the data in the database. If the form is not appropriate, the package is rejected and an error message is reported.

C. Web application

Information systems are intended to facilitate and accelerate the company business and provide them with the ability to better position themselves on the market. A system for the tracking of working hours, monitoring of processes and business activities of employees, provides users with a set of consistent data relevant to the company management. The application is web-oriented, which means that the management and authorized users can access the application and the data from any location. The requirements for the access to the application are a connection to the Internet and availability of any web browser. Upon opening the application, the page for authentication is loaded. The application is implemented in such a way that there are different user roles that are assigned when creating the user account. Depending on the role that the user has, the user will be able to access relevant information. Figure 3 shows the layout of the user-authentication page of the web application.

Figure 2: *Authentication page*

Once the credentials are entered, the main page of the application is loaded, where different sections related to the business of the company are presented. If the user enters wrong credentials, and error notification appears.

The application is multi-language and allows for the use of the application in Serbian, English, German and Hungarian. The language selection is enabled on all pages of the application, simply by clicking the flag of the language in which one wants to use the application. Flags are positioned in the header of each page.

The main page of the application is structured so that it consists of three parts. The first segment represents the main

menu, the second presents the functionality related to data management, while the third section presents various types of reports. In each section, a new item of functionality can be added, modified of deleted.

The main application menu contains the following items:

- Settings – selecting this option displays the information related to the company.
- Links – under this option links that are of importance for the company's employees can be accessed.
- News – represents the information which the user publishes and is visible to all users, regardless of the role and privileges assigned to them.
- Documents – selecting this option displays all the documents that were uploaded for sharing.
- Dashboard – is a page with a table that contains all the important information about the employees. There is the ability to filter data by any of columns. In addition to services offered on the website, there are posted messages and documents that are shared. This page can be accessed by all users which are able to read messages sent by the management and take the documents they need.
- Change password – allows the users to change their password. The password must be changed every three months.
- Log Out – check-out from the application.

Figure 4 shows the main page of the application with full user rights.

Figure 3: *Main page of application*

The system provides extensive data management options:

- Sectors – this functionality allows for keeping records on specific sectors within the company, as well as the definition of working time in the sector.
- Absence types – provides an overview of the defined absences from work.
- Absences – this functionality is extremely important both for management and for the other participants in the system. Through it, the employees can apply for absences, provide the reason for the absence, as well as the date of absence, so the management can decide whether to grant the absence or not. Also, there is a tabulation of all absences of employees which can be filtered by different columns. Figure 6 shows the absence form, which is forwarded to the management.
- Exceptions – this functionality represents non-working days at the company level or sector.
- Events – an overview of all entries and exits from the offices recorded by the system. It is possible to filter the data by various columns. Figure 5 shows a sample view of all the events of exit and entrance to the company for a selected date.

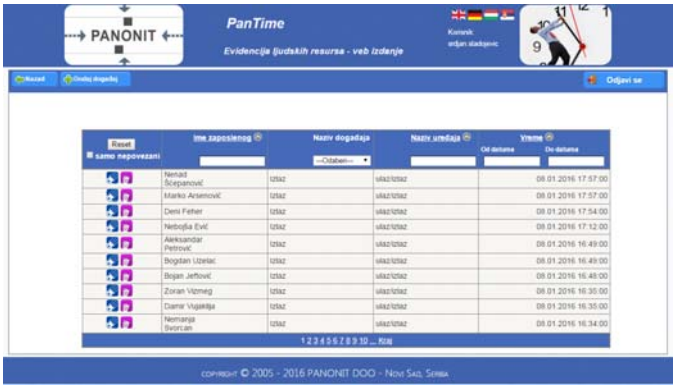

Figure 4: *Overview of events input-output*

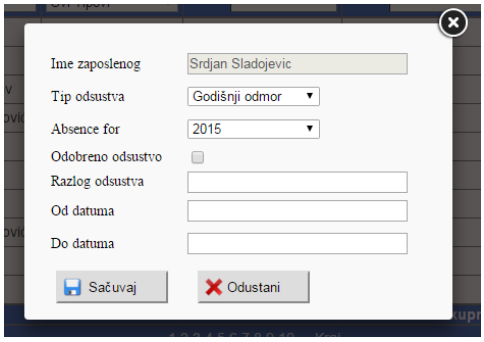

Figure 5: *Absence form*

- Employees – is a functionality where people can find information on all the company's employees with basic information about the sector in which they are employed, the number of offices, RFID, etc.
- Avocations – presents an overview of all jobs in the company.
- Salary – the functionality that provides a tabular overview of salaries for employees with basic information in the form of employee accounts, gross profit, net earnings, bonuses, etc.
- Projects – presents an overview of current projects in the company with information about the owner of the project and project description.
- Timesheets – represents important information for the project in the form of an employee who works on it, the description of work, type of work, time, etc.

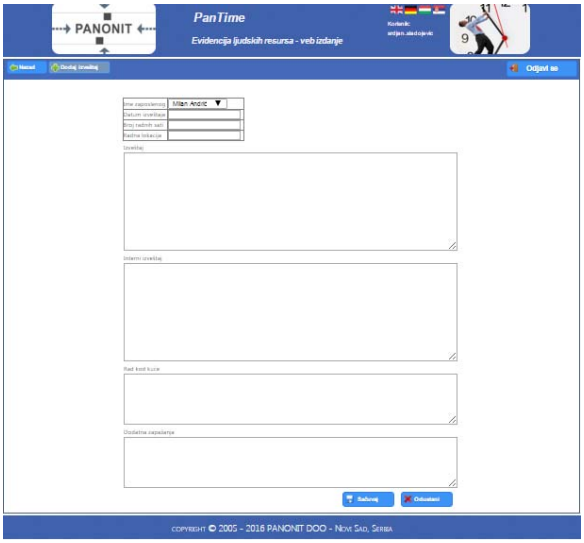

Figure 6: *Form for daily report creation*

- Daily reports – also extremely important functionality for the management of the company, it is always possible to view daily reports of employees in order to have information about their daily activities on company projects. This functionality has an option to view existing reports and filter them according to different conditions, as well as open form to create a new report that is shown in Figure 7.
- Vehicles – This functionality provides an overview of all the vehicles owned by a company, as well as basic information about vehicles such as vehicle's brand, license plate number, fuel type, color, etc.
- Tours – This functionality provides the information which car is busy in a given period by certain employee, how the route looks like, etc.

Report generating functionality is very important for the management of the company. The application provides an option for daily, monthly, and annual reporting based on different criteria. It also supports filtering of reports by projects and employees, as well as the printing of all different types of reports. Filtration supports the following reporting cases:

- Events – reports showing the exit and entrance of employees from the company.
- Unrelated events – reports that are created in cases when the user entrance is identified in the RFID reader and not identified exit and vice versa.
- Attendance – report provides an overview of the presence of employees in the company.
- Absence - report provides an overview of employees who are not currently present in the company.
- Work hours – report that provides a detailed picture of the working time of employees for the period defined in filtration. Figure 8 shows part of the report working hours.
- Salary report – is a report that relates to the payment of financial compensation of employees.

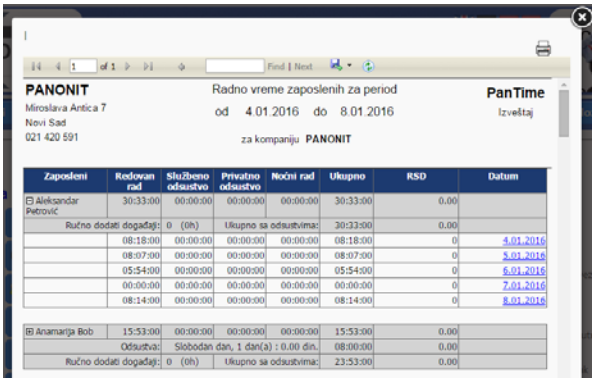

Figure 7: *Part of the report of the working hours*

IV. DESCRIPTION OF APPLICATION TECHNOLOGIES

A. *ASP.NET*

ASP.NET is web development environment designed for web programming of dynamic web sites, web applications and web services. It is provided by the Microsoft. ASP.NET uses the HTTP protocol and its methods of communication that takes place between the browser and the server. It contains a large range of controls such as text boxes, tables, lists, views for configuring and manipulating the code that is used to create HTML pages.

For the purpose of this paper, a web application was developed where the application is implemented in ASP.NET web form technology. The application is loaded via a web browser.

A special page of the application called input.aspx is used to collect the data from remote devices. Each device has its own deviceID, and several devices could be linked to one company. Each employee has its own RFID card or tag which has an employee code saved in the memory. As the reader devices have their own real time clock, when an employee registers itself with the device, the device sends the employee code, deviceID and a timestamp to the remote server where the page input.aspx is waiting for the event to be registered. Input.aspx parses the data, pairs the employee code with the employeeID from the database, pairs the deviceID with the appropriate in the database and stores the data using ADO.NET to SQL Server database.

All reports inside the application are Report Definition Language Client-side (RDLC) based. RDLC can be run completely client-side in the ReportViewer control. This removes the need for a Reporting Services instance, and even removes the need for any database connection whatsoever. However, it adds the requirement that the data needed in the report has to be provided manually. RDLC reports do not store information about how to get data and can be executed directly by the ReportViewer control.

B. Microsoft SQL Server

Microsoft SQL Server is a management system for relational databases owned by Microsoft. As a database server, this is a software product with the primary purpose of storing and consuming data through requests, usually sent by other applications that can reside on the same computer or on another computer, when the interaction takes place via the Internet. For the purposes of this study, Microsoft SQL Server 2005 Express Edition was used.

Database used for storing data has 28 data tables. Most important for the system functionality are: tblCompanies, tblEmployees, tblDevices, tblRegister, tblAbsences, tblProjects, tblReports, tblRealizations, tblUsers, tblRoles etc.

C. IIS (Information Internet Service)

Internet information service enables Microsoft Windows based systems to run a web server that can provide publishing services such as File Transfer Protocol (FTP) service, the Simple Mail Transfer Protocol (SMTP) Service and Network News Transfer Protocol (NNTP) service. IIS can be used for hosting and managing Web sites and other Internet content when it receives an IP address register the domain in the DNS server and configures the network appropriately. IIS is a component of Microsoft Windows operating system. The Web application described in this publication is deployed on IIS and has been working uninterupted for more than 2 years.

V. CONCLUSION

Almost all economic and non-economic systems are in need of certain types of record keeping. Application of RFID technology to support web applications represents an effective solution for the automation of the recod-keeping system. Such systems, currently in existence, differ mainly in terms of the environment in which the application is developed and the type of RFID technology components employed, which depend on the specific application. The main advantage of these systems is the consistent business-process-related data which is integrated into a database, facilitating the maintenance of data, data storage, reducing the time required for recording, providing access from different locations via the web and increasing the reliability and security of the data at a higher level.

The development of the application presented in this paper has been incremental. The development began with the idea of recording working hours, but is presently provides the users with a lot more options. The daily use of the application, serves as a perpetual source of new ideas for the development and modifications, which increase the functionality and the usefulness of the application. Concretely, the functionalities related to management of table data can be extended with specific columns, and thereby the user may at one point have a clearer insight into certain functionalities. Functionality of the projects and implementation of them could be integrated into a single functionality with a larger number of columns that reflect the overall state of the project. The practice is that the best ideas come as customer requirements, and the application is open to continuous improvement and adaptation to the demands of clients.

Another possible direction for further development of the application is to include additional responsive utilities to achieve mobile-friendly look and feel.

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