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Development of Prototype Automated Storage System

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Abstract - This paper proposes a Prototype Automated Storage System to pick up the parts from preset pickup point located at the end of ramp using robotic arm. The size of individual part is identified by making use of Part Identification System and subsequently placed into a suitable compartment of Storage System. Part Identification System, Robot Arm and Storage System are integrated and controlled by programming the microcontroller.

Keywords — Robotic arm, Part Identification System, Microcontroller, Automated Storage System

I. INTRODUCTION

Kalyanaraman, P and C. Keerthika [1] made a shuttle-based storage system which consists of elevators, lift tables and storage racks to increase throughput capacity of the system. NK, Muhammed Jabir *et al.* [2] made a pick and place robotic arm which can be controlled by an android application using a ATMEGA328 microcontroller main to handle soft materials. Mudasser, Tayyaba [3] developed a Storage and Retrieval Vehicle (SRV) to perform storage and retrieval operation. This vehicle has three axis motions which are controlled by the commands fed in the microcontroller. Ashna Joy *et al.* [4] developed an Elevator Conveyor Setup (ECS) which can move in X, Y & Z directions. Jeroen P vanden [5] did experiments on optimum dwell point in AS/RS system to decrease the travel time in next operation. Russell D. Meller and Anan Mungwattana [6] made a multi shuttle-based S/R system where it can perform the two storage and retrieval operations in an interval. Krishna *et al.* [7] made a pick and place robot controlled through Arduino which can move in any kind of soft and hard surfaces, but it can move its arm only in upward and downward direction. Chakole, Smita U [8] developed a prototype of AS/RS system for Flexible Manufacturing System (FMS).

II. AUTOMATED STORAGE SYSTEM

In this work, a prototype automated storage system comprising of part identification system, robot and storage system which are integrated and controlled by microcontroller has been proposed. A robot with jointed arm configuration has been selected to pick the part from the preset pickup point located at the end of ramp to place it in the appropriate compartment of the storage system based on its size. Fig.1 shows the various components of prototype storage system.

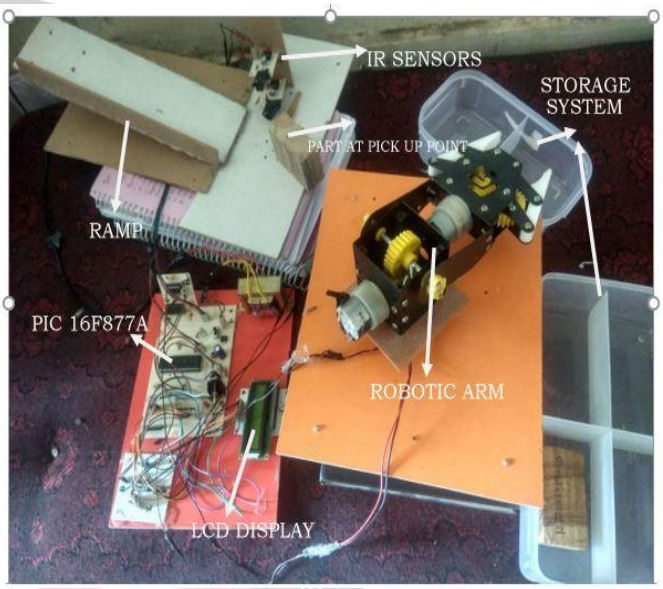

Fig. 1 Prototype Automated Storage System

A. Part Identification System

The presence and size of the part is detected by making use of Infrared (IR) sensors placed beside the pickup point. Part identification system can detect size of parts by placing IR sensors at suitable heights beside the pickup point.

B. Storage system

Storage system can accommodate four parts out of which two parts are of bigger size and others are smaller.

C. Material handling system

Robot is employed for transfer of parts and it supports arm movements in upward and downward directions and base rotation of 360^0. The part can be picked by closing the gripper of the robot at the pick point and subsequently the gripper is opened to release the part after reaching the appropriate compartment of storage system.

The microcontroller is programmed to distinguish the parts based on height through IR sensors of part identification system and transfer the parts by manipulating the motions of robot. It detects the availability of appropriate

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compartment based on the size of part for storage and notifies the operator by showing message *Storage is Full* as incase no compartment is available for storage through LED.

III. METHODOLOGY

In this automated storage system, PIC microcontroller is selected due to its ease of operation and integrated flash memory which enables to erase and rewrite the data. The components to be stored are loaded manually on top side of the ramp and slide down to reach its bottom (pickup point) by taking advantage of gravity.

The parts arrived at the bottom of the ramp in the random order are halted by stopper. Robot picks a component using its gripper and places it into appropriate compartment by identifying its size through part identification system implemented by IR sensors under the guidance of microcontroller. Robot can open and close the gripper to grip and release the part by a DC geared motor controlled by a motor drive (L293D). It can actuate its arm movements in upward and downward directions and rotate with respect to its base by two more DC geared motors. These motors are controlled by motor drive (L293D).

PIC microcontroller with control program is used to control the operation of storage system where motor drivers L293D rotate the motors in both clockwise and anti-clockwise directions to provide robot arm and base movements. Microcontroller control the robot to place the component in an appropriate compartment based on availability of compartment with appropriate size in the storage system based on the inputs received from sensors through part identification system. The status of storage system is displayed as FULL when no storage compartment is available, and size of object as Large Object or Small Object through LCD display as shown in Figure 2, Figure 3 and Fig.4 respectively. Parameters that are taken into consideration in the proposed system are size of part, size and availability of storage compartments and arrival of objects in random order.

Fig.2 Smaller Object

Fig. 3 Larger Object

Fig. 4 LCD display while Storage full

IV. WORKING

A jointed arm robot is moved to pickup point by controlling the motors through motor drivers which are in turn controlled by programming the microcontroller. It moves to pickup point after detecting the presence of the object. The gripper of the robot is controlled by separate DC motor under the control of motor driver. All the three DC motors provides 10 rpm with DC power supply. A step-down transformer along with a bridge rectifier is used to convert AC to DC. The DC obtained is an oscillating pulse which is not pure, so a capacitor along with filter in series is employed to smoothen the oscillating pulse into a pure DC.

Finally, voltage regulator step's down the power from 15V to 5V DC which is operating voltage required for PIC microcontroller 16F877A. Robot performing storage operation is displayed in Fig.5.

Fig.5 Robot performing storage operation

The circuit diagram used in the automated storage system has been shown in Fig 6.

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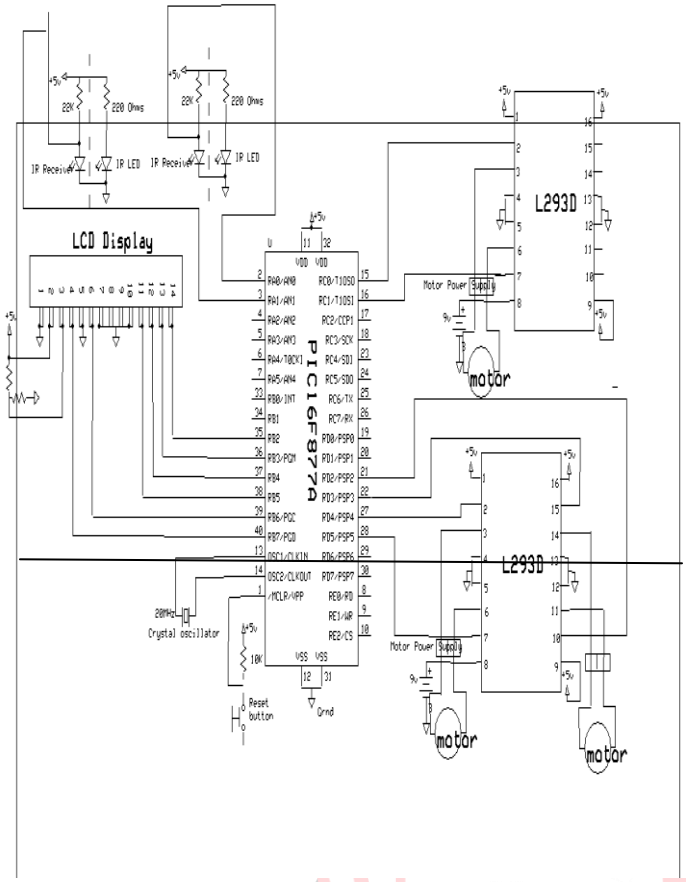

Fig. 6 Circuit Diagram

V. PROPOSED SYSTEM VS EXISTING SYSTEM

In some of the existing systems, robotic arms are mostly employed for pick and place operations which are controlled by an android device. In the proposed system all the operations are performed automatically once object reaches the pickup point. The objects of different sizes are loaded manually at the top of a ramp and a part identification system detects the size of the parts once they arrive at the preset pickup point, and then the robotic arm gets activated to pick the part and place it into an appropriate compartment based on its size under the control of a L293D PIC microcontroller. It stops its operation when storage space is not available and alerts the operator by displaying "Storage = Full" message on LED for necessary action. The system can handle arrival of the objects in random order.

VI. CONCLUSIONS

A prototype model of automated storage system is developed to store the objects of different sizes. It can be used in warehouses, small scale industries to store the objects automatically. It uses IR sensors to detect the objects of different heights and place it in the appropriate compartment in storage system based on the availability. This automated storage system reduces the labor cost and increase productivity of storage operations in industry.

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