Pharmacological Delivery Automation, Chronological Drug Administering and Supervision System

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Abstract- Pharmaceuticals is considered to be a vital field in health care industry. It plays a vital role treatment of any diseases. The application of robotics can revolutionize this field with its striking set of advantages as there is a vital role for robotics in the complex acts of research and development, production, and packaging. Robots posses traits like improved worker safety, improved quality, speeding up the drug discovery or delivery process. Drug Production Robotics is considered to be vital in the manufacture of medicines because higher speed and accuracy is critical in this field. Many medical components such as syringes, inhalers, IV bags and diabetes testing kits are manufactured with the help of robotics. The interdisciplinary reputation of robotics has revolutionized numerous fields of its involvement. Pharmacology is addressed to be one such field that inherits its vast possibilities, versatility and virtues. It's alone a rapidly expanding domain in health care fields. Hence the application of robotics in pharmacology systems has ignited an ample array of possibilities and improvements compared to the conventional systems.

Index Terms- Pharmaceuticals, Robotics, Automation, Microcontroller, PIC-Controller

I. INTRODUCTION

Robotics is the branch of technology that involves design, construction, operation, and application of robots. Robots have the ability to perform tasks at accuracy, precision, and speeds beyond human capability. It deals with the designation, construction, operation and application of numerous systems like mechanical, electrical, electronics, software, and information technology which are interrelated in a constrained approach so as to achieve the designated function of the system. Its interdisciplinary reputation has revolutionized numerous fields of its involvement. Pharmacology is addressed to be one such field that inherits its vast possibilities, versatility and virtues. It's alone a rapidly expanding domain in health care fields.

Robotics have emerged and advanced at an exponential rate since the initiation of the 20th century. These robots function in potentially hazardous conditions and in exposure to biological dangers, radioactive contamination, and toxic chemotherapy compounds. Possibly the greatest benefit of robotics in fields of pharmacology is the elimination of wrong dosage, wrong medication, and other errors due to human mistakes. Large hospitals have hundreds of beds and numerous wards. Hence it can be difficult to keep track of medication's flow from pharmacy to patient. Automated systems make such tracking more efficient. But smaller hospitals do not have the capital necessary for the high costs of installing such automated systems. However, there is a shift towards such systems, which means costs will be going down in time.

The design of medicine collector robot uses engineering method. In sequence, the method is identification of the needs required. Then these needs are analyzed to get specific components. The operation of the robot can be classified into three main categories. They are motion control of the robot, medicine collection.

II. LITERATURE REVIEW

The Estimates for the number of medical human errors that occur in hospitals in the United States alone was almost 400,000 in 1999 [1]. Studies also show that medical errors are the third leading cause of deaths [2]. The occurrence of drug prescription errors is 7%, affecting 2% of patients per day and 50% of hospital admissions. [3] Conversely, a systematic review indicated that approximately 10% of errors involving drugs corresponded to administration errors. [4] Application of robotics in pharmacological systems have proven to be a breakthrough in the drastic reduction of errors, elimination of wrong dosage or medication, efficient tracking of flow of medication from pharmacy to patient, eradication of any errors majorly contingent on human mistakes and also frees staff time. [5] As per the statistics obtained by Ray Fitzpatrick [6] and his co-scholars, the existing systems presently in application an automated pharmacy dispensing system can take up $2m^3$ lesser space, 16% reduction in errors during the final checks, and improved service quality. Similarly a case study conducted by Roderick J Beard and Peter Smith [7] also states that the electronic systems performed perfectly and produce absolutely no dispensing errors in action. De´bora de-Carvalho et al [8] also stated in their impact assessment of automated drug-dispensing systems to be positive. Despite all the positive virtues, these systems are expensive and may not be

affordable for application by smaller hospitals as per the observation stated in the study of recent trends in these sectors done by Lakshmi Teja et al. [9] Taking these facts into account an expansion of robotic pharmacological systems that starts from drug inventory management, prescription interpretation, fetch and delivery, to the patient's medication routine management, analysis and recording can result in a drastic improvement in pharmacology efficiency, effective treatment, and healthcare service quality. All these systems may add up the expenditure on the robotic system, but on the contrary it ensures an all-round excellence in healthcare quality. Hence we came up with a proposal for a prototype that covers all the above-mentioned tasks.

III. PROJECT DESCRIPTION

The proposed prototype includes Inventory Management, Prescription Interpretation, Robotic Retrieval, Drug Delivery, and Patient Monitoring Systems. All the systems are interdependent and function with the help of a Central Processing Unit (CPU) that works on Closed Feedback System to ensure precision of functioning. The processing capability of the CPU varies with the capacity of Hospital in which it is applied. A high-end CPU is applied for an enormous medical institution and smaller CPU for minor clinics. A block diagram of the system architecture is as follows.

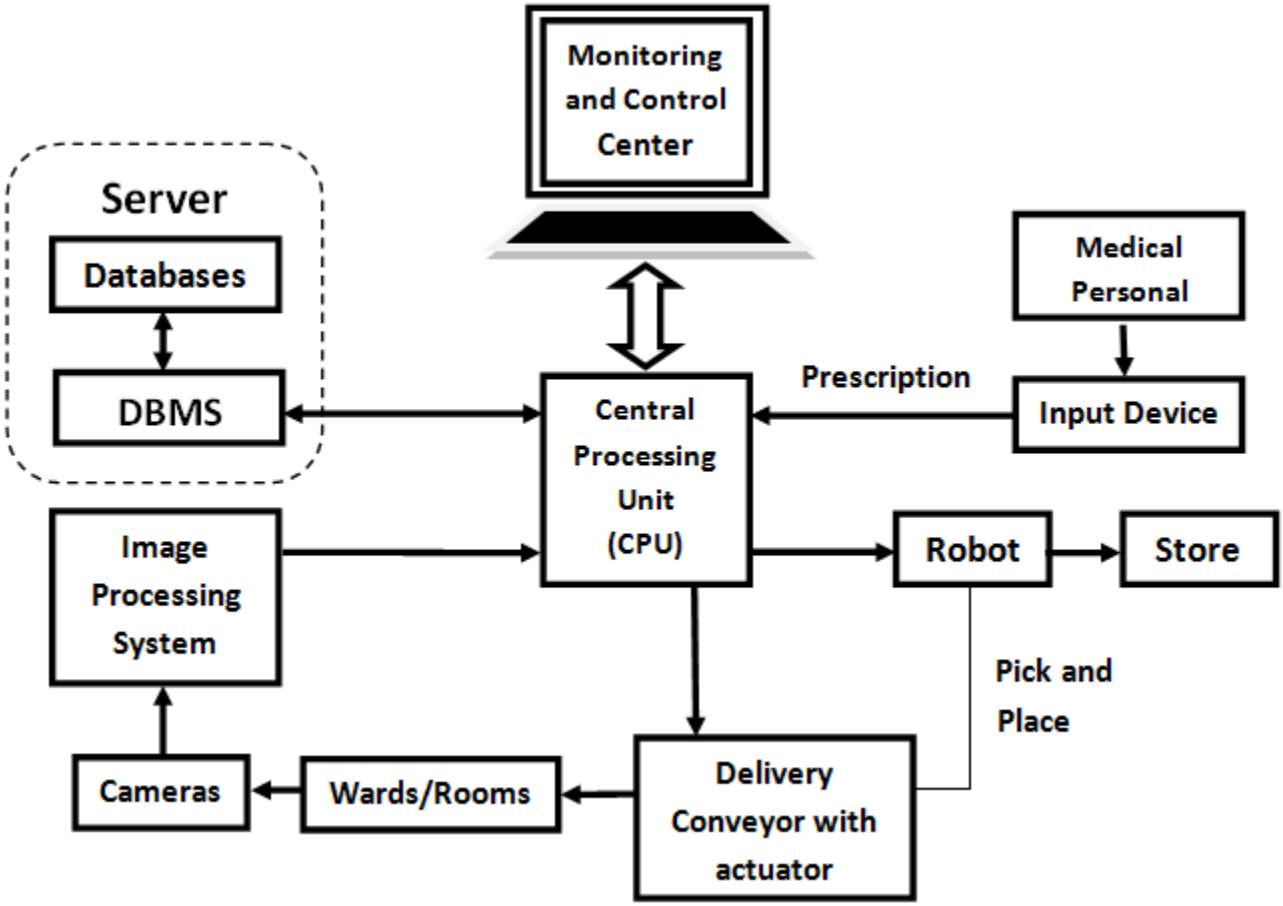


Figure 1: Architecture of the Pharmacological System

IV. CONSTRUCTION

The system consists of a Central Processing Unit that controls every other components in the system. It has a server that holds the database that includes the drug inventory, drug locus data, patient records, memory and the programs that are required for the functioning of the whole system. It also contains a DBMS (Database Management System that interfaces the CPU with the server databases. The CPU accesses the Database through the DBMS in the server. An input device is connected to the CPU to input the prescription data of the medicines. These devices may be a bar-code reader or other input options. The CPU is connected to the electro-mechanical robot that retrieves the medicine specified from the store. The CPU is also interlinked with the delivery conveyor that reaches every room with a hydraulic actuator for every room to drop medicine in the room's hopper. The rooms in wards are incorporated with a number of cameras that records photographic images at the time of patients' medicine intake routine. These cameras' connections converge at a image processing system which in-turn is connected to the CPU. The CPU then send master signals and information to the monitoring and control center which is under close supervision of expert medical personals.

The implementation of a part of the proposed system was done. The implemented part consisted of an input module, CPU, pick and place robot and the delivery conveyor system. The components include LCD Display for input, PIC Microcontroller, DC Wiper Motors to control the motion of the fabricated pick and place robot, Geared DC motor to control the gripper mechanism and conveyor motion, RFID Module for medicine identification, and Pneumatic System to perform medicine actuation of delivery to the rooms.

V. WORKING AND COMPONENT DESCRIPTION

A. Component Description

The following are the major components used in the implemented part of the system:

PIC Microcontroller:

A PIC microcontroller is a processor that is used as the CPU of the implemented part of the system. It consists of built-in memory and RAM. The microcontroller uses its memory and RAM to transmit or receive data, monitor, control and process the data required for its programmed function. Hence we do not have to build a circuit that has dedicated components like RAM, ROM and peripheral components. It also has many useful built in modules like EEPROM, Timers, Analogue comparators, and UART which adds to the advantage of applying a PIC Microcontroller as a CPU.

LCD Display:

LCD modules are very commonly used component in projects due to its cost effectiveness, availability and programming simplicity. LCD displays are used in almost every electronic system in our day to day life. We have used a 16×2 LCD display which is named so because; it has 16 Columns and 2 Rows in its display. Other combinations like, 8×1, 8×2, 10×2, 16×1, etc. are also available but the commonly used one is the 16×2 LCD. It has 32 characters in total and each character will be displayed with 5×8 Pixel Dots.

DC Wiper Motor

It is commonly used as wiper motor for cars and can also be used in the field of projects that require high power and torque. The motor speed is 55rpm and 12V operating voltage rated. It is capable of working for prolonged operation periods. It has 6mm screw holes for mounting on shaft and its gear is on left side of the motor.

DC Geared Motor

A DC Motor is any electrical device that converts electrical energy into rotational motion. It is of different types based of application, power supply, and speed. A DC Geared motor consists of a gearing mechanism that reduces the speed of a motor and converts the lost amount of speed into torque for application. The motor applied here is a 12V motor with base speed of 300RPM. The gearing gains a torque in rotation and also reduces speed to 100RPM which is optimal for our application.

RFID Module

RFID is Radio Frequency Identification Device. It consists of 2 parts namely reader and the RFID tag. The module we used is a passive RFID since the Card is active in power. The reader is supplied with a 5V DC supply for reading the card in identifying the medicine. It works on a frequency of 125 kHz and can sense up to 1 meter of range. It also has an output that is interfaced with the microcontroller to sense the card data and verify the medicine corresponding to it.

Pneumatic System

The pneumatic system consists of 2 parts namely the actuator and the control valve. Pneumatic systems use high pressured compressed air to function. The system we used requires a 3 bar pressure to work. The actuator is a double acting cylinder and the control vale is a 2 position, 3 ways, solenoid controlled Direction Controlled Valve (DCV). The solenoid is controlled by the microcontroller.

B. System Working

The process starts at the prescription point when a bar-code is read consisting of the prescribed data of medicine, intake frequency, dosage, etc. and encoded to digital format and sent to the CPU. The CPU accesses the server and writes the prescription data for the corresponding patient and then retrieves the locus of the medicines prescribed in the store. These datas are sent to the CPU and it

retrieves the motion programming of the robot in pharmacy store to retrieve the medicines from the memory in server. The robot follows the programmed instructions and retrieves the medicines and places them on the delivery conveyor. The CPU controls the actuator of the specified room in which the corresponding patient is admitted and once the medicines reaches the room through the conveyor the actuator drops the medicines into the room's hopper hence completing the delivery process. The patients' admission rooms are equipped with a number of cameras as per the requirement of the system. The sole purpose of these cameras is to monitor the patients' medicine intake routine. It obtains images whilst the patient takes a prescribed medicine. These images are sent to the image processing system for recognition of the medicine taken and the time at which the patient has taken the medicine. The image processor obtains the data related to these factors and sends it to the CPU which verifies it with the prescription data in the server. If the data matches with each other the patient record is updated with the medicinal intake data into the patient records. In case, the patient takes the wrong medicine at the wrong time, then the system sends an alert to the monitoring and control center which is closely monitored by a medical personal who alerts the nurses in the corresponding ward or room regarding the wrong medicine intake. All the above mentioned processes are closely monitored and the progressions of every single processes are monitored and its data feedback is supplied to the monitoring and control center to ensure proper functioning and for simplified maintenance in case of a component failure. The part of the system implemented performs functions from receiving input prescription, medicine retrieval and delivery of the medicine to the wards.

VI.BLOCK DIAGRAM

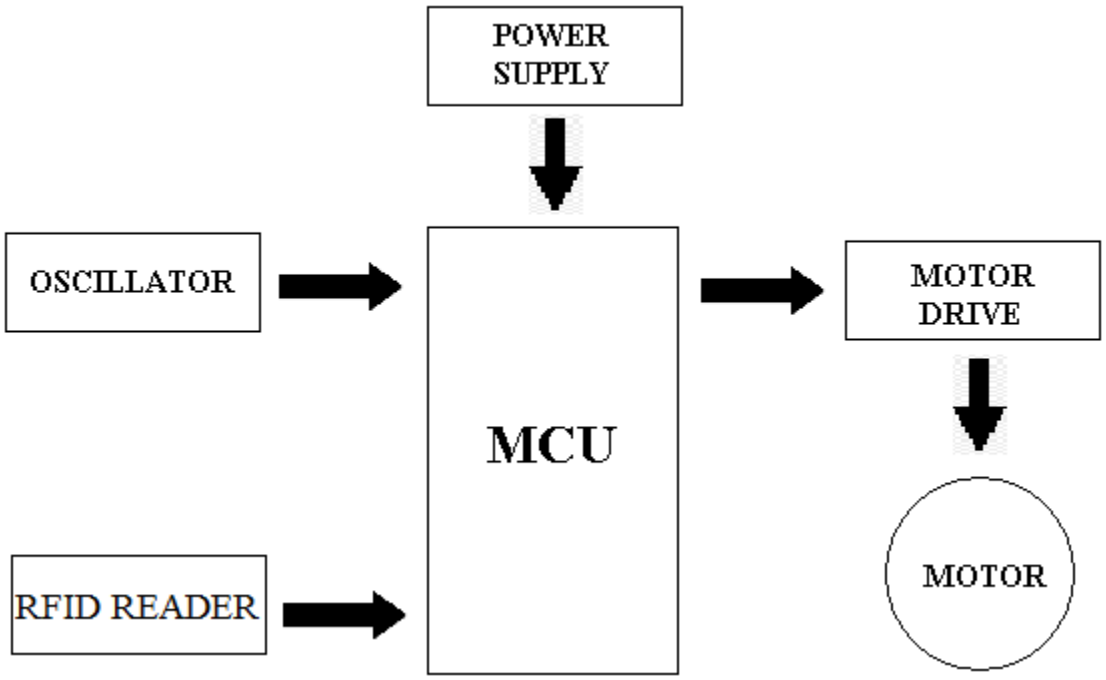
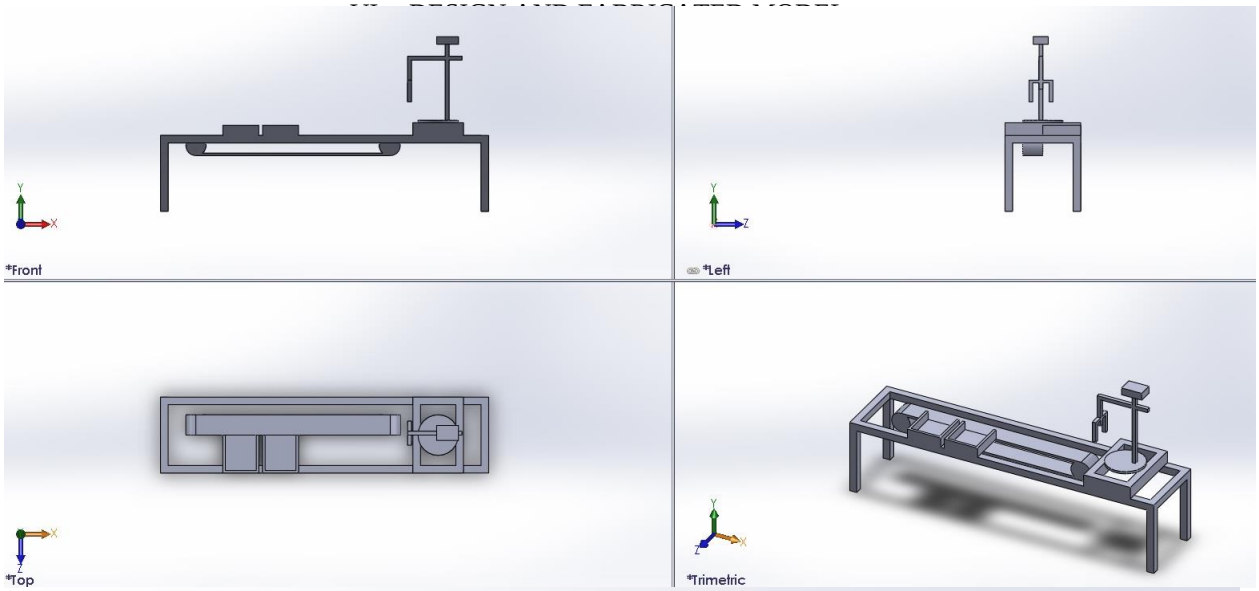


Figure 2: Block diagram of the implemented system

The block diagram shown above clarifies the data and signal flow in the implemented system. The Microcontroller (MCU) is powered by a 12V power supply and clock signals are given by the oscillator. MCU then draws data from RFID Reader and processed the data with respect to the input and controls the various motors necessary for functioning.



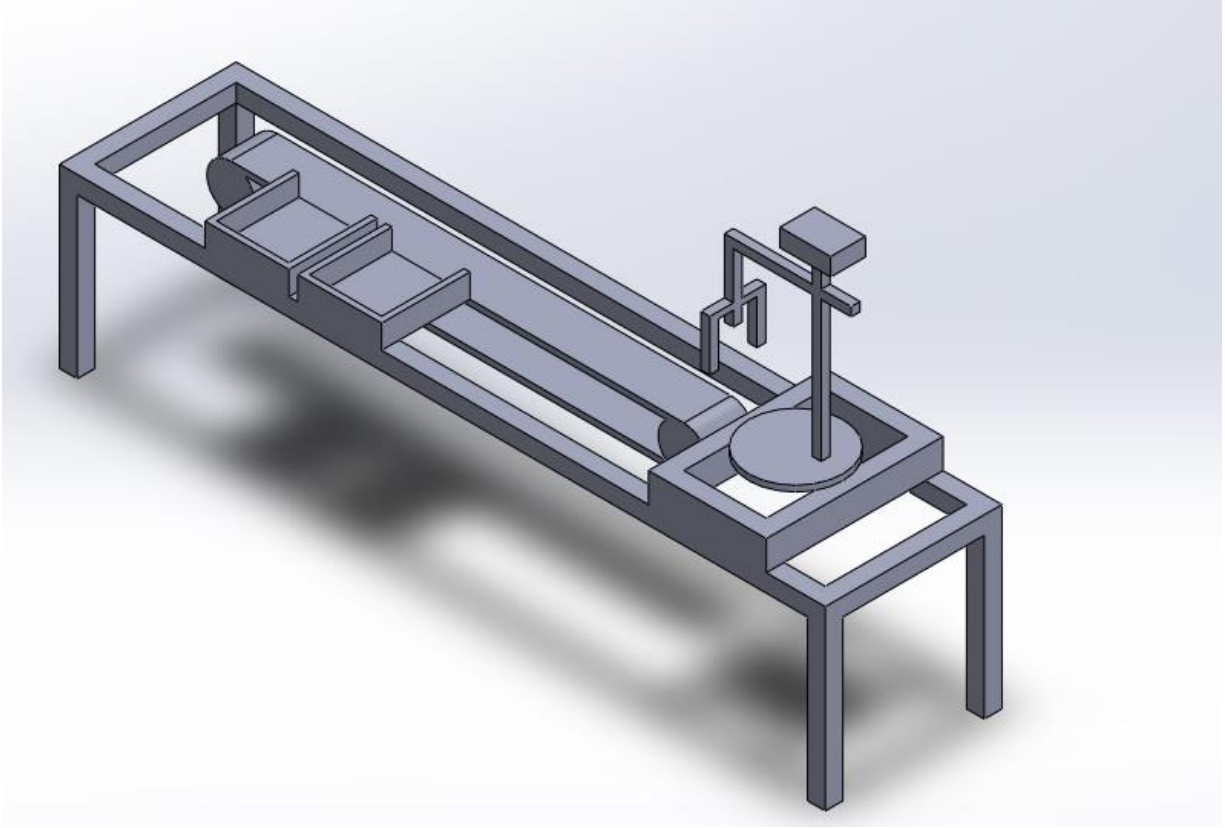


Figure 3: CAD Representation of the system

Figure 4: Implemented Working Model

VII. CONCLUSION

Considering the revolutionary breakthrough the field of robotics have achieved with time, this project, though containing complex systems that involve almost every basic streams of engineering have managed to prove highly efficient and effective in fields of pharmacology that has upgraded its face to a whole new level of perfection by maximizing efficiency and effectiveness along with minimization or nullification of errors leading to achievement of excellence in the healthcare industry.

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