

ROBOT ASSISTED SENSING, CONTROL AND MANUFACTURE IN AUTOMOBILE INDUSTRY

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Abstract: Robots are used in a wide extent in automobile manufacturing industry. This system adds to the safety and flexibility of the stages of production. These robots protect the employees from dangerous, difficult and dirty tasks, improve quality, relieve bottlenecks, and improve capacity. In this paper, we propose a novel pick and place robot for sensing, control and manufacture in automobile industry. The payload and mean error rate are analysed and the performance of the robot is analysed and optimized. This technology is more affordable and can be installed for speeding up the manufacturing process and improve the production rate.

Keywords: Robot, Automation, Encoding, Decoding, RF Transmission, 8051 Microcontroller

1. Introduction

Robots provide a competitive advantage to the automobile industries. The applications of these robots include welding, painting, assembly, material removal, sealing, coating and part transfer. These robots reduce the variability of parts. They can perform every cycle in a similar manner and never get distracted or tired and are high. It also improves the safety of the parts by avoiding breakage or damage. This greatly decreases the number of discarded parts that was caused due to human error and hence offer lesser variability. Variation in incoming materials can be identified with vision based systems in automotive robots and the programmed paths can be modified. This further improves the accuracy and customer satisfaction as well as reduces the cost of warranty.

Pick and place robots are used in assembly, packaging, bin packing and inspection in several industries. Based on the specific manufacture requirements, it is possible to customise the pick and place robots. These robots make it easy to move products that are hard-to-handle, heavy, small or large in a consistent manner. It is also possible to customize and program these robots based on specific requirement. It improves the efficiency of manufacture

and production. With technological advancements and innovation, these robots are made more affordable and user friendly.

In this paper, we present a pick and place robot that offers sensing, control and manufacture assistance in automobile industry. There are various types of pick and place robots namely robotic arm, Cartesian, delta, fast pick and collaborative. These robots can improve profit, run the manufacturing plant continuously, reduce risk of injury and stain due to repetitive task, reduce wastage of space, improve production, minimize defective products and improve the efficiency. The pick and place robot system consists of a robot, touch screen based control system, safety doors with interlocks, gripper and conveyor. The robot is made of a rover, end effector, actuators, sensors and controller.

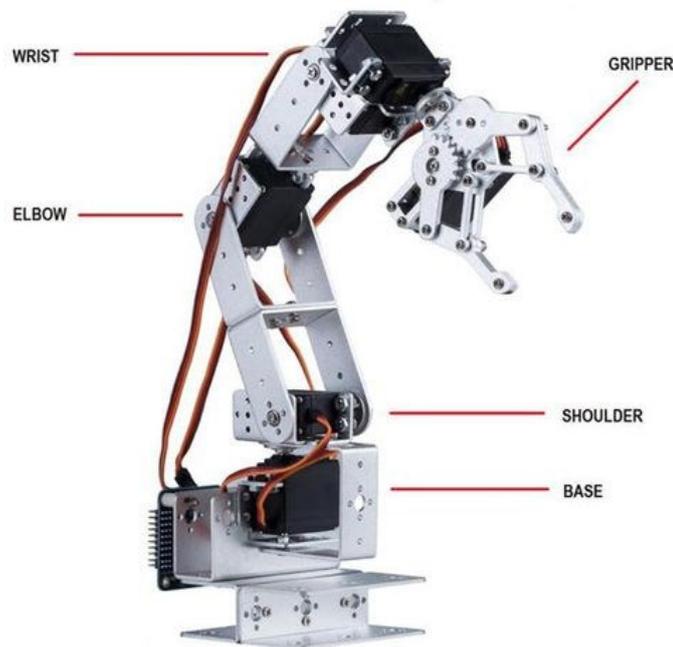


Figure 1: A typical Pick and Place Robot [17]

Figure 1 represents a typical pick and place robot arm and its parts. These robot arms can also be made compatible with internet of things. The other important factors to be considered while building these robots include programmability, consistency, safety, and flexible deployment. This robot perform detection of object with the help of IR sensors. The existing robotic systems are inflexible and are of high cost. These robots exemplifies certain modern trends in computerization of the process of manufacture.

2. Existing work

Several researchers have worked on developing and improving the efficiency of pick and place robots. Davis Meike et al [1] offered improvement of power efficiency by inclusion of a stand-by mode for low power consumption. Dmitry Akimov et al [2] used fuzzy rule base for modelling an automobile robot suitable for non-stationary environment. Robert D. Atkinson [3] performed an extensive analysis of adoption and trends of industrial robots among nations. Korea used the maximum number of industrial robots as per the survey of 2017. These robots impact the standard of living in a positive and sustainable manner. Russia and India use the least number of robots approximating to 3 to 4 robots per 10,000 employees. Lei Chen et al [4] developed a robot arm that works on the principle of artificial intelligence and machine vision as shown in figure 1.

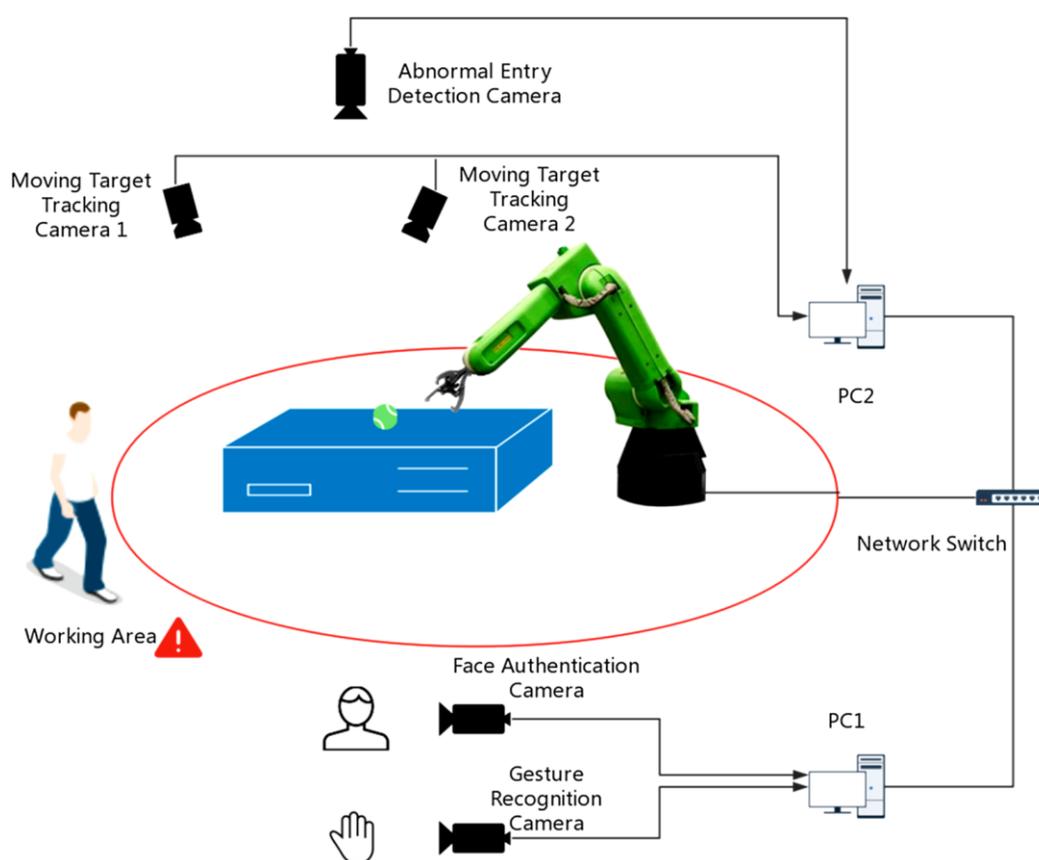


Figure 2: Intelligent robot arm framework [4]

Factors such as face authentication, gesture recognition, abnormal entry detection, and moving target tracking are discussed. Lixiong Gong et al [5] performed the modelling and optimizing of automobile assembly line system consisting of production, logistics and information systems. The paper proposes the use of intelligent production robots through Cyber-Physical Systems (CPS) and intelligent robot monitoring. Guoqin Gao et al [6] designed an electric conveyor motor using sliding mode control (SMC) technique.

Carlos Garriz et al [7] used Kalman Algorithm for trajectory development in industrial robot. Optimization of the manipulator with six degrees of freedom (DOFs). Arc welding is done by the spherical wrist. Weiwei Wan's [8] review article on application of smart robots in the assembly of automotive parts. The paper also discusses on the glitches in the implementation of industrial robots and the technological solutions required to overcome these difficulties. Isak Karabegović [9] describes the revolution in automobile industries in China through the use of industrial robots. China has been the largest manufacturer of automobiles in the year 2015 with a net manufacture of about 25.5 million automobiles. It also has been the leading user of industrial robots according to this research.

Davis Meike et al [10] analysed the energy saving techniques of automobile industry based industrial robots. The paper also focused on variation in acceleration and speed as well as point approximation. It is suggested that up-to 40% of energy can be saved by reuse of recuperated energy, brake power adjustment, asynchronous brake management, and trajectory optimization, active usage of stand-by mode, robot shutdown and appropriate choice of robot. Carl H.A. Dassbach in [11] discussed about the deployment of robots in automobile industries across America.

Isak Karabegović in [12] deliberated Asian and Australian manufacturing industries and their usage of industrial robots for the purpose of dispensing, processing, assembly, welding and operations. Chan-Hun Park et al [13] proposed "Development of Industrial Dual Arm Robot for Precision Assembly of Mechanical Parts for Automobiles". Technologies like RTX Ardence, motion engineering and XMP motion board were used in this paper. Pongsak Joompolpong et al [14] developed "Robot Vision System for Coordinate Measurement of Feature Points on Large Scale Automobile Part".

Anand Nayyar et al [15] developed "Smart Surveillance Robot for Real-Time Monitoring and Control System in Environment and Industrial Applications". Yancong Li et al [16] proposed "A Concept Map-Based Learning Paths Automatic Generation Algorithm for Adaptive Learning Systems".

3. Proposed work

In a pick and place robot, the linear and rotary joints perform the basic function. These joints connect the rigid sections of the robot and can be linked based on the degree of freedom. The transmitter consists of a touchscreen that acts as the input interface. This data passes through the microcontroller and further to the encoder that converts the data into serial format and transmits with the help of RF module. The receiver consists of four motors of which two are used for movement of the robot and other two are for movement of gripper and arm. The decoder converts the received data into parallel bits and transmits it the data to the microcontroller which drives the motors with the help of L293D motor driver IC. It is essential to apply the adequate amount of pressure on the product so as the product is not damaged or dropped.

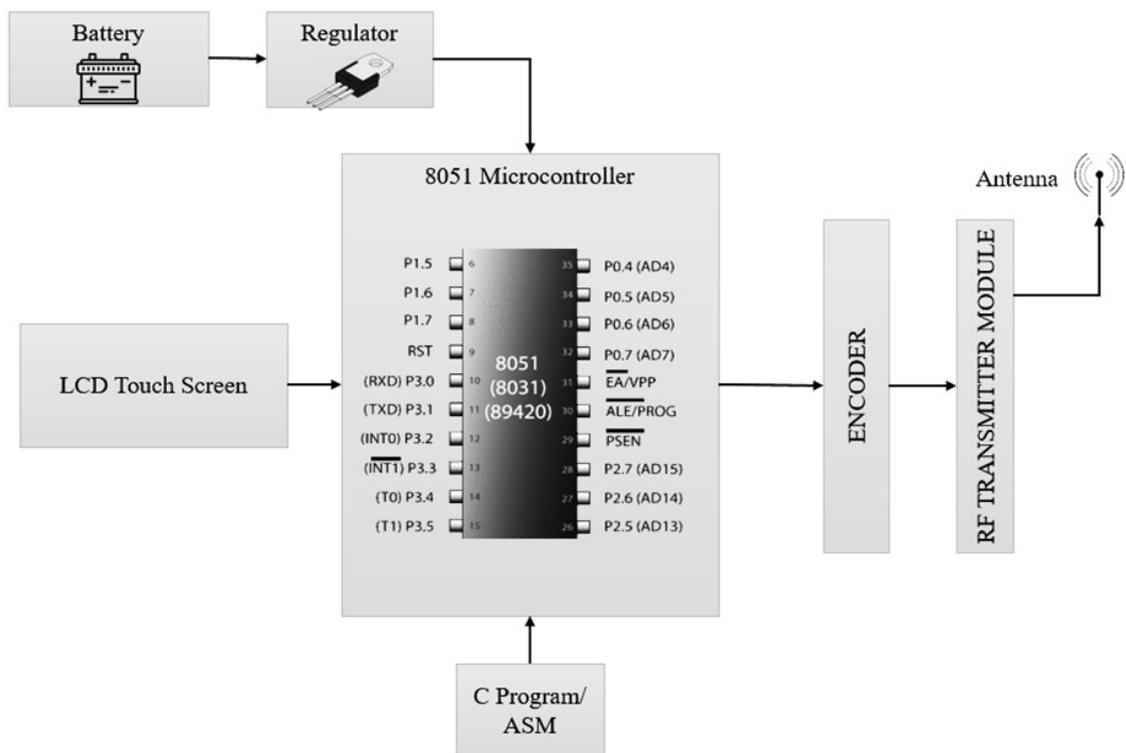


Figure 3: Transmitter Block diagram of Pick and Place Robot

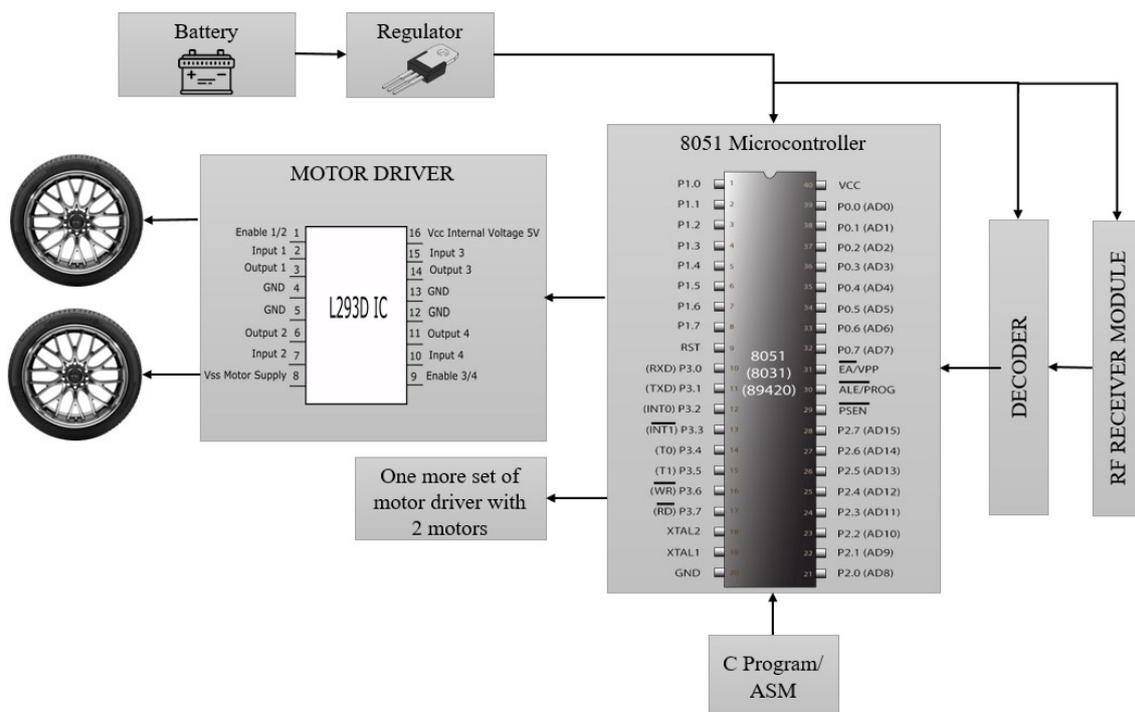


Figure 4: Receiver block diagram of Pick and Place Robot

In automobile industry, these robots can be used for completion of machinery fixtures by picking up the necessary parts and placing them in the right position. The gripper can be controlled by the motor for opening and closing operations. The robot is designed to be of light weight and small size. The throughput of the robot can allow pick and place of 100 objects per minute.

4. Results and Discussion

Table 1: Quantitative analysis of the pick and place robot

Motor	M1	M2	M3	M4
Operation	Arm and Gripper movement	Arm and Gripper movement	Robot movement	Robot movement
Inertia	0.0233 Kgm ²	0.0264 Kgm ²	0.0871 Kgm ²	0.0825 Kgm ²
Payload	0.055	0.057	0.069	0.070
Mass	1.6 Kg	1.6 kg	0.9 kg	0.9 kg
Radius	0.210m	0.210m	0.250m	0.250m
Mean error	2%	2%	3%	3%
Response time	5s	5s	4s	4s

Payload refers to the amount of weight that can be lifted by the robot arm. The end of arm tooling (EOAT) weight is also included with the payload. When the object resist velocity changes, the property is termed as inertia. The rotational inertia is calculation is done using the formula

$$RI = m \times r \times r$$

Where m and r represents the mass and radius respectively.

$$I = \frac{1}{2} \times m \times r \times r$$

Represents the inertia of a solid disk or cylinder. The response time represents the time taken for the receiver module to receive and act on the data that is obtained from the transmitter module.

5. Conclusion and Future Work

This paper presents an automobile industry based pick and place robot that assists in sensing, control and manufacture. The transmitter and receiver modules of the robot are designed, programmed and developed. This pick and place robot overcomes the leakage issues as in hydraulic mechanism. It offers no friction as there is no sliding member. It is inexpensive, simple and easy to manufacture. Factors such as inertia, payload, mass, radius, mean error and response time of the robot are discussed and analysed. As a future scope, this robot can perform more accurate actions with the use of feedback sensors. It can also be used in climbing, swimming, fire control, and various such applications.

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