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# RoMed - Robotic Vehicle for Pill Delivery

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**Abstract**: The objective of this project is to develop a robotic system –RoMed; for effective storage, dispensing and tracking of medication, that helps in better hospital management. The system mainly aims at helping patients in taking their medicines in correct dosages. The characteristic features of this prototype model include: reading of distribution details at the start of the day, loading of medicines from the available stock for multiple patients based on input data, distribution and delivery at corresponding rooms. It incorporates microcontroller with servo motors for the dispensing of medicines. The device works according to the prescription entered by the doctor. There is also a provision for the doctor to change the dosage or even the medicine as required. The vehicle carries out the process by reaching out to every assigned room, notifying the inmates (alarm) about their medications and also delivering the same. The vehicle has mechanisms for obstacle detection. Upon encountering an obstacle in its path, the vehicle assumes an alternative path and continues the process assigned to it. The vehicle also has the added feature of "double trial" of deliveries. The vehicle attempts to deliver the undelivered medicines one more time if the delivery fails in the first chance, even then if the attempt fails, the information of the same is passed on to the concerned personnel. There are segregated cartridges for medicine storage. The path is predefined and realized using rpm based concept with infrared sensor array for obstacle detection.

**Keywords**: Storage, dispensing, tracking, medication, cartridges

## I. INTRODUCTION

Caring of the patient in the hospital is of a serious concern. The hospital management is responsible for the care and management of the patients. In the modern age it is increasingly becoming difficult for them to be available all the time. Efficient management is of important area of concern in every section of the society. Sometimes despite their best effort, there may be certain draw backs. The robotic vehicle for pill delivery is one such approach to help the medicine dispensary system of a hospital to deliver the required medicine as per prescription to desired patients at desired time and location efficiently. The proposed product serves to ease up the human effort.

An autonomous mobile delivery robot, which transports medication within hospital, is designed here. The robotic vehicle enables hospitals to automate and improve the delivery and retrieval process of medication. It is a system that tracks and maintains the chain-of-custody control of medication delivery. This product would allow hospitals to automate, manage and track the internal logistics that are critical to hospital operations. On employing this system the hospital management would be able to reallocate and refocus staff on what matters – the patient experience. This system enables hospitals to improve staff efficiency and satisfaction, decrease missing medications, reduce errors, and improve regulatory compliance and leading to a better overall patient experience. Most existing medication dispenser require users to configure the schedule and settings manually. This leads to inconvenience and errors due to mistyping. An error in a medication dispenser can have fatal consequences. Nonetheless existing medication dispensers are not equipped with remote device management functions. Therefore users should manage their MD by themselves. For example devices like 'med time' provide only one medicine at a time and medication loading is difficult. 'Computed' dispenses only four times a day and its medicine cassette need to be changed weekly.

Here we have developed a device which can accept the prescriptions from the doctor every day. Pills are loaded into its respective cartridges by a caretaker accordingly. The vehicle moves to reach the desired destination where the system sounds an alarm and the patient can get his medicine upon entering the preset code corresponding to each room. On entering the preset code, the prescribed medicine combination is fetched from the individual cartridges and finally delivered at the outlet. The system has a provision for the doctor to change the prescription.

## II. LITERATURE SURVEY

The entire process of medicine delivery incorporates storage, selection and delivery at the desired locations. All these processes are carried out manually. The pharmacy serves as the central storage unit where the medicine reserves are maintained. It is the place where selection of medicines is carried out by the pharmacist or the nurse, according to prescriptions. The medicine delivery is also a manual process. Another existing technology which incorporates a small fraction of automation is the automatic pill dispenser or the access controlled pill dispenser. The automatic pill

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dispenser dispenses medicines in a timed manner in which the loading is manual. The mentioned system has been used commonly in old age homes, in housing environments and in those situations where the receiver is ready to receive the medicine from the location where the device has been installed.

## III. BLOCK DIAGRAM

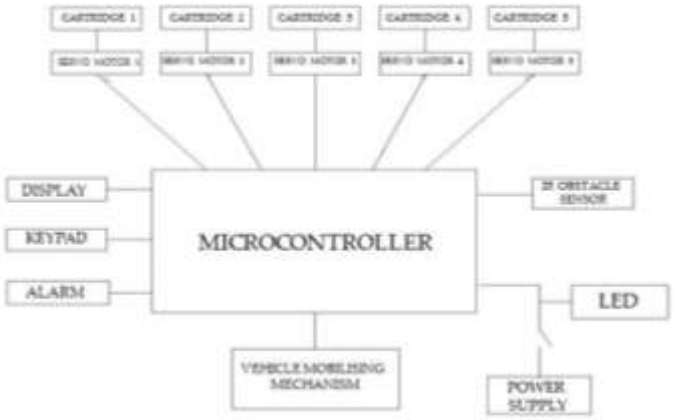


Fig1: Block diagram of pill delivery robot

The block diagram shows the overview of the system. The microcontroller (ATmega 2560) acts as the central processing unit. All the connections are made to this unit. It is powered by a 9V supply. The IR obstacle sensor used for obstacle detection. The keypad serves as an interface to enter the unique code. The alarm serves as the alerting system. The entire arrangement is mounted on a robotic vehicle which uses the DC motor for movement. The cartridges serve as the medicine reserve and the dispensing action is accomplished using a servo motor.

## IV. HARDWARE IMPLEMENTATION

The main hardware used in the system is the microcontroller.The Arduino Mega is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHzcrystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller. A servomotor is used for controlling the opening and closing of the pill cartridge.The servo circuitry is built right inside the motor unit and has a positionable shaft, which usually is fitted with a gear. The motor is controlled with an electric PWM signal which determines the amount of movement of the shaft. Inside servo, there is a pretty simple set-up: a small DC motor, potentiometer, and a control circuit. The motor is attached by gears to the control wheel. As the motor rotates, the potentiometer's resistance changes and the control circuit can precisely regulate how much movement is there and in which direction. When the shaft of the motor is at the desired position, power supplied to the motor is stopped. If not, the motor is turned in the appropriate direction. The desired position is sent via electrical pulses through the signal wire. The motor's speed is proportional to the difference between its actual position and desired position. So if the motor is near the desired position, it will turn slowly, otherwise it will turn fast. This is called proportional control. The DC motor is integrated to the microcontroller using a driver IC. L293D is a dual H-bridge motor driver integrated circuit (IC) that act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. An IR sensor is used for obstacle detection. It is a general purpose proximity sensor used for obstacle detection. It consists of an IR emitter and receiver pair and a comparator IC.The output of the sensor is high whenever the receiver receives a signal of IR frequency or low otherwise. The power consumption of this module is very lowand it gives a digital output.

A keypad is used for user control. It is a means of entering a code. In order for the microcontroller to determine which button is pressed, it first needs to pull each of the four columns either low or high one at a time, and then poll the states of the four rows. Depending on the states of the columns, the microcontroller can tell which button is pressed.

An alarm is used for intimidation. The piezo buzzer produces sound based on reverse of the piezoelectric effect. The generation of pressure variation or strain by the application of electric potential across a piezoelectric material is the underlying principle. These buzzers can be used to alert a user of an event corresponding to a switching action, counter signal or sensor input. The mobilising unit is formed by a chassis, dc motor, wheels and castor wheel provided with required power supply.

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## V. WORKING

The robotic vehicle for pill dispensing consists of three main sections: cartridges for medicine storage, pill combination generator and the mobility unit. The process begins with the entry of prescription data into the programming code of the system. This data entry is done on a daily basis based on the prescription received from the concerned doctor. The cartridges manufactured using 3D printing technology, are the medicine reserve for the system. Each medicine is stored in a separate cartridge and the befitting combination is chosen as per the necessity. The actual operation begins once the entry of prescription and loading of the program onto the microcontroller is done, after which the vehicle is switched on. The vehicle traverses its path by the rotation of the motor wheel to reach the destined location. On reaching the location the bystander is alerted by means of an alarm. An additional level of security is included in the system using a 4-bit key where in the bystander is required to enter a unique key for authentication. During allotment, each room is provided with a key; if the entered key matches with the allotted key of the particular room then the assigned combination of medicines are produced. The vehicle resumes its transit after the delivery is completed. The delivered room number gets stored. After all the deliveries are done at the desired locations a comparison is made between all rooms and the delivered room numbers. Hence the information about the undelivered room numbers is obtained. Deliveries are done to those undelivered roomsen route to the start point. On reaching the start point the comparison operation is again performed between all rooms and the delivered rooms and the undelivered room numbers are displayed out. During the entire passage the IR sensor output is continuously monitored for a high output. When a high output is received (indicating that an obstacle is detected) then the vehicle first sounds an alarm and waits for a short while.This is done to allow the obstacle to move away in case the obstacle is animate or is in the vicinity of a human, if the obstacle persists the vehicle is veered to follow a parallel path. The vehicle moves by means of a dc motor. Combination of medicines is produced by means of servo motor connected to the cartridges. The circular motion of servo motor is converted to a sliding motion by attaching a rectangular piece to the servo motor‘s hub. So that when the motor rotates for some specified angle, the rectangular piece moves linearly (about 1cm) through the rectangular hole in the cartridge which causes the pill to come out through the other hole at the opposite side.The pills from each cartridge are dispensed one at a time and are collected in a collecting cup through a common funnel.

The manoeuvring system of the robotic vehicle for pill delivery consists of a chassis with one castor wheel and two support wheels. The programming of the vehicle is done using a microcontroller. The location of rooms is identified based on a predefined fixed distance concept and the traversing speed (in revolutions per second) of the vehicle will be proportional to the distance. The distance calculation is done using IR transmitter and receiver module fixed on wheels. Using this module the number of revolutions is computed. Using the knowledge of the circumference of the wheel and the number of revolutions made the distance covered is calculated.

## VI. RESULT

Here we have designed a robotic vehicle for pill delivery whose mobility is on the rpm based distance coverage model. Delivery points are identified with fixed distance concept. The storage of pills is by means of separate cartridges fabricated using 3D printing. Delivery at each room is done based on the prescription details entered. Information of failed delivery is notified to the concerned personnel upon failing in a second attempt of delivery.

## VII. COST ANALYSIS

TABLE 1 COST OF COMPONENTS REQUIRED

| COMPONENTS | QUANTITY | COST (USD) |
|---|---|---|
| µC 2560 | 1 | 11.05 |
| 12V 100rpm DC motor | 1 | 2.95 |
| Servo motor | 5 | 13.26 |
| Motor driver IC | 1 | 1.91 |
| Chassis | 1 | 0.88 |
| Castor wheel | 1 | 0.74 |
| Main wheels | 4 | 5.89 |
| IR sensor | 1 | 1.47 |
| Cartridges | 5 | 22.09 |
| LCD display | 1 | 6.63 |
| 4X4 Keypad | 1 | 2.21 |
| Power supply | 1 | 1.77 |
| | Total | 70.84 |

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Cost analysis is an integral part of any project that is carried out. Here, we try to provide the cost estimate of our project. The components used here can be brought from many of the online electronic stores which are found on the internet. A list of components and their prices are given in the above table:

From the above table we can see that this robotic vehicle for pill delivery can be made with components that are very cheap and readily available in the market. It was designed keeping in mind the cost considerations. The total cost of this project is around Rs.5000/- and if manufactured in bulk the cost will be even less.

## VIII. APPLICATIONS

The robotic vehicle for pill delivery can simplify pill dispensing for hospitals with small to large capacities. With the presence of a pill dispenser, nurses and doctors can significantly reduce the amount of time for prep work and doing rounds. Medical professionals can be notified if a patient has not taken his pills. By hooking up a dispenser to a simple network, access can be changed in a second with patients constantly changing rooms and coming in and out of the hospital. The system is used to initiate the pill dispensing for the user‘s personal dietregime and a buzzer can remind them when the supplements need to be taken. It can also control the access to pills that can be sensitive for young children and teenagers since it is locked and only can be retrieved by the person who has the key and only at the right time of day. It is an excellent way for the elderly to be reminded whento take their pills and it can also limit the amount of pills that someone could have access too without having an in house nurse and one that can still be monitored very simply with a database of all logs for pills being dispersed.

## IX. FUTURE SCOPE

The system can be used to move an immense amount of materials through hallways, on elevator, in basements and to patient units. Technologies that evaluate stocks and accordingly place orders for supplies can be introduced. Clinical supplies, food delivery, product delivery and other miscellaneous works can also be accomplished. Keeping up with growing demand for new orders, reducing delivery time, reducing delivery errors and incorporation of dosages in fractions are some of the areas of futuristic expansion.

## X. CONCLUSION

Automating the distribution of medication throughout the hospital not only allows the right medications to reach the right individuals at the right time but also enables nurses and skilled professionals to focus on direct patient care and not routine delivery tasks. The system mainly aims at helping patients in taking their medicines at the correct time in correct dosages. It incorporates Arduino board with servo motors for the dispensing of medicines. The device works according to the prescription entered by the doctor. The system has a provision for the doctor to change the dosage or even the medicine as required. The vehicle carries out the process by reaching out to every assigned room, notifying the inmates about their medications and also delivering the same. The vehicle has mechanisms for obstacle detection. Upon encountering an obstacle in its path, the vehicle assumes an alternative path and continues the process assigned to it. The vehicle also has the added feature of “double trial” of deliveries. The vehicle attempts to deliver the undelivered medicines one more time if the delivery fails in the first chance, even then if the attempt fails, the information of the same is passed on to the concerned personnel. Thus hospital can automate all aspects of medicine delivery, enhancing patient and staff satisfaction.

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