

Design of controlling SCARA robot for transit

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Abstract. Controlling movement for robot is extremely concerned with kinematics, dynamics and planning track. It is mainly introduced in this paper that we can bring the robot into action by designing the circuit. In order to test whether the design is suitable or not, simulation of controlling is introduced, which proved that the circuit can be available for tasks or assignments and easy to operate compared with other ways.

Keywords: robot, controlling movement, designing circuit

1. Introduction

With the development of control system^[1], intensive control can no longer meet the demands of modern robots and will inevitably be replaced by the form of principal and subordinate or distributed. Distributed structure is adopted in this paper, under such control system, the superior computer answers for the whole system, coordinate transform and other calculating functions, and subordinate systems are composed of different micro controllers which dominate every articulatory movements. At the end of this paper, simulation in ADAMS can give a conclusion that position control and velocity control adopted in this design can meet the demands of task, which is easy to handle and save the cost of production.

2. Design of circuit

Module can be applied in design^[2] as much as possible, which contains following advantages: nice performance, short period, low cost and open system that is prone to modify, rebuilt and add functions.

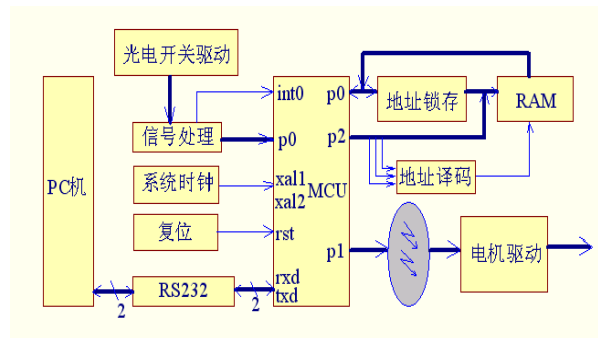


Fig. 1: The Principle of controlling circuit

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2.1. Single chip processor

Single chip plays an essential role in control system, whose performance can be improved as a result of proper work frequency. AT89C52 Single chip^[11] with 12MHz from American ATMEL company is employed in this system which are qualified with 8KB ROM、 256B RAM、 double timer/counter (T0、 T1) and eight interrupt supply.

2.2. Serial communication module

Serial communication module is responsible for carrying data between control circuit and PC. We must convert level to communicate as a result of TTL of single chip which is not matching with RS-232, detailed in Figure2.

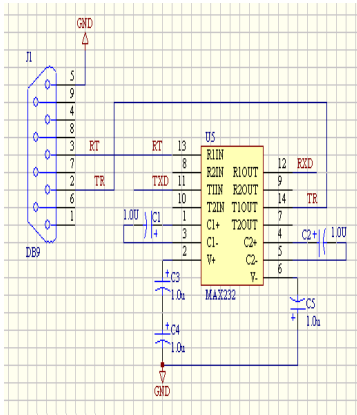


Fig. 2: Serial communication circuit

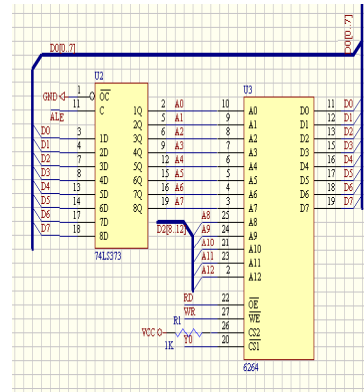


Fig. 3: Address latch circuit

2.3. Address latch circuit

It is required to make an extension of bus when in need of extension and access to I/O port because special address bus and data bus for extra use are not available in AT89C52. Extension for outer bus can be related with pin ALE, and P0 cannot be served as port of address bus when effective high level edge of ALE is working as latch signal until ALE work right next time. During invalidation of ALE, P0 will be served as port of data bus. Address latch circuit is shown in Figure3.

2.4. Address decoding circuit and chip selecting signal

We must make sure that the selection of chip won't influence other units when exerting an operation on a outer chip or a inter unit. As is shown in Figure 4, Address coding circuit can make a right choice of outer chip or inter part for the system when inputting and outputting, and the single chip can write data or information into a designed unit or read data or information from a designed unit.

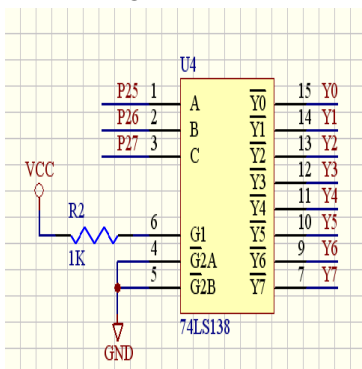


Fig. 4: Address decoding circuit

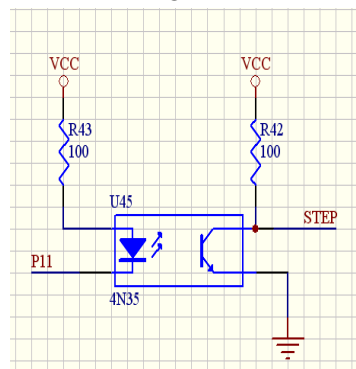


Fig. 5: Photoelectrical coupling circuit

2.5. Photoelectrical coupling circuit

Photoelectrical coupling circuit is contrived on the Port 1 for the safety of running system(As is shown in fig5, and only one coupling circuit is given). The main purpose of this circuit is to separate single chip system from driving module under the state of normal communication, and the main control module would not be endangered even if any short circuit or other accidents occurred in driving module.

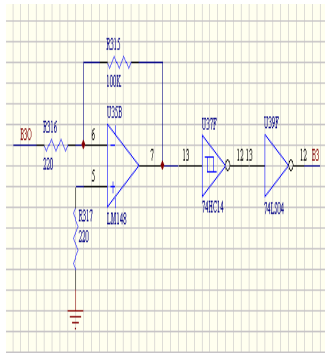


Fig. 6a: limiting signal processing

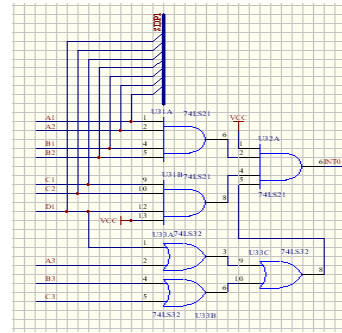


Fig. 6b: limiting signal numbering

2.6. Sensor module

Interior sensor is taken in this circuit [3], which is required to inspect the limited position of every joint angle, and then we make a choice of photoelectrical switch, it can send out infrared and check whether there is enough infrared to return or not. Each of Joint 1, 2, 3 is inspected by three IR sensors to make sure the limited positions and the zero position; Joint 4 is inspected by only one IR to get limitation of the rotation angle. Once the sensor get the limited signal, we will get to know which joint overpasses its limited position by checking signal circuit as is shown in fig 6b, and giving interrupt order to INT0, then the circuit ceasing exporting data after the response to INT0. Parts of checking signal circuit are shown in fig 6a, and only one limited signal is given in this figure.

3. Simulation of controlling

ADAMS can set up dynamic^[4] equation, analysing statics、 kinematics and dynamics, exporting curve of displacement、 velocity and acceleration, which can built a virtual environment and therefore we can make a more sound designment and provide reasons for decision-making, Model of simulation has been shown on fig7.

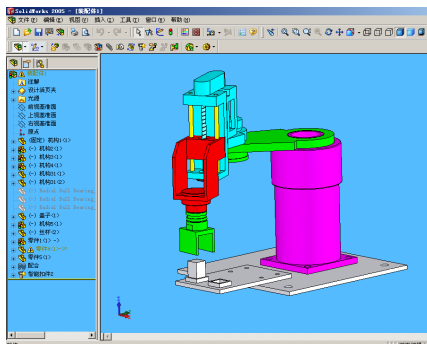


Fig. 7a: Model under Solidworks

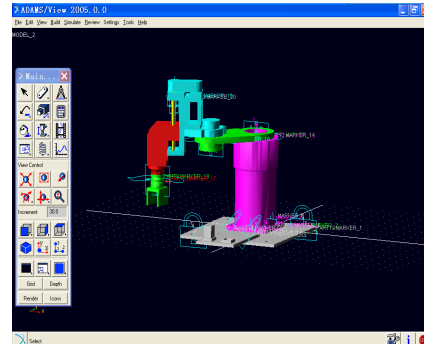


Fig. 7b: Model under ADAMS

3.1. Kinematical simulation of SCARA robot

Kinematical parameters of SCARA robot are following:

Big arm: position $-100 \text{---} +100^\circ$ fastest speed $30^\circ/\text{s}$

Small arm: position $-70 \text{---} +70^\circ$ fastest speed $15^\circ/\text{s}$

Wrist: position $-50 \text{---} +50\text{mm}$ fastest speed $1\text{mm}/\text{s}$

Paw: position $-180 \text{---} +180^\circ$ fastest speed $60^\circ/\text{s}$

Four joints angular velocity of SCARA robot are following:

Big arm: $+30^\circ/\text{s}$

Small arm: $+15^\circ/\text{s}$

Wrist: $0.001\text{m}/\text{s}$

Paw: $-60^\circ/\text{s}$

3.2. Kinematical simulation curves of SCARA robot

1. simulation curves of the paw

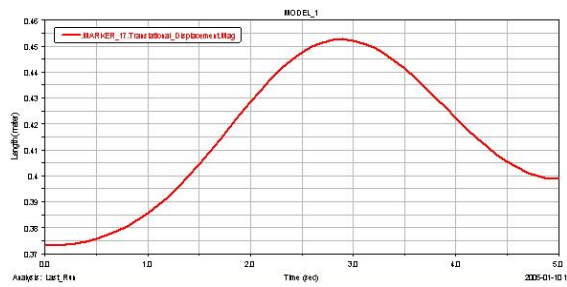


Fig. 8a: Displacement curve of the paw

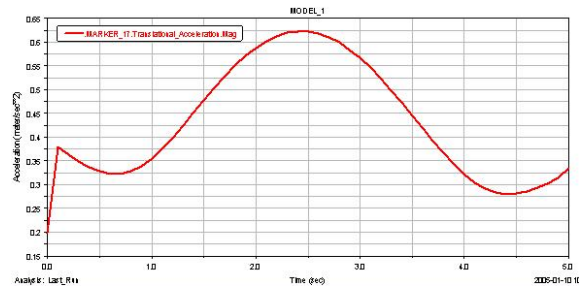


Fig. 8b: Acceleration curve of the paw

2. simulation curves of joint(joint between paw and wrist is selected)

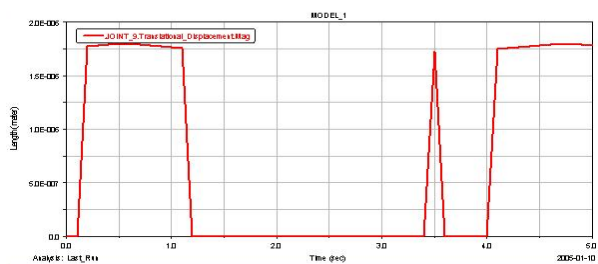


Fig. 9a: Displacement curve of joint

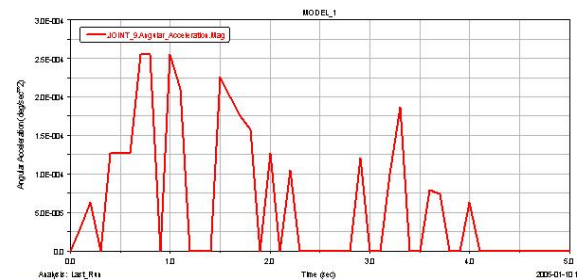


Fig. 9b: Acceleration curve of joint

With the assistance of ADAMS, kinematic simulation has been achieved, we can define the position limitation and posture limitation of the whole SCARA robot [5], and simulation curves are also been acquired, which can help us to make a judgment whether the track is applicable or not, whether the controlling algorithm is feasible or not. According to the Fig8, curves are smooth and serial, the parameters we chosen are feasible; and according to the Fig9, there are some breaks in the curves, which result from the low frequency vibration of SCARA robot. When we saw the shaking of paw at the time of start and termination, the Acceleration break is the main reason for this phenomenon.

4. Acknowledgements

Under my tutor Xu ying's instruction, the design and simulation have been done successfully. After several years practicing, I rearrange my paper with the help of Yaji Song whose major is concerned with design of control circuit. I show my great gratitude to all these persons to support my research.

5. References

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