

# Scara Robot With Adaptive Controller

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**Abstract:** A scara robot is the most widely used in industry. In this study, the robot scara 2 links that it is a series of robots have been used. With adaptive controller the first and second arms have been simulated. In this simulation, the error rate considers as zero because it was a very short time.

**Keywords:** Scara Robot, Adaptive Controller, Simulator Adaptive, Arm Scara, Scara 2 Link, Equation Error, Nonlinear System

## I. INTRODUCTION

The robot is an electromechanical device performing various tasks. A machine can be programmed to act to varied commands or entirely carry out important tasks especially those groups of tasks that are beyond natural abilities and possess a constitutional context. These mechanical machines are processed for the better accomplishment of tasks like perceptions, receptors and movement of objects or repetitive tasks like welding.

A robot is generally an electromechanical device which with motion or appearance transmits a concept form itself or its owner. The word robot is predicted to physical as well as virtual robots. For virtual robots the term 'bot' is utilized which usually are similar to software representatives.

A robot is generally used in the cases where it can perform a better task than a man or act in a hazardous environment. The benefits of using a robot are:

- 1- Usually a robot can perform the tasks in a cost-effective manner that we humans want to do.
- 2- Robots can do hazardous tasks like supervising atomic energy organizations or excavation or volcano.
- 3- A robot carries out tasks more precisely than a human being and speed up the advancement process in medical sciences and other applied sciences.
- 4- Robots are advantageous especially in repetitive and tedious tasks like making of circuit boards and pouring glue on spare parts and etc. (1)

Normally, the general structure of a robot is minimally comprised of five different but related parts.

### 1- AMS (Articulated mechanical system)

This system is comprised of arms, wrists, connections and the final mechanical factors which in total are conjunct and linked connectively.

### 2- Actuators

This section provides the needed ability via some controlled and precise specifications for articulated mechanical system (AMS). This ability comprises of electrical, hydraulic and neumechanical types.

### 3- Transmission system

This connects the actuators complex to AMS. In this manner the availed ability is transferred through actuators

to mechanical sections in such a way that it provides a separate movement facility for each joint. The geared belts and rotators are of this kind.

### 4- Sensors

Sensors are the fragments constituted of electrical touch tools with a ray that besides other electrical ingredients plays an essential role. The role of these parts is to gather information about the status of a robot's joint and its environmental condition like light, heat and the objectives present in its surrounding.

### 5- CPU

This section is regarded as an area for taking commands and decision making of a robot. In other words, the duty of processing the obtained information is the responsibility of this section where this function is carried out through the programs present in the computer's memory. The software section also relates to this part(2).

## II. MATERIALS AND METHODS

### A. SCARA

SCARA is the acronym of selective compliance articulated robot arm and possesses sense of assembly. SCARA is a novel structure and is popular and as depicted by its name can be used for assembly operations. This robot was built in the year 1981 via professor 'Hiroshi Makino' a professor at the University of Yamanashi.

The arm of SCARA is comprised of RRP which means that it possesses three joints. Its first and second joints are of swinging or rotational type and its third joint is sliding or linear. This joint is composed of parallel axes (as shown in picture). The first and second joints are used for the determination of coordinate any and third joint is used to determine coordinate z.

SCARA robot has an efficaciousmanoeuvre ability in the x and y disc. Due to this reason it is perfectly suitable for the manipulations. This robot in addition to assembly tasks is also effective in lifting tasks and locating (physical mobility from one place to another (Figure 1).

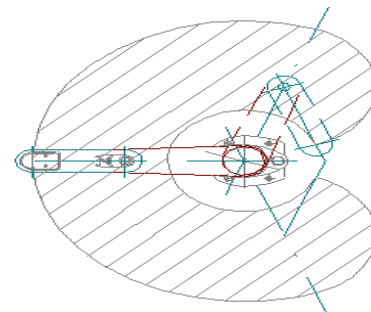


fig 1(a)

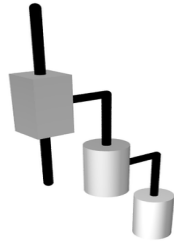


fig1(b)

Figure 1: Appropriate robot for displacement in axis x, y

The importance of a SCARA robot is attachment of two sequential swinging connectors with the parallel axes similar to a human hand. Due to this reason it is called a craftsman. This peculiarity gives the robot's ability wherein a limited area with collective arm it reaches itself quickly from one point to another (3).

The SCARA robot is secured only with a single foundation and it requires a little space for installation and easily starts working. Its control software needs inverse kinematics (kinesiology) for linear interpolated moves.

The software that is sold with SCARA generally is easy for end-users. At present the SCARA robots due to their increased speed are used in different production plants. It can be said that they are suitable for tasks that need speed in three or four parameters. In addition, it has an optimal economic feasibility (operating cash).

### B. Adaptive

The adaptive is designed for the replication to the needs of innumerable audiences without losing the quality and precision from the mathematical viewpoint. This adaptive is designed for the presentation of designing and analysis and research and with the utilization of a wide spectrum of algorithms for the management of dynamic systems with unknown parameters.

Adaptive is a law of physics which observes the process and performance of control and variation in problem behaviour of the automatic closed loop and is made-up of the following structures.

1-Online parameter estimator based on current measurements and control action

2- A control law that recalculates the controller based on the estimated parameters

For an example  $x' = ax+bu$  is a linear system with unknown amplification in which a and b are unknowns but positive in a manner that system is unstable and increase is positive then the adaptive stabilizes the system in such a way that  $k'=x^2$  and  $u = -kx$ .

With the increase of x it also again increases k till there is enough  $a-bk<0$  and the system reaches a stable system.

Adaptive processes a special kind of closed loop adaptive and constitutes the foundation and behaviour based system and operation and system information. This could vary based upon and in order with realization

controlled aim interruptions but in general it can be categorized upon variations.

- 1- Signals – signal adaptation
- 2- Parameters – parameter adaptation
- 3- Structure – structure adaptation

In fine a structure of the above cases is possible (4).

An adaptive is a special kind of controller that has a process application with dynamic variations in the normal process condition with a subject of stochastic disturbance.

The reason for using adaptive are:

- Variation in process dynamics
- Variation in the character of disturbances
- Engineering efficiency

In fine the process with dynamic variation for adaptive is not easy which today these two problems are resolved by the two below mentioned method.

- 1- Adaptive control
- 2- Robust control

When the processing of parameters is considered an adaptive is used. In the course and duration of processing variables we cannot know the progress and which variations are in the resultant processing thus with an assumption of the process an inflexible variation in a time period should not be considered (5).

The solution is in the special form of adaptive in which parameter assessment and design upon line and in the period of natural system processing an adaptive is adjusted.

## III. RESULTS AND DISCUSSION

Adaptive of a biaxial mechanical arm (SCARA)

If we consider a nonlinear system in the form mentioned below (6).

$$\begin{aligned} \dot{x}_i &= F_i(X_1, \dots, X_N) + g_i(x_i)u_i \\ y_i &= h_i(X_1, \dots, X_N) \end{aligned}$$

Thus we can rewrite the above connection in the following manner

$$y_i^{(m_i)} = \sum_{k=1}^i \alpha_{i,k} f_{i,k}(x_i) + \beta_i u_i + \Delta_i(X_1, \dots, X_N)$$

In which the above relation

$$\sum_{k=1}^i \alpha_{i,k} f_{i,k}(x_i)$$

For approximation

$$F_i(X_1, \dots, X_N)\beta_i u_i$$

For approximation

$$g_i(x_i)u_i$$

And also

$$\Delta_i(X_1, \dots, X_N)$$

For considering the uncertainty in the system in which the uncertainty is in the system and the uncertainty considered is limited.

$$|\Delta_i(X_1, \dots, X_N)| \leq \rho_i$$

The tracking error of the system is in the following manner.

$$e_i^{(m_i)} = r_i^{(m_i)} - y_i^{(m_i)}$$

Considering the above relation the tracking error can be rewritten as follows:

$$e_i^{(m_i)} = r_i^{(m_i)} - \sum_{k=1}^i \alpha_{i,k} f_{i,k}(x_i) - \beta_i u_i - \Delta_i$$

At this stage the suggestive adaptive is the following

$$u_i = \frac{v_i}{\hat{\beta}_i}$$

In which we have

$$v_i \cong (a_{i,0}e_i + a_{i,1}\dot{e}_i + a_{i,2}e_i^{(2)} + \dots + a_{i,m_i-1}e_i^{(m_i-1)}) - \sum_{k=1}^i \hat{\alpha}_{i,k} f_{i,k}(x_i) + r_i^{(m_i)} + \hat{\rho}_i \operatorname{sgn}(e_i^T p_i b_i^T)$$

With the replacement of adaptive we have the suggestive adaptive in the error relation.

$$e_i^{(m_i)} = r_i^{(m_i)} - \sum_{k=1}^i \alpha_{i,k} f_{i,k}(x_i) - \frac{\beta_i}{\hat{\beta}_i} v_i - \Delta_i$$

Considering the below relation

$$\frac{\beta_i}{\hat{\beta}_i} = 1 - \frac{\hat{\beta}_i - \beta_i}{\hat{\beta}_i}$$

The error can be written in following form

$$e_i^{(m_i)} = \sum_{k=1}^i \hat{\alpha}_{i,k} f_{i,k}(x_i) - (a_{i,0}e_i + a_{i,1}\dot{e}_i + \dots + a_{i,m_i-1}e_i^{(m_i-1)}) - \rho_i \operatorname{sgn}(e_i^T p_i b_i^T) + \beta_i v_i - \Delta_i$$

Finally the relation of tracking error is as follows

$$\dot{e}_i = A_i e_i + b_i (\sum_{k=1}^i \hat{\alpha}_{i,k} f_{i,k}(x_i) - \hat{\rho}_i \operatorname{sgn}(e_i^T p_i b_i^T) + \frac{\hat{\beta}_i}{\beta_i} v_i - \Delta_i)$$

The laws of suggestive adaptive is as under

$$\dot{\hat{\alpha}}_{i,k} = -\gamma_{\alpha 1} f_{i,k}(x_i) e_i^T p_i b_i^T$$

$$\dot{\hat{\beta}}_i = -\frac{\gamma_{\beta} e_i^T p_i b_i^T v_i}{\hat{\beta}_i}$$

$$\dot{\hat{\rho}}_i = \gamma_{\rho 1} |e_i^T p_i b_i^T|$$

The structure of suggestive adaptive is figure 2.

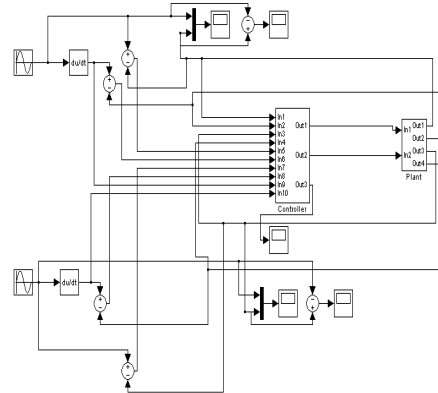


Figure 2. The structure of adaptive is scara robot with 2 links.

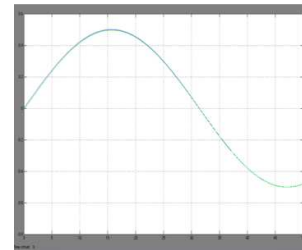


Figure 3. Position of first arm.

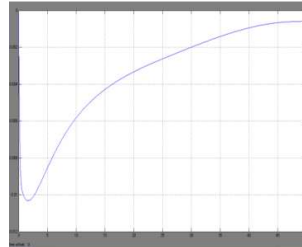


Figure 4. Error of first arm.

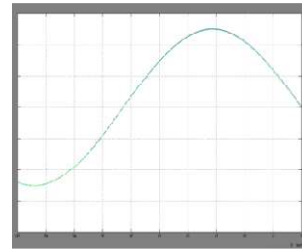


Figure 5. Position of second arm.

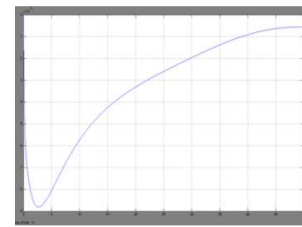


Figure 6. Error of second arm.

The results obtained from the simulator adaptive are as follows. Figure 3 to 6 show the results of this simulation show that the position of the arms and the error rate. The position of the simulator's first arm in the adaptive is synchronous to the position of second arm and the level of error in the first arm is its minimal which is approximately -0.0101 where this error after step 2 lean towards zero. The error level of the second arm is approximately -  $8.8 \times 10^{-3}$  which lean towards zero almost in the step 3. The error level of the second arm is lower than the first arm but this error due to its smallness can be ignored and after a specified period of time the errors lean towards zero.

The complete structure of the suggestive adaptive system for the robot SCARA with consideration to the level of errors and the synchronism of the first and second arm is acceptable.

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