DENTAL UNIT MANAGEMENT SYSTEM USING ONLINE DATA TRACKING SYSTEM (ONLINE DENTAL UNIT DATA ASSESSMENT SYSTEM)

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ABSTRACT

Research and development for the design, improvement of dental unit structures and online display systems among the College of Biomedical Engineering. Rangsit University and CC. Auto Parts Co., Ltd., a manufacturer of medical devices in Thailand. Most of the operators have found factors affecting the stability of their businesses in many areas, such as persistently high import costs from the global economy, slowness in the import of various equipment. And slow maintenance service in remote areas which is of utmost importance. The entrepreneurs have the idea to reduce the cost of importing about 80-90% and want to improve the efficiency of the dental unit to be up to date, easy to keep track of maintenance information. This research has designed a system to monitor and display online in a Web Browser format, such as water supply pressure range 2-8 Bar, Main air pressure range 4–12 Bar, air pressure of the scraper range 2 - 6. Bar, main voltage range 184-240 VAC., Hydraulic current range 100-300 mA., Vale water current, gargling range 100-300 mA., Lamp current range 100-300 mA., HL Oil level, and Safety Switch, which can save data to the server at a specified period of 1-30 minutes, initially researching and developing a prototype dental unit for testing the accuracy of control and transmission of data. With an online display system Including the safety system of the dental unit during operation with a domestic cast iron construction measuring 640 x 2,500 x 750 mm. It can support weight up to 150 Kg. The system is tracked and displayed online. In the form of a Web Browser.

Keywords: Dental Unit, Assessment System, Monitoring System, Online System.

1. INTRODUCTION

Today dental clinic business in Thailand expands rapidly and most business operators, around 80%-90%, imported dental units for sales including C.C Autopart Co.,Ltd, an operator who distributes and installs dental units across the regions of Thailand. Over the past 10 years until now, C.C. Autopart Co.,Ltd. has encountered factors affecting business security in many aspects such as the continuous rising of import costs, delay in importing equipment, and delay in provision of services and maintenance, considerably affecting service provision and customer satisfaction. C.C. Autopart Co.,Ltd. is aware of problems and obstacles in using dental units. Therefore, the company collaborates on conducting research and development to improve a dental unit structure, control system, and warning system with College of Biomedical Engineering, Rangsit University by using domestic cast irons so as to reduce import costs and the equipment can bear much weight up to 150 kg. Modern electronic devices easy to find in the country are used while operational situations of electrical system, water pressure system, and air pressure system of a dental unit can be tracked continuously and rapidly via an online data output system, convenient for planning preventive maintenance and engineers are able to trace data and make coordination for solving problems initially over the phone with customers, enhancing after sales service to achieve a more efficient, convenient and speedy manner.

2. DENTAL UNIT COMPONENTS

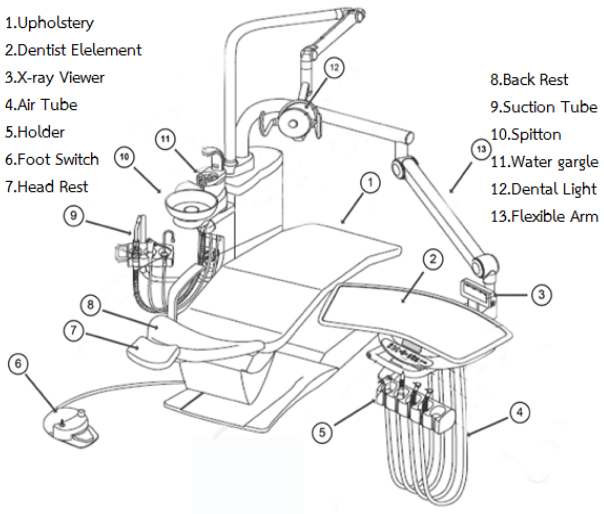

Figure 1. Dental Unit Components

There are 13 components in a dental unit as seen in Figure 1. In this study, 7 major components are developed as follows:

1) Dental patient chair; it comes with a Z-Type structure and its back can be adjusted to place a patient in reclining, sitting, or lying positions, equipped with

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occipital prominence support for a patient's head, preset and auto return system (Zero position), and safety plate.

2) Dental operator stools and chairs must not have any sharp edge and corner that can do harm to patients and dental personnel.

3) Dental light that illuminates the oral cavity of the patient is the light without heat. Intensity of light within a focus distance is not lower than 13,000 and not greater than 28,000 lux, color temperature ranges between 3,600-6,500K (Degree Kelvin). The focus distance at a working area is not less than 50 centimeters. The lamp is secured for vertical and horizontal adjustment.

4) Spittoon is made of materials resistant to cleaning and disinfection. The spittoon is not damaged or has any mark of defect after the application of cleaning agent or disinfectant as recommended for 20 times. Water level automatic system to control the amount of water supplied to the cuspidor cup is available in both weighted control and time control.

5) Aspirator system; high volume suction source vacuum should be set not lower than -80 mmHg. A saliva ejector and high-volume equipment are used at the same time automatically.

6) Compressed air system should provide air pressure suitable for the operation of dental unit with enclosure and protective covers including a pressure relief device to facilitate excessive pressure that can occur in every part.

7) A dental drill control system is equipped with first priority system and non-return valve system. The amount of water and compressed air in a dental drill can be adjusted by a needle valve and a compressed air gauge used for a dental drill is available.

3. METHODS FOR DENTAL UNIT DEVELOPMENT

The development process of dental unit and online data tracking system is implemented in each part such as a design of dental unit structure, a design of a control system and online data output system.

3.1 Design of dental unit structure

Characteristics of the structure and function of a dental unit chair developed from Figure 2:

1. The structure of an existing dental unit previously made of welded steel is developed to be made of cast iron. Design and production are made domestically and the size is 640 x 2,500 x 750 mm. which can bear much weight to 150 kilograms.

2. It can be raised and lowered by a hydraulic system, making the adjustment is soft and smooth. It is strong, durable, and capable of bearing much weight.

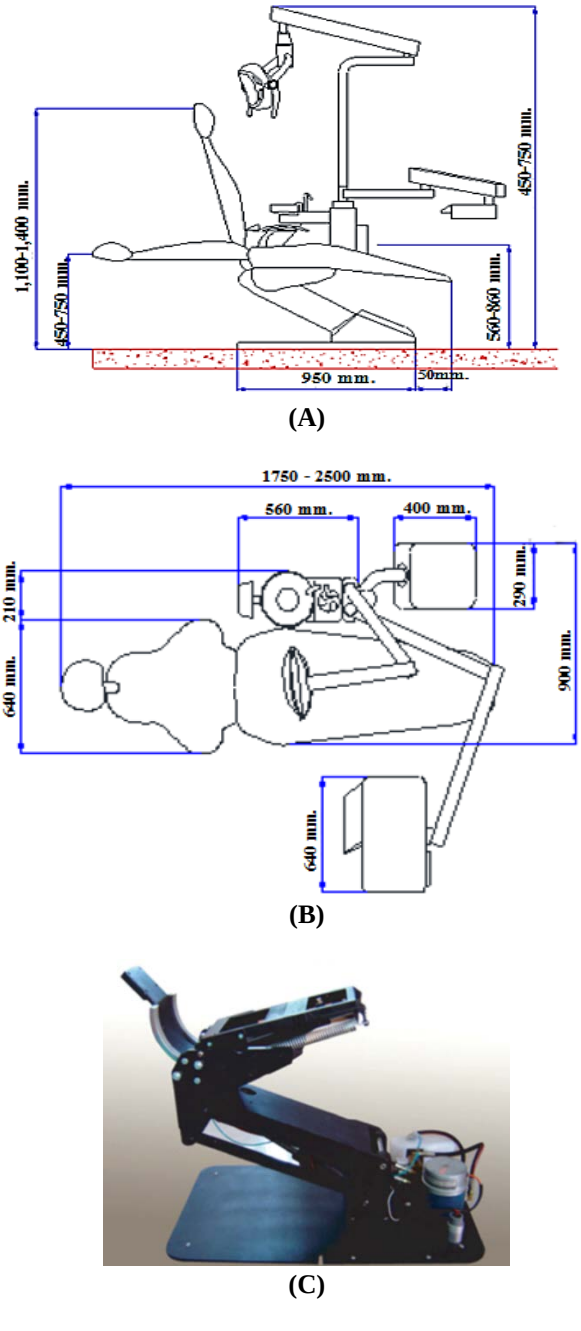

Figure 2. A design for dental unit development
(A) Structure design of the side views
(B) Structure design of the top view
(C) Structure formation in cast iron

3. A spittoon is developed to be rolled away from the chair up to 90 degrees.

4. A safety switch system is equipped with the patient dental chair that can prevent the chair to press on objects. Beneath the chair base, an emergency switch system is installed to control a manual chair in case of errors in a microprocessor control system.

3.2 Diagram showing the design for the operation

Diagram showing the design for the operation of the control system and online data transmission system.

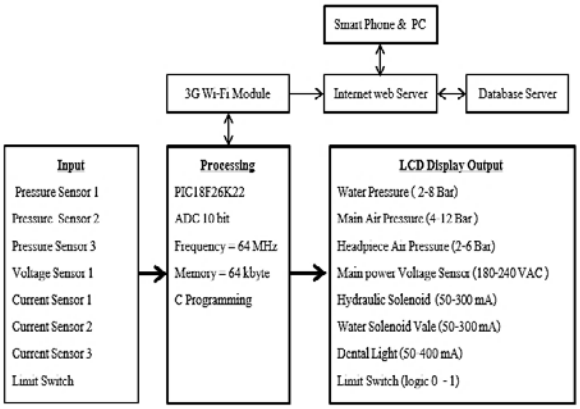

Figure 3. Shows the operation of a control system and online data transmission system

The development of characteristics in terms of the control system and data transmission of a dental unit from Figure 3 is detailed as follow:

1. The control system is developed using C programming language and microprocessor PIC18F26K22, 10-Bit ADC, 64 Kbytes of internal memory. This dental unit is equipped with sensor input devices to control and trace data output of important systems in the dental unit such as tap water pressure, main air pressure, air driven dental handpiece, input voltage, hydraulic electrical current, electrical current of water mouth rinse valve, electrical current of lamp, HL oil levels and safety switch. The devices consist of 3 pressure sensors (0-12 Bar), 1 voltage sensor (184-240 VAC), 3 current sensors 5 A., and 2 limit switches. The operation control program of the dental unit can be operated through the following functions:

1.1 Microprocessor controls the hydraulic system to adjust the dental chair in reclining, sitting, and lying positions.

1.2 The system shall remember 4 positions of the chair adjustment, enabling a user to press only one button and get the right position that was set up in advance for more convenience to start working.

1.3 The microprocessor system shall control the water system of water mouth rinse valve and the water system of the spittoon.

1.4 The lighting control system of the dental unit.

1.5 The dental drill machine control system can increase or decrease speed according to the amount of compressed air.

2. The development of the microprocessor to be able to connect to 3G Wi-Fi module and database server to transmit data measured by the sensor input devices to control and trace data output of the dental unit such as tap water pressure between 2-8 Bar, main air pressure between 4-12 Bar, air driven dental handpiece between 2-6 Bar, input voltage: 188-240 VAC, hydraulic electrical current: 100-300 mA, electrical current water mouth rinse valve :100-300 mA, electrical current of lamp: 100-300 mA, HL oil levels and safety switch.

This system can show data output through a web browser based on a responsive web design accessible from mobile phones, laptops, PC.

3.3 System architecture

Figure 4. Shows the system architecture

The experiment is to test the efficiency of the proposed prototype. It can be divided into 3 sections which are heating rate of fluid warmer prototype, temperature holding of fluid warmer prototype and temperature of saline after warming.

The dental unit system using online data tracking system comprises various sensors that measures required values in the dental unit and data from the dental unit are transmitted to a cloud server to store the data at MySQL database and users can open the system to trace data of the dentally unit through a computer, iPad, and smartphone. Levels of users are categorized as system administrator, biomedical engineer, and dental personnel to enable them to retrieve dental unit data in real time.

3.4 Division of the sum of total data using total data

Division of the sum of total data using total data can be calculated by the formula:

$$\bar{X} = \frac{\sum x}{n} \quad (1)$$

where $\bar{X}\bar{X}$ is Mean

$\sum x \sum x$ is the sum of all of the data values

n is Total of all data

4. RESULTS

4.1 Function test result of the operation control system of the dental unit

Table1: Shows test results of characteristics of internal equipment of the dental unit

List of data	Value in test	Mean (n= 5)	Results
Tap water pressure	2.00 Bars	2.220 Bars	Normal
	8.00 Bars	8.220 Bars	Normal
Main air pressure	4.00 Bars	4.663 Bars	Normal
	12.00 Bars	11.663Bars	Normal
Air driven dental handpiece	2.00 Bars	2.950 Bars	Normal
	6.00 Bars	5.663 Bars	Normal
Input voltage	220 Volts	225.15 V.	Normal
Hydraulic electrical current	100 mA.	100.05mA.	Normal
	300 mA.	300.15mA.	Normal
Electrical current water mouth rinse valve	100 mA.	100.62mA.	Normal
	300 mA.	300.35mA.	Normal
Electrical current of lamp	100 mA.	100.33mA.	Normal
	500 mA.	500.07mA.	Normal
Leakage of electrical current	≤ 500 uA.	115 uA.	Normal
Highest level of adjustment at 45 cm. according to changes in load bearing.	50 Kg.	45 cm.	Normal
	100 Kg.	45 cm.	Normal
	150 Kg.	45 cm.	Normal

4.2 Data output of Login into the system

To log in to the system, a user name and password are required every time to identify a person is authorized to operate the system as seen in Figure 5.

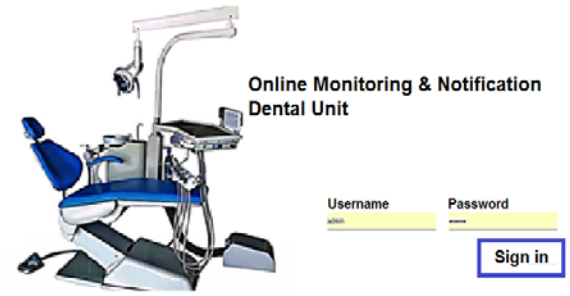

Figure 5. The page of login into the system

4.3 Data output of configuration setting of the operation control system through the online system

Configuration setting of the electronic equipment that control the internal operation of the dental unit can be implemented through the online system as seen Figure 6.

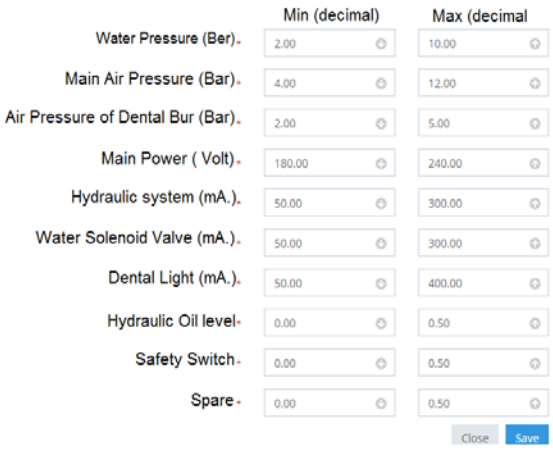

Figure 6. Test of data output of the operation control through the online system

4.4 Operational performance of the system through the online system

As for the operational performance of internal electronic equipment of the dental unit, users can trace the operational performance of the electronic equipment through the online system as seen in Figure 7.

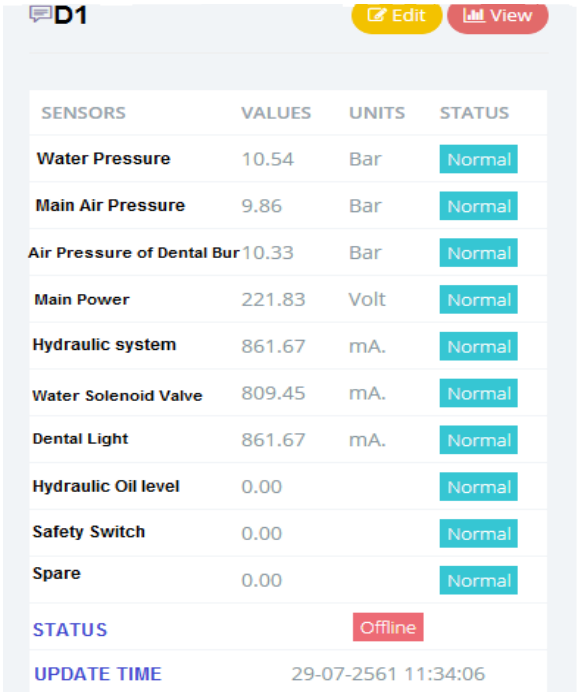

Figure 7. Operational performance of the electronic equipment through the online system 3.3 Data Dictionary of Nursing License

5. CONCLUSION AND DISCUSSION

Based on the development of dental unit and online data tracking system shows the test results as seen in Figure 4 and 5 which the size of dental unit structure made of cast iron is 640 x 2,500 x 750 mm., it can bear the maximum weight up to 150 kg. Microprocessor PIC18F26K22 is used to control and the following sensor input devices are used to measured values; 3 pressure sensor (0-12 Bar), 1 voltage sensor (184-240 VAC), 3 current sensors 5 A, and 2 limit switches. All equipment's are installed to connect to 3G Wi-Fi module and database server to transmit data measured by the sensor devices for controlling and tracing data output on the basis of a web browser and data are stored in a server according to the specified periods of time from 1-30 minutes such as tap water pressure between 2-8 Bar, main air pressure between 4-12 Bar, air driven dental handpiece between 2-6 Bar, input voltage: 188-240 VAC, hydraulic electrical current: 100-300 mA, electrical current water mouth rinse valve :100-300 mA, electrical current of lamp: 100-300 mA, HL oil levels and safety switch. The system can be accessible from mobile phones, laptops, and PC. As for the function test result of the dental unit prototype, the research team selected a topic serving a basic standard test in accordance with Thai Industrial Standard TIS. 2610-2556. The overall test results in terms for mechanical and electrical approaches are compliant with the standard specification as detailed in Figure 5. Therefore, it can be seen that the study and development of the dental unit prototype and online data tracking system adopted modern technologies for convenient utilization and maintenance planning which can be developed to production for commercial purpose in the future so as to minimize importation from abroad.

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