A SECURE DISPENSER UNIT WITH BIOMETRIC SECURITY SYSTEM

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Abstract - Medical/Chemical Industries have a challenge in calculating the amount of chemicals that is being dispensed, our goal is to develop a secure, automated dispenser system using Atmega 1284 microcontroller and Raspi along with TLS and biometric security for safety measures with usage track and control of the fluids where the dispensers would have Ethernet connectivity and hence this would be possible to connect it to a Desktop PC or can be handled over the internet. The Desktop PC would have a Application running which would make handshaking with the dispenser as soon as its connected to the network and starts requesting liquid dispensed data. It would request the dispensed data depending on the configured time in the application. Later the data can be plotted onto a chart and provided as a report.

I. INTRODUCTION

A dispensing system is a system designed to respond to the user's instruction to dispense the liquid. In today's era when precise, accurate and time efficient systems are in great demand, automated techniques supersede manual practices. As a need of time, we introduce a , automated, cost effective, yet reliable and efficient system of fluid dispensing. Our prototype system can dispense varying amounts of fluids in milliliters (maximum 1L) as per demand of the user. In earlier days the dispensing systems were used in the medical field for storing and dispensing the medicines. Now a day's many harmful chemicals are used in industries for various purposes. These chemicals can cause harm to human beings if they come in direct contact. This is the purpose for the automatic dispenser unit. It can also reduce the manpower used for each application. Ammonia is a chemical that is used in textile and industrial refrigeration industries. This can cause lung problems and coughing etc. Another example is arsine which is used in semiconductor industries. This can cause rapid poisoning and skin problems. These are a few examples of chemicals that are used in industries but are harmful for human beings. Here we discuss about an automatic dispensing system along with TLS for safety measures and a system log to give information of the liquid that is in the system and the amount of the liquid that is dispensed. Here we use a Ras pi to improve the efficiency and cost effectiveness of the system.

II. EXISTING SYSTEM

In earlier days the dispensing systems were used in the medical field for storing and dispensing the medicines. All systems are hardware based ,place consuming, difficult to operate and high cost manegment. A literature survey provided us with a spectrum of automated techniques used for fluid dispensing along with several designs of dispensing systems proposed by various inventors but they all lacked the features of a pump and the ability for the user to control the quantity of liquid being dispensed. Also lack of security features where the fluid data is vulnerable in the network.

III. PROPOSED SYSTEM

Our work presented here is about the design and implementation of a cost effective, reliable and flexible prototype of a secure automated adjustable fluid dispensing system. The Flow sensor based dispensing technique along with the property of the Atmega1284 microcontroller and Raspi with encryption of fluid data in the network when connected to Aggregator.(Personal computer / Server , laptop) is employed and the designed system can be used in clinical labs , chemical laboratories and pharmaceutical industry. To satisfy the principle used and verify the system's accuracy, fluids of varying viscosities were dispensed and monitored. The experimental results of the fluid dispensing system when tested showed linear relationship between the dispensing time and desired volumes of fluids having differing viscosities. The added feature of biometric security for user authentication for accessing the dispenser and tls to securely exchange the dispenser liquid consumed data to the pc application and pc application stores and maintains the dtabase. Ras pi also improvse the efficiency and cost effectiveness of the system.

IV. METHODOLOGY

The low cost fluid dispensing system is developed using microcontroller “Atmega 1284” with port connections and controls and also Raspi which takes care of encryption of fluid data in the network when connected the dispenser to the Aggregator.(Personal computer / Server , laptop).The flow of the system is programmed in Embedded C language. The principle utilized for dispensing precise, accurate and user defined volumes of fluids is based on flow sensor dispensing i.e. the amount of fluid to be dispensed will be determined by the rotation taken by that fluid in sensor to dispense completely. By a series of experiments, an average rotation was determined to dispense a fluid having a volume of 1ml. This caliberated rotation was loaded in the micro controller through programming to control the opening and closing of solenoid valve along with the working of the pump. We aimed to investigate the working accuracy of the fluid dispenser by dispensing three different fluids having increased viscosities in the order of less viscous, slightly viscous and highly viscous fluids. A separate number of rotations was measured for each type of fluid to be used in programming. We also tested the optimum security working range of our developed prototype using the biometric security system that is fingerprint authentication of the user who wants to access the dispenser and also the TLS to secure the dispenser fluid data in the network.

- **SYSTEM COMPONENTS**

The system hardware involved in the development of the secure fluid dispensing system is shown in Figure 1

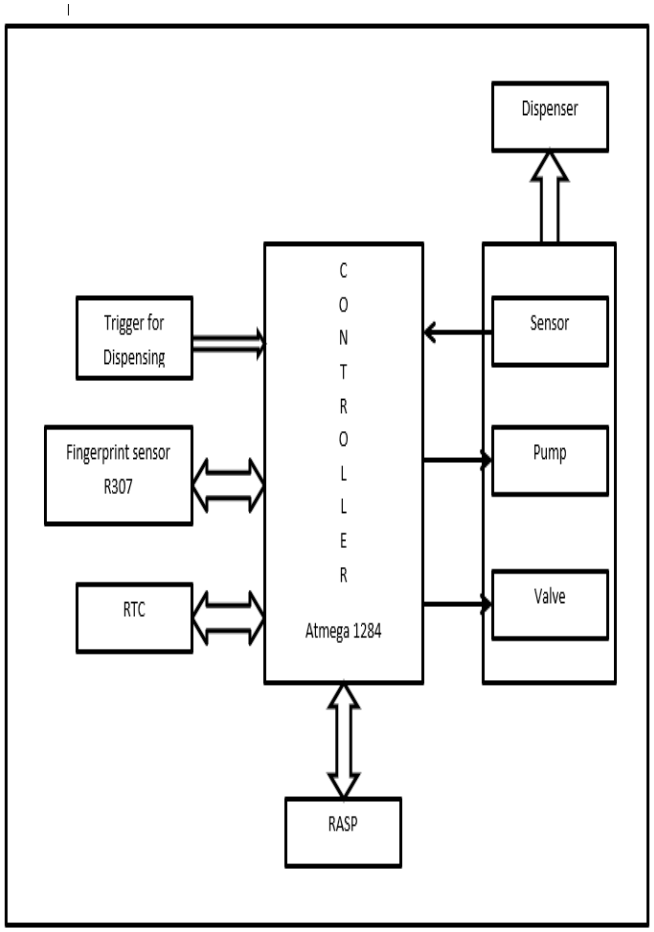

Fig. 1. Components involved in the development of secure operated fluid dispensing system

- 1. Microcontroller (Atmega 1284)

The high-performance Microchip 8-bit AVR RISC-based microcontroller combines 128KB ISP flash memory with read-while-write capabilities, 4KB EEPROM, 16KB SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a real time counter, three flexible timer/counters with compare modes and PWM, two USARTs, a byte oriented 2-wire serial interface, an 8-channel 10-bit A/D converter with optional differential input stage with programmable gain, programmable watchdog timer with internal oscillator, SPI serial port, a JTAG (IEEE 1149.1 compliant) test interface for on-chip debugging and programming, and six software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

- 2. Water Flow Sensor

Water flow sensor consists of a plastic valve body, a water rotor, and a hall-effect sensor. When water flows through the rotor, rotor rolls. Its speed changes with different rate of flow. The hall-effect sensor outputs the corresponding pulse signal. This one is suitable to detect flow in water dispenser.

- 3. Pump

A 5 V dc pump was used to draw the fluid contained in the dispenser. The working of the pump was controlled by the controller from port A pin 7 through a driving circuit containing a L293D H bridge.

- 4.Solenoid Valve

At the end of the reservoir tubing a 12 V dc solenoid valve was housed to control the flow of liquid to be dispensed. It is controlled by controller port A pin 6 via a driving circuit made of a 5v SPDT relay and a L293D H bridge. After dispensing

the programmed fluid volume, the valve closes automatically. Upon pressing the dispenser button, the controller opens the solenoid valve, hence opening the flow tube.

- 5. Raspi

Raspi is connected to the Atmega 1284 via UART interface and messages are exchanged regarding setting up of RTC with the current time and finger print scanner with the finger prints from the data base also query dispensed fluid data from the controller. It's also connected to the aggregator through Ethernet interface. And UDP and TCP (over TLS) messages are exchanged between the two.

- 6. RTC

A real-time clock (RTC) is an IC that keeps an updated track of the current time. This information can be read by a microprocessor, usually over a serial interface to facilitate the software performing functions that are time dependent. RTCs are designed for ultra-low power consumption as they usually continue running when the main system is powered down. This enables them to maintain current time against an absolute time reference, usually set by the microprocessor directly.

- 7. Fingerprint Sensor (R307)

R307 Fingerprint Module consists of optical fingerprint sensor, high-speed DSP processor, high-performance fingerprint alignment algorithm, high-capacity FLASH chips and other hardware and software composition, stable performance, simple structure, with fingerprint entry, image processing, fingerprint matching, search and template storage and other functions. The R307 fingerprint module has two interface TTL UART and USB2.0, USB2.0 interface can be connected to the computer; RS232 interface is a TTL level, the default baud rate is 57600 , And microcontroller with a connection, 3.3V 5V microcontroller can be connected directly. Needs to connect the computer level conversion, level conversion note , embodiments such as a MAX232 circuit.

- 8. Trigger for Dispensing

The trigger for dispensing is by a push button. It's connected to the controller via port B pin 2. On press of it. It triggers an interrupt on the controller that checks if the finger print is already authenticated. If authenticated pump and valve are triggered and water dispensed is calculated from the flow sensor.. If finger print is not authenticated red led glows to indicates failure in authentication.

V. SYSTEM OVERVIEW

The system setup involved in the development of the secure fluid dispensing system is shown in Figure 2

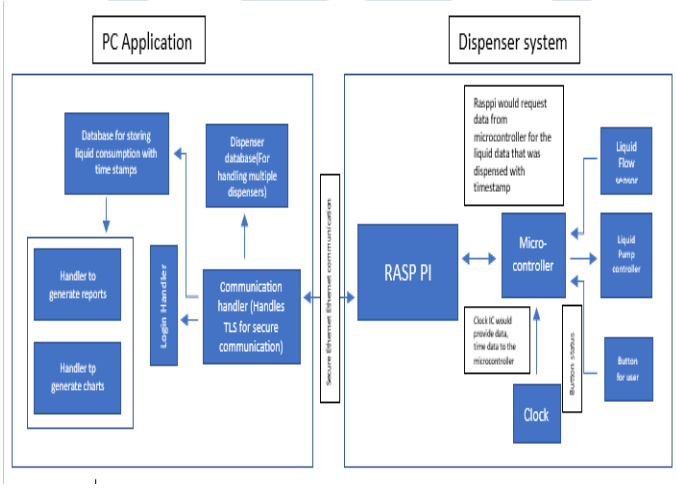

Fig 2 - System setup involved in the development of the secure fluid dispensing system

- DISPENSER SYSTEM :

When user presses the dispensor button the liquid pump is turned on and also the microcontroller starts reading data from liquid

flow sensor. Once the button is released the total amount of liquid dispensed is stored in RAM with that also the time and date is taken from clock and stored on RAM. Rasppi would request the data from Microcontroller when a request is obtained to it from PC. Here Rasp pi is mainly used for Secure Network handling as it would handle the TCP(Over TLS)/UDP communication and sensor handling is done by Microcontroller.

- PC APPLICATION :

When a dispenser is connected to the network, and its identified, a login Page is provided where user need to login using credentials and then the dispenser information (What chemical/liquid) is added onto the data base of the Application running on PC. Then Application starts requesting data from the dispenser every few seconds once by opening a (TCP over TLS) communication. And stores that data onto the another Database. This is later requested by the Report/ Chart generators to generate reports that admin would request.

VI. RESULTS AND DISCUSSION

The testing was performed on the developed equipment to determine the relationship between the volume of fluid and the rotation taken by the sensor to dispense the required volume into a graduated flask. For this purpose, the experimentations were carried out iteratively on less viscous, slightly viscous, and highly viscous fluids for the user defined volume fillings in a series of marked vessels. Three different volumes of each kind of fluid were taken with a 100 ml gap between each volume sample. We observed a linear relationship between the volume of the fluids and the rotation taken by the sensor to dispense those fluids . It also describes that increased number of rotation was required to fill highly viscous fluid for a given volume as compared to slightly viscous and less viscous fluids. For instance, the rotation of the sensor taken to fill the 400 ml volume of more viscous fluid was double then slight viscous and less viscous fluids. This shows that there occurs a direct relationship between the number of rotation of sensor taken to dispense a fluid and its viscosity keeping the volume as a constant variable. The more viscous a fluid is, the more rotation it takes to flow and to be dispensed.

The system was also checked for its Security operability using the Fingerprint R307 module for the user authentication for accessing the dispenser. When the false fingerprint was placed we noticed that there was no actions of fluid dispensing that took place in the system. It demonstrated satisfied and accurate working of the secured prototype dispensing system. Raspi setup provided with a lot of flexibility to the user in terms of fluid Encryption using tls in the network. At the same time, the sensor based dispensing along with the PC application method reduced the hardware and cost of the dispensing system which would otherwise increase if volumetric positive displacement piston pump or time-pressure dispensing techniques were employed.

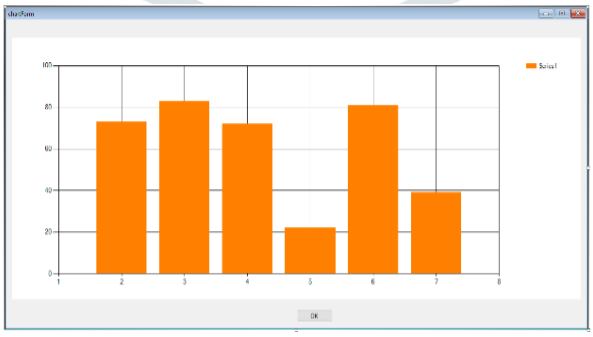

Fig 3 - Plot representing the relationship between the volume of the fluid (ml) and the rotation of the fluid in sensor required to dispense the fluid.

VII. CONCLUSION AND FUTURE WORKS

A secure adjustable fluid dispensing system was successfully developed in connection to a prospective usage in the pharmaceutical, food and beverage companies and clinical labs for sensor based dispensing of different fluids with varying viscosities. It allowed

its operator to control the working of the system through a PC application other than the feature of on-site hardware operation. Future modifications include wireless and distant control of such systems by distance enhancement beyond 15 meters and dispensing lesser fluid volumes ranging below 1 ml. Remote distance monitoring and control features can be achieved through the use of programmable logic controllers; and their enhancement by supervisory control and data acquisition (SCADA) for potential studies. The decrease in pump size and tubing system will allow micro liter fluid dispensing desired for micro level applications Prospective studies will also emphasize on enhancing system accuracy.

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