

Development of a General Algorithm– Open & Close Mechanism Based on Arduino Microcontroller and an Application of Algorithm on an Ordinary Door

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Abstract:

Smart homes play a major role in lives for maximum utilisation and for secure environment. Home automation covers a wide range of facilities, from opening of doors to switching on/off the appliances as it increases the comfort level of the user. The current study aims at developing a cost effective and a general methodology to operate such systems by using remote controller. The general method developed in a open and close mechanism. Here, in this current study as an example, a case study on ordinary door operation is presented. This methodology aims at installing the circuit to automate the existing system within the RF range. Analysis is conducted to provide an alternative approach to existing methods. For any automation, controller is the heart of the system and for the current study Arduino controller was implemented.

Keywords: RF technology, home automation, servo motor, open and close mechanism.

I. INTRODUCTION

In modern days, home automation has been playing a key role in making the human life more comfortable. Home automation can be implemented in various ways like automation of doors, lights and numerous electrical appliances. To operate a garage door, Dennis W. Waggamon, Willem J. Marneweck have developed mechanical system with switch on/off motor. But such a system will not comfort a physically challenged person [1]. The alternate technology for such operation can be evolved by using wireless and wired communication. The wired communication is rarely used because it is complex and costly with limited distance from the system. Under wireless communication, using RF waves is the most common technology within the limited range of signals. This can be implemented using a remote controller which helps in controlling the system.

In 1996 a set of transmitters and a receiver were used for a single door [2]. Consequently the security levels were improved. In 1998 a door locking and unlocking system using a telephone receiver / Dual tone multi frequency (DTMF) decoder and a wireless radio frequency was developed. A speech recognition was also installed in this method [2]. As the scope such technology was foreseen, researchers started developing new controllers for such applications. A door locking and unlocking system was designed using a PIC microcontroller by Min Chit Ko and KyawSoeLwin [3]. As the method found to be successful, optimization of such approach is expected to make cost effective and user friendly.

There are various microcontrollers available in the present market as discussed above (for example like PIC microcontroller, AVR, ARM and Arduino). Based on available literature on microcontrollers, arduino microcontroller is found the latest, easier method to interface in the system. The user can change the code according to functional needs [4]. The method employed in this current algorithm is an upgraded version of PIC microcontroller as conducted by Min Chit Ko and KyawSoeLwin [3]. General algorithm developed in the present study aims at designing a circuit to open and close mechanism for any system. In the following section, design and experimental validation is presented.

II. METHODOLOGY

A general method for open and close mechanism

The method developed is applicable for any opening and closing of an appliance. In this method, two servo motors, one for the latch motion (M2) and the other (M1) for the motion of door opening and closing were used. Now a remote controller which is built on RF technology having a range of 250mts and frequency 50Hz was used to open and close. The controlling part in the circuit was done with the help of controller and arduino was implemented and the code can be changed according to the user's requirement. To open or close the door, the transmitter from the remote controller sends a signal and the receiver at the door acts accordingly. In order to check the status of system IR sensor sends a signal to the receiver at the remote controller. A half bridge motor driver IC L293D, was used in the circuit to control the speed and direction of DC motors. A rack and pinion pair of gears was used to convert rotational motion of the servo motor into linear motion of latch. The operating condition of the system can be implemented by the user in the required appliance. As a case study, implementation of this open close mechanism based on arduino on an ordinary door is presented in the following section.

A Case study on a door for Open Close mechanism: Application of algorithm

Fig 1 gives the overview of the open and close mechanism that is designed in this method

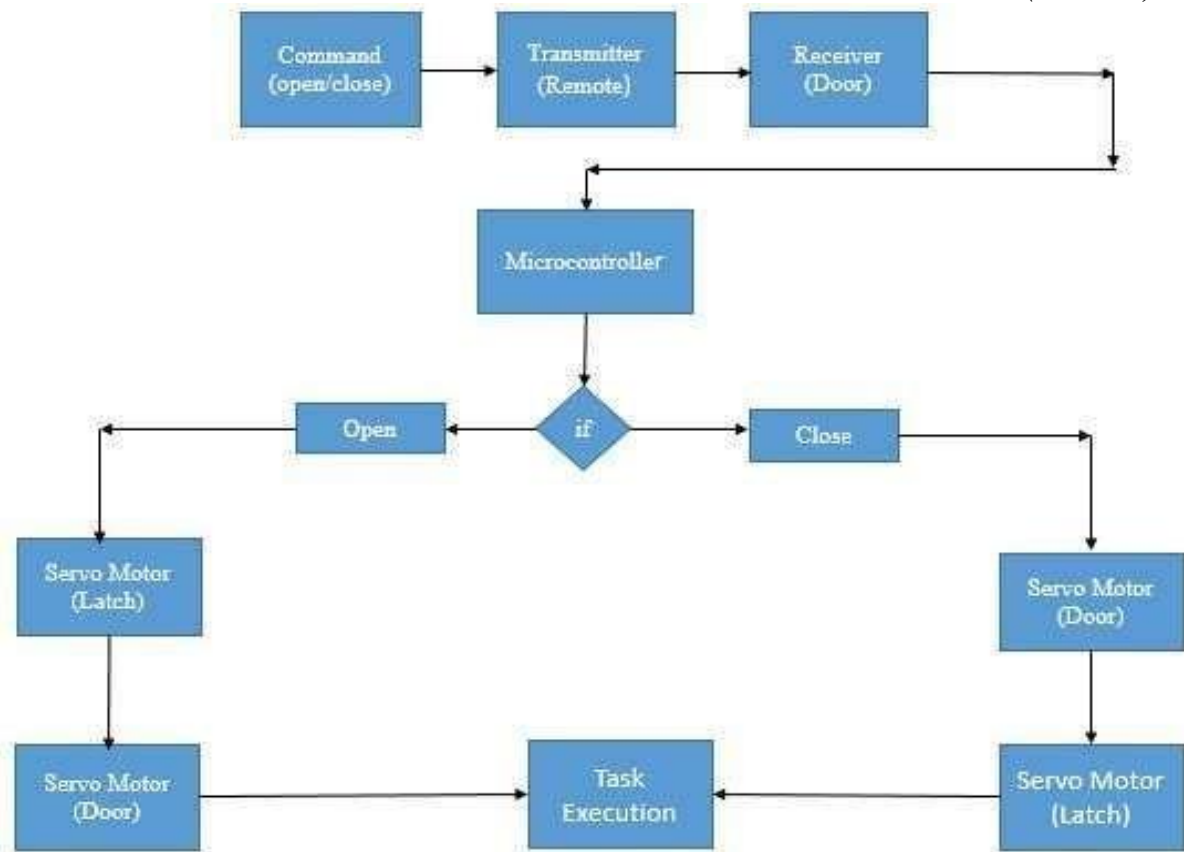


Fig. 1 Block diagram of open close mechanism on an ordinary door

III. VERIFICATION OF THE ALGORITHM USING TEST RIG

Any controlled system needs a good microcontroller which controls the events deliberately. It is an open source platform which can be rebooted easily and its programming is user approachable [4]. Interfacing of Arduino is much more user friendly and the cost is also very low. Arduino is used to control the pair of stepper motors which are responsible for the latch movement. As shown in the Fig.2 (a) the experimental setup was developed to validate the control mechanism and the instruments used are tabulated in the Table 1.

Table 1. List of components used in the present study

Hardware	Specifications	Quantity
Servo motors	10rpm	2
Arduino	Uno	1
RF transceiver	250Mts,50Mhz	1
Circular gear	-	3
Half bridge	L293D	1
Rack and Pinion	-	1

Radio frequency technology is one of the most efficient and fastest mode of transmission and its implementation is also cheap.

The major reason for selection of RF technology is that it doesn't require Line of sight [5]. RF modules are most often used in medium and low volume products for consumer applications such as garage door openers, wireless alarm systems, industrial remote controls, smart sensor applications, and wireless home automation systems. The project aims at using two RF transceivers out of which one is used to check the status of the door and the other for establishing a communication between the door and the remote controller. The frequency of RF waves here is 50 MHz and its range is 250mts.

An IR sensor is used to check the status of the door latch. An IR transceiver pair is used in which if the sent Infra-red rays is reflected back we assume that the door is locked else we deduce that the door is open. A half bridge motor driver IC L293D, is used in the circuit to control the speed and direction of DC motors. It is mainly used in power electronics which is used in building robots and power harnessing gadgets. Stepper motor which is a brushless

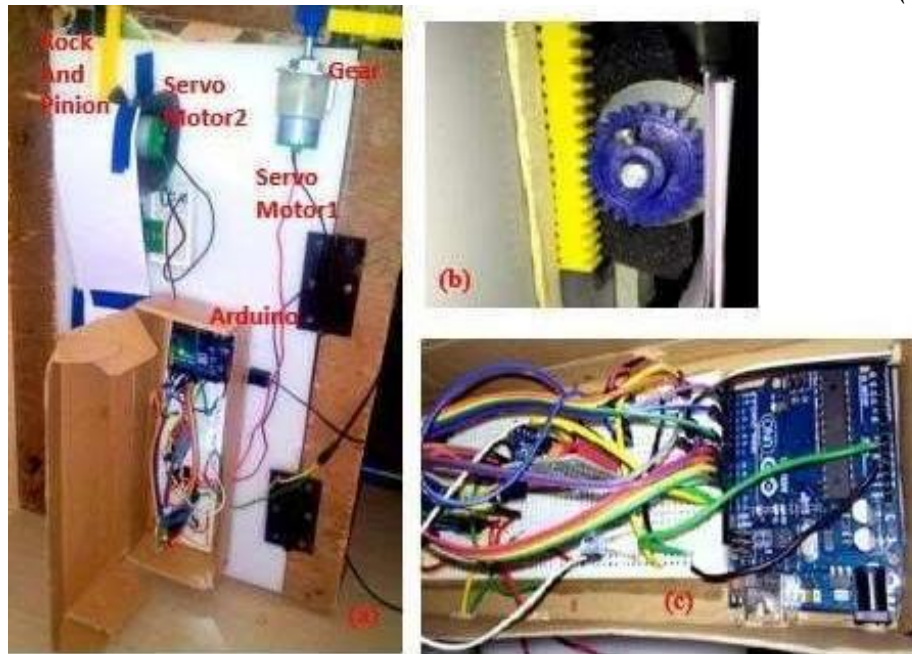


Fig 2: (a) Experimental circuit setup (b) Gear with rack and pinion at Motor 2 (c) Arduino connected to the circuit board DC electric motor which works by dividing a full rotation into number of equal steps.

These motors doesn't have commutators, so the commutation is handled externally by motor controller such as half bridge IC. The motor used here has the torque about 10kgcm and rated speed is 10rpm. The project aims at using two servo motors. The first one is used for closing and opening of the latch and the other servo motors are used to open and close the door. Both these servo motors are controlled with the help of Arduino as shown in Fig 2 (c). Rack and pinion is a pair of gears which converts the rotational motion into linear motion. The rotational motion of the servo motor is converted to the linear motion of the latch with the help of a rack and pinion as shown in Fig 2 (b). Three circular gears are used for the motion of rack and pinion as well as the rotation of the door. The project, in the future aims at developing a circuit which can be used for opening and closing of multiple doors which can be achieved by frequency multiplexing.

IV. LOGIC CHAIN

In current algorithm used has a logic chain and presented in simple structure in Fig. 3 to make the reader understand and apply. As shown in the Fig. the below logic chain depicts, closing and status checking. The step by step procedure has been clearly depicted here.

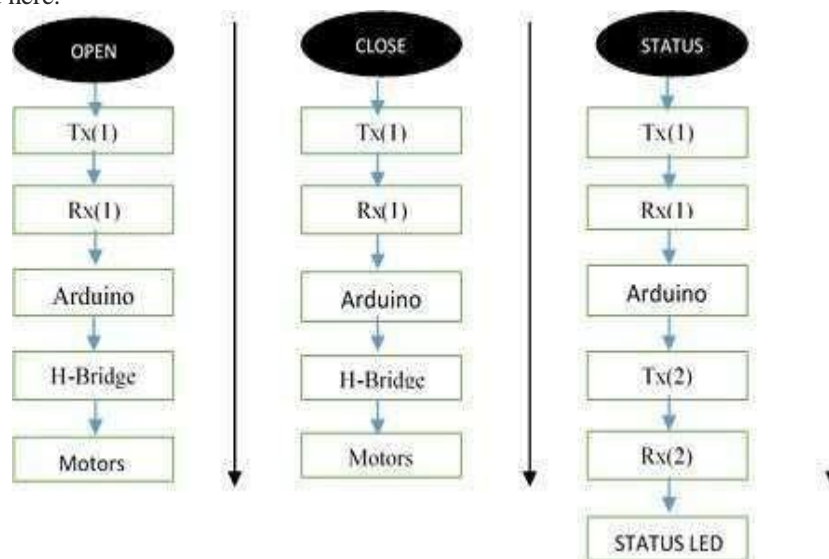


Fig 3: logic chain of open/close mechanism

Here the following abbreviations in the logic levels are as follows

- Tx(1) = Transmitter at remote
- Rx(1) = Receiver at Door
- Tx(2) = Transmitter at door
- Rx(2) = Receiver at Remote

V. CONCLUSION

A general algorithm for open and door mechanism was designed based on arduino microcontroller. The algorithm and code implemented was successfully tested using a experimental setup. As the method used RF and wireless technology, it will be user friendly for physically challenged and cost effect.

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