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Original Research Article

Research on Light Source Tracking Method of Photovoltaic Power Generation System

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ABSTRACT

In this paper, a new type of solar energy automatic tracking controller based on single chip microcomputer is designed to improve the utilization rate of solar energy. Using AT89S52 microcontroller as the core control components, through two photoelectric sensors, signal is collected through the comparison circuit and A / D, the results will be outputted to the single-chip microcontroller for data analysis and processing before output to ULN2003A to control the five-wire four-phase step motor to achieve the tracking of the sun position. The system has the advantages of low cost, and has good anti-interference ability improving the utilization rate of solar energy. The design firstly completed the simulation of the program, and then mainly editing using C programming to complete the program design. Through the downloader the program will be programmed into the microcontroller. Finally, through the construction of hardware experiments to achieve the objective of designed tracking.

KEYWORDS: solar radiation utilization rate tracking

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1. Energy status and development

Energy is the material basis for the survival and development of human society. At present, the vast majority of countries, including China, oil, natural gas and coal and other fossil fuels are the main energy source. With the depletion of fossil fuels and the deteriorating global environment, many countries are seriously exploring ways to diversify energy and actively carry out research and development of new forms of energy and renewable energy.

Although fossil fuels such as coal, oil and natural gas will still have a significant share of the world's energy mix for the foreseeable future, there is a significant impact on nuclear energy and solar energy, wind energy, geothermal energy, water conservancy, bioenergy and other sustainable energy resources. The increasing attention in their presence alternative energy source in energy consumption is significantly increased. According to statistics, in the 1990s, the global coal and oil power generation experienced growth of 1% per year, while solar power grew 20% per year, while the annual growth rate of wind power is as high as 26%. It is expected that in the next 5 to 10 years, sustainable energy will be able to compete with fossil fuels, thus ending the situation of fossil fuels domination in the world. Compared to the increasingly depleted fossil fuels, solar energy seems to be the hope of future social energy.

1.1. The current development and utilization of solar energy

Human direct use of solar energy comprises of three major technical areas, namely, light and heat conversion, photo-

electric conversion and optical conversion, in addition with energy storage technology. Solar light and heat conversion technology has a number of products such as water heaters, water boilers, dryers, heating and cooling, greenhouse and solar houses, solar cookers and high temperature furnaces, desalination plants, thermal power generation devices and solar medical equipment [6].

1.2. Characteristics of solar energy

Solar energy as a form of new energy has three advantages compared with conventional energy: First, it is the most abundant energy human beings can use, it is estimated that in the past 1.1 billion years, the sun used up 2% of its own energy. It can be said to be inexhaustible. Secondly, on the earth, solar energy can be used in situ, there is no logistics problem. This is especially more valuable in the underdeveloped rural areas, islands and far-reaching areas. Third, solar energy is a clean energy. Development and use will not produce any waste, waste water, waste gas, noise, and will not affect ecological balance.

The use of solar energy has its shortcomings: First, the energy flow is low. In areas where sunshine is better, the ground area of 1 square meters of energy received only about 1 kilowatt. This often requires a considerable collection of lighting surface to meet the requirements. Hence large area of installation of the device is required, making cost of materials increase. Second, due to the great changes of the atmosphere, bring a lot of difficulties to solar use.

1.3. Purpose and significance of research

In this paper, a solar ray automatic tracking device based on photoelectric sensor is designed to automatically track the movement of solar rays and ensure that the energy conversion part of the solar energy equipment is always perpendicular to the sun's rays and improve the energy efficiency of the equipment.

1.3.1 To improve the rate of utilization of solar energy

Solar energy is an ever-changing energy with low density, intermittent, with spatial distribution. This set higher requirements on the collection and utilization of solar energy. Although the successes of solar energy devices such as solar water heaters, solar dryers, solar cells, but the use of solar energy is still not enough, due the reason of low utilization rate. Maximizing the utilization of solar energy is a problem to solve. One is to improve the efficiency of solar energy conversion device. The second is to improve the efficiency of solar energy reception. The former belongs to the field of energy conversion which remains to be studied, while the latter can be resolved with existing technology.

1.3.2 Solar photovoltaic power generation system

During the daytime, under the lighting conditions, the solar cell components produce a certain electromotive force, through the series of parallel components of a solar cell array, making the square array producing voltage to the system input voltage requirements. The voltage is then gone through the charge and discharge controller to charge the battery, storing up the energy converted from light energy. In the night, the battery pack provides the input power for the inverter, converts the DC into AC power through the inverter, and supplies it to the power distribution cabinet, which is powered by the switching effect of the distribution cabinet. The discharge of the battery pack is controlled by the controller to ensure the normal use of the battery. Photovoltaic power plant system are limited to the protection and lightning protection devices to protect the system equipment from overload and lightning, maintaining safe use system and equipment.

Solar energy → chemical energy → light energy.

1.3.3 Components of solar power generation systems

Solar PV system schematic diagram shown in Figure 1.

The PV system is composed of solar cell array, battery pack, charge and discharge controller, inverter, AC distribution cabinet, automatic solar tracking system, automatic solar module dust removal system and other equipment.

1.3.3.1 Solar cell array

In the case of light (whether sunlight or other light generated by the light), the battery absorbs light energy, the battery at both ends of accumulate different charges, which are 'light production voltage', which is the 'photovoltaic effect'. Under the effect of the photovoltaic effect, the solar cell at both ends produce electromotive force, converting the light energy into electricity. Solar cells are generally silicon cells, comprised of monocrystalline silicon solar cells, polysilicon solar cells and amorphous silicon solar cells.

1.3.3.2 Battery pack

Its role is to store solar energy when the light emitted on the square array and can always supply power during load. The basic requirements of the battery used by the solar cell are: (a) Self-discharge rate is low; (b) Long service life; (c) Deep discharge capacity; (d) High charging efficiency; (e) less maintenance or zero maintenance; (f) Wide range of working temperature, and (g) Low price. Lead-acid batteries above (how-many) Ah are generally choices between fixed or industrial sealed maintenance-free lead-acid batteries. Each battery is currently supporting the use of solar power systems and batteries are mainly lead-acid batteries and nickel-cadmium batteries. Package 200 rated supplies voltage of 2VDC with lead-acid batteries supporting 200 Ah and below. Generally small sealed maintenance-free lead-acid batteries are selected with each battery rated voltage of 12VDC.

1.3.3.3 Charge and discharge controller

Charge and discharge controller is able to automatically prevent the battery overcharge and over discharge equipment. As the battery cycle charge and discharge times and the depth of discharge determines the battery life, hence by controlling the battery overcharge or over discharge, charge and discharge controller is an essential equipment.

1.3.3.4 The inverter

The inverter is a device that converts direct current into alternating current. As the solar cells and batteries are DC power, and the load is in AC load, the inverter is essential. Inverter according to the operation mode, can be divided into independent operation inverter and grid inverter. Independent operation inverter works independently in solar cell power generation system, for independent load power supply. Grid-connected inverter uses grid-connected solar cell power generation system. Inverter according to the output waveform can be divided into square wave inverter and sine wave inverter. Square wave inverter circuit is simple, low cost, but the harmonic components are generally used for hundreds of watts and harmonic requirements of the system are not high. Sine wave inverters are expensive but can be applied to a variety of loads.

1.3.3.5 AC distribution cabinet

Its main role in the power plant system is the backup function of the backup inverter to ensure the normal power supply system, as well as the measurement of line power.

1.3.4 Classification of solar photovoltaic power generation systems

Solar photovoltaic power generation system is divided into independent photovoltaic power generation system and grid-connected photovoltaic power generation system:

First, the independent photovoltaic power generation system is also called off grid photovoltaic power generation system. Mainly comprises of solar cell components, controllers, batteries, to AC power supply, and a need to configure AC inverter.

Second, the grid-connected photovoltaic power generation system is generated by solar modules DC power through the grid inverter into the AC power grid in accordance with the requirements of direct access to the public power grid. Grid-connected photovoltaic power generation systems are centralized large-scale grid-connected photovoltaic power plants are generally state-level power plants. The main features are the power generation can be directly transported to the grid, making unified power distribution to the user. But the investment is huge, with long construction period, covering large area. Currently there is not much development. The decentralized small-scale grid-connected photovoltaic system,

especially the integrated photovoltaic power generation system, is the mainstream of grid-connected photovoltaic power generation due to its small investment, fast construction, small footprint and strong policy support.

1.3.5 Photovoltaic power generation system for solar tracking systems

Solar tracking system is able to keep solar panels at any time on the sun, so that the sun's light at any time vertically shines of solar panels' in the power plan. This can significantly improve the efficiency of solar photovoltaic modules. This is the first device that complies with domestic independent intellectual property rights, completely without computer software. The sun space positioning tracker with the international leading level cannot be limited by geographical and external conditions, works in the -50 ℃ to 70 ℃ ambient temperature range of normal use and its tracking accuracy can achieve ± 0.001°, which is the maximum in accuracy of the sun tracking. The device is a perfect realization of timely tracking to maximize the utilization of solar energy. The solar tracking system can be widely used in various types of equipment need to use of tracking of sun. It is affordable, stable in performance, reasonable in structure, accurate in tracking, and easy to use. The solar energy tracking system installed in the solar power system installed in high-speed vehicles, trains, and communications emergency vehicles, special military vehicles, warships or ships, no matter where it is driven or turned around, the automatic solar tracking system can guarantee the equipment tracking site is always facing the sun.

2. Comparison of tracking methods

2.1. Classification by control

Automatic tracking method based on different classification criteria can be divided into many kinds, according to the control method there are three kinds, namely photoelectric tracking, daily trajectory tracking and hybrid control.

2.1.1 Photoelectric tracking

Photoelectric tracking is through the photosensitive sensor (such as silicon photovoltaic tube) for detecting sunlight. The basic principle is: when photosensitive sensor installed fixed on the tracking device. When the sun shifts, the photosensitive device will receive current deviation. A series of magnification shaping, digital-to-analog conversion and calculation processing acquires the tracking signal. Through the tracking signal, servo action in driven to adjust the device to achieve accurate tracking [18]. Photoelectric tracking based on the detection of different devices (such as photosensitive resistors, photodiodes, phototransistors, etc.), constitute different performances of the sun tracker. The advantage is that it is not affected by geography and winter and summer time difference. It is easy to use, flexible, simple in structure, low in cost and more accurate. The tracking accuracy of reference [18] can reach 0.003° [19]. However, the sensitivity of the sensor is poor, subject to relatively large external environment changes, especially during cloudy weather; bright spots on cloud will cause the tracking device to tremble, seriously affecting the normal function [20].

2.1.2 Daily trajectory tracking

The principle of tracking the trajectory as follows: According to the astronomical formula, solar azimuth and the height angle of the local sunrise to sunset every day is calculated. According to the parameter, control motor rotation is activated to track the sun. The essence of this method is based on geographical location and time to determine the location of the sun information, according to the current trajectory of the sun to carry out fixed tracking. The advantage is that it can be used all day, without the need for artificial intervention and help. The control is simple, easy to implement, and no need of additional hardware equipment. Its drawback is the need for the calculation of the sun positional error, mechanical structure accuracy error for the entire tracking process to amend the accumulated errors. In addition, the mechanical processing and the installation of the instrument are in more stringent requirements with higher cost [21].

2.1.3 Hybrid control

Hybrid control tracking is a combination of the above two methods of the characteristics of the use of advantages to overcome shortcomings, organic fusion of a new control method. From the usage it can be divided into two kinds: one is

in the case of good weather, the use of closed-loop photoelectric sensor tracking is used, daily movement trajectory tracking mode is switched on during rainy weather for continuous tracking, until the weather clears and photoelectric sensor tracking is reactivated. The other form simultaneous use two tracking methods, first through the daily trajectory tracking and then by the photoelectric sensor tracking for fine tracking, thereby improving tracking accuracy. Hybrid control system, combined with the advantages of open-loop and closed-loop control, can get better control [22].

The relationship between the sun and the earth

The earth is revolves every day around a day of the imaginary axis of the Antarctic and the Arctic. One rotation is a day for 24 hours; hence the earth is rotated 15 degrees per hour. In each turn at the same time, the earth revolves around the sun in an oval orbit, every revolution is a solar year, equaling 365 days 5 hours and 48 minutes, i.e. 365.241 days. Every four years makes a leap day. Earth's rotation axis and the orbital plane running with normal line tilts at the angle of 23.27 degrees, and Earth's rotation axis is always the same, always pointing to the celestial sphere of the Arctic, which is the sun's largest angle.

There are four special dates in the year of the earth revolving around the sun, which is the largest winter solstice and summer solstice affected by the earth's sloping movement, and the vernal equinox and autumnal equinox, which are not affected by the tilting movement of the earth.

In the northern hemisphere, the vernal equinox is about March 21st, the summer solstice is June 22nd, the autumnal equinox is September 23rd, and the winter solstice is December 21st. Summer solstice days are the longest and winter solstice nights are the longest; vernal equinox and autumnal equinox's days and nights are each 12 hours. In the design of solar energy applications, will inevitably involve the Earth and the sun's positional relationship, such as the sun height angle, azimuth and other issues.

A. Horizontal coordinate system

To the horizon as the basic circle, the zenith as the basic point with the southern point as the origin of the coordinate system is called the level coordinate system, as shown in Figure 2.1. Through the zenith and the sun (any celestial body) X for a large circle, called the horizon circle. The arc X is the elevation angle α (horizon latitude), and the arc SM is the azimuth angle γs.

The arc XM is the elevation angle α (horizon latitude), the upward is positive, and the downward is negative. The arc ZX is called the zenith distance, measured from Z, denoted by Z. Obviously Z = 90 °-α.

B. Angle coordinate system

The coordinate system of the origin is the angle coordinate system or the first equatorial coordinate system, which is the based on a point of the equatorial circle and the northern part of the sky.

Through the North and the sun forms a large circle, called the time circle; when the circle crosses equator at the T point; from the origin Q along the equator clockwise measurement, arc QT for the time angle ω. ω is expressed in degrees, minutes, and seconds units, and can be expressed in hours, minutes, and units; the arc XT is the declination angle δ, δ is expressed in degrees, minutes, and seconds units; From equator, going up is positive, down is negative. When the celestial body is moving in a day, the declination of the celestial body does not change with the daily motion, but the time angle of the celestial body increases from 0 ° evenly to 360 °.

2.2. Calculation of the relevant angle

In terrestrial applications of solar energy, most of the lighting components or arrays are not installed in a horizontal form, but are mounted in a sloping form at a certain angle to the ground plane.

It is necessary to analyze the calculation of the incident incidence of the sun at a given time and place.

A. The definition of the angle

If the tilt angle and azimuth of the solar panels are determined, some angles must be defined to calculate the energy of the direct solar radiation incident on the surface of the lighting assembly.

Solar ray's incident angle θ: The angle between the sun's rays and the surface normal of the lighting assembly, known as the incident angle of the sun's rays. The sun's rays can be divided into two components, one perpendicular to the light, another parallel with the light-emitting surface, only the former, radiant energy can be obtained from the north side. It can be seen that the actual use should be the incident angle θ as small as possible, which is used the tracking.

Solar elevation angles α and the sun azimuth angle γs: a line from the ground observation point to the sun center. The ray on the ground has a projection line, from the two lines of the angle α is the height of the sun angle. The angle between the ray and the ground norm is called the sun zenith angle θz. Where α + θz = 90 °. The angle of projection of the sun's rays on the ground and the angle of the south is the azimuth of the sun. Going to west is positive, to east is negative.

Light assembly azimuth angle of the component γ: The surface normal of the lighting assembly has a projection on the ground, and the angle is between the projection line and the south of the azimuth of the lighting assembly. The tilt angle of the lighting assembly β: the angle between the plane of the lighting assembly and the horizontal plane. The tilt angle for the lighting assembly is shown below

B. The relationship between angles and the formula

The amount of solar radiation obtained by the lighting assembly depends mainly on the solar incidence angle θ, and θ is the sun's horn angle δ, the sun's angle ω, the geographical latitude φ, the lighting component tilt angle β, the lighting component azimuth angle γ

And the function of their specific relationship is:

$$\cos\theta = \sin\delta\sin\varphi\cos\beta - \sin\delta\cos\varphi\sin\beta\cos\gamma + \cos\delta\cos\varphi\cos\beta\cos\omega + \cos\delta\sin\varphi\sin\beta\cos\omega\cos\gamma + \cos\delta\sin\beta\sin\gamma\sin\omega \quad (2.1)$$

where the sun's declination angle δ can be approximated by the Cooper equation:

$$\delta 23.45°\sin[360(n-284)/365] \quad (2.2)$$

n: the number of days in a year, such as: in the vernal equinox, n = 81, then δ = 0.

$$\omega=(t-12)\times 15° \quad (2.3)$$

t: the local time, calculated by the hour.

Earth rotates 360 ° a day, corresponding time is in 24 hours, Every 1h of Earth rotation angle is defined as the sun when the angle ω , then = 360 ° / 24 = 15 °, noon angle is zero. Other time when the value of the angle is equal to the time from the noon (h) multiplied by 15. The morning angle is negative and the afternoon angle is positive, for example, morning 10 and 2 pm are respectively at -30 ° and + 30 °. From the formulas (2-1), (2-2) and (2-3), it can be seen that when δ, ω, φ are determined, the tilt angle β and azimuth γ determine the value of the direct sunlight incident angle θ. Hence, as long as the control of the lighting components to its inclination and azimuth angle is with the appropriate value, you can ensure that the sun's incident angle θ is 0, so as to maximize the collection of solar energy.

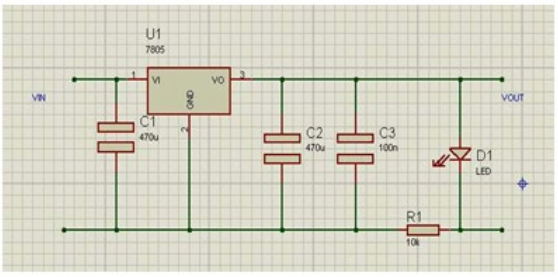
Hence according to the situation, we can in different regions determine a suitable solar array of fixed installation angle, which can maximize the efficiency of the use of solar energy.

3. Hardware circuit design

Single-chip power supply

Through the 7805-regulator chip and capacitor filtering composition of the 5V regulator circuit, is mainly the power supply to the microcontroller, the circuit schematic shown in **Figure 1**:

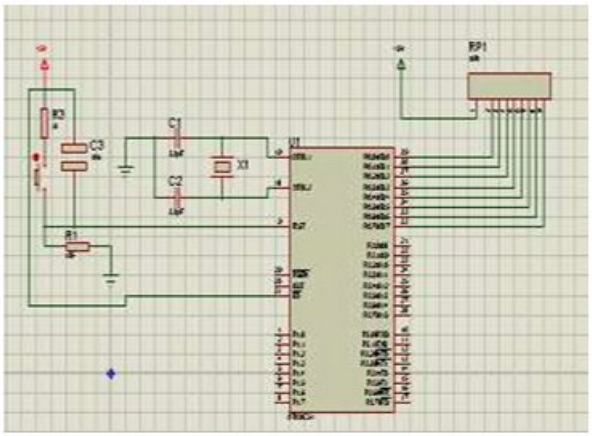
Figure 1. Schematic diagram of 5V regulator circuit



Single chip mini system

The design of the tracking control device is a typical closed-loop control system, controlling the object is two pieces of photosensitive circuit board. The control element is the corner position of the tracker, the execution element is the stepping motor and the feedback element is the photoelectric sensor. The stepping motor rotation state and the sensor feedback signal are under the control of the single-chip control system . The mini system schematic is shown in **Figure 2.**

Figure 2. Schematic diagram of the mini system of the microcontroller



Tracker design

This design uses two photoresistors to form a 45-degree tracking structure, the phtoresistor will convert to the size of the solar resistance of the size of the current resistance, and then through the Wheatstone bridge resistance into voltage changes. Through the proportion of operational amplifier circuit into suitable A / D analog input. The following describes in detail the devices used in this process.

Introduction to photoresistor

Photoresistor is the use of semiconductor photoelectric effect to create a resistance value with the intensity of the incident light to change the resistance. When incident light intensifies, resistance decreases. When the incident light is weak, the resistance increases.

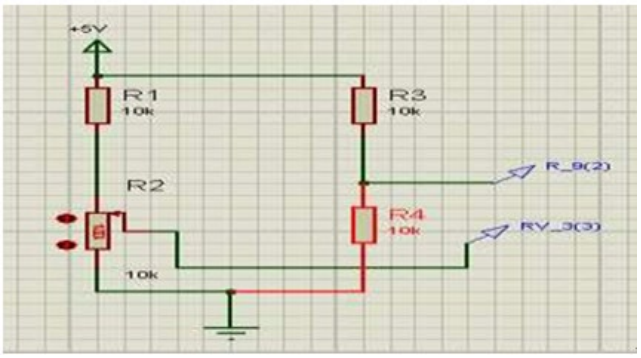
Photoresistors are fabricated in a thin film structure to absorb more light energy. When it is exposed to light, the semiconductor chip (photosensitive layer) stimulated the electron-hole pairs, involved in conduction to enhance the circuit current. In order to obtain high sensitivity, the photoresistor electrode is often used in comb pattern.

Under a mask, the photoconductive thin film is formed on the deposition of gold or indium and other metal. General photoresistor structure as shown below. Photoresistor is usually composed of photosensitive layer, glass substrate (or resin moisture film) and electrode. The photoresistor is indicated by the letter 'R' or 'RL', 'RG' in the circuit. Based on the requirements of this design, I use CDS photoresistor GL3537 with the dark resistance of 10K.

Introduction to Wheatstone Bridge

Bridge method measurement is a very important measurement technology. Because of the simple principle of the bridge method, the instrument has the advantages of simple structure, convenient operation, high sensitivity and high precision; it is widely used in electromagnetic measurement and widely used in non-electric quantity measurement. Electrical bridge can measure resistance, capacitance, inductance, frequency, pressure, temperature and many other physical quantities. At the same time, in the modern automatic control and instrumentation, these features of electrical bridge are often used to design, debug and control. The bridge is divided into two categories: DC bridge and AC bridge. DC bridge is divided into single-arm bridge and double-arm bridge. Single-arm bridge is also known as Wheatstone bridge, mainly used for accurate measurement of the median resistance. Two-arm bridge, also known as Kelvin bridge, is mainly used for accurate measurement of low-value resistance. This design is mainly the application of Wheatstone bridge to change the resistance changes into voltage changes. As shown in **Figure 3**:

Figure 3. Wheatstone Bridge



Since the dark resistance of the selected photoresistor is 10K, when R1 = R3, R2 = R4, the output voltage of the bridge is the most sensitive, called the arm bridge. Then the bridge output is VOUT = R1 / R1 * U, hence R1, R3, R4 also use 10k resistance.

Op amp LM358 Introduction

The signal collected by the photoresistor needs to be converted into a signal suitable for microcontroller processing via an operational amplifier circuit, thus justify the use of an integrated operational amplifier. This design selects the LM358 operational amplifier.

The LM358 includes two independent, highgain, internal frequency compensated dual op amps that are suitable for use in a wide range of supply voltage ranges and are also suitable for dual supply modes. Under recommended operating conditions, the supply current and power supply voltage are independent to each other. It uses in areas such as sense amplifiers, DC gain modules, audio amplifiers, industrial controls, DC gain components, and all other commercially available single-supply operational amplifiers. LM358 package is sealed in the form of plastic 8-lead dual in-line and patch type.

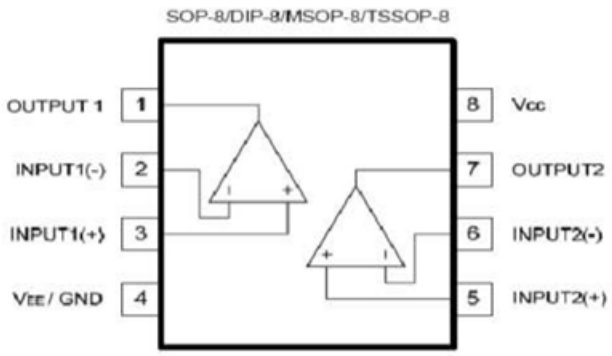
Features:

Internal frequency compensation. DC voltage gain is high (about 100 dB). Unit gain bandwidth (about 1 MHz). Wide supply voltage range: single power supply (3-30 V); dual power supply (± 1.5 ± 15 V). Low power consumption, suitable for battery power. Low input bias current. Low input offset voltage and offset current. The common-mode input voltage range is wide, including ground. Wide differential mode input voltage range, equal to the supply voltage range. Large output voltage swing (0 to Vcc-1.5 V).

Parameter:

Input bias current 45 nA. Input offset current 50 nA. Input offset voltage 2.9 mV. Input common mode voltage maximum VCC ~ 1.5V. Common mode rejection ratio of 80 dB. Power supply rejection ratio of 100 dB. LM358 pin diagram is shown in **Figure 4**:

Figure 4. LM358 pin diagram



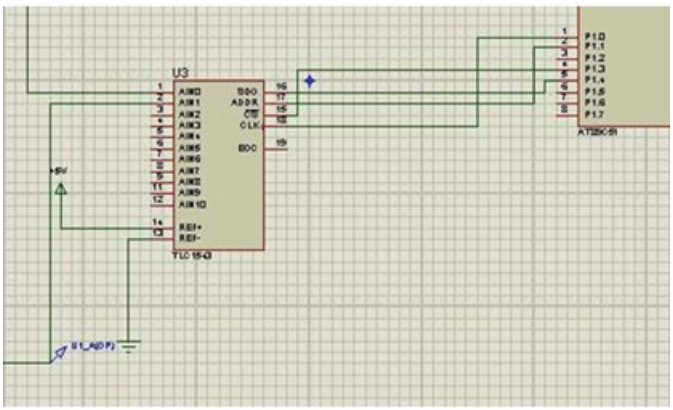
A / D acquisition circuit design

Serial output A / D converter, such as TLC1543. This type of A / D only requires 3 to 4 data lines and control lines can be controlled, and parallel port A / D to 8 data lines, 8 to 16 address lines, 2 to 3 control lines, and thus A / D use can simplify the circuit design, eliminating a lot of conventional circuit interface devices thus improving the reliability of the design.

TLC1543 have three control inputs CS, I / O, CLOCK, ADDRESS and a data input terminal DATAOUT, following the serial peripheral interface (SPI) protocol, which requires the microprocessor to have an SPI interface. But this design uses 51 series MCU does not have an SPI interface, hence there is a need to simulate the SPI protocol through the software and TLC2543 interface. P1.0 and CLOCK are connected in this design, P1.1 and ADDR are connected to each other, P1.3CS and (?) are connected, while P1.4 and DATAOUT are connected.

This design uses only two channels, A1 and A2, making the channel addresses 0000B and 0001B. REF + are connected to 5V power supply, REF- are grounded. This is shown in **Figure 5**:

Figure 5. Schematic diagram of A / D acquisition circuit



Stepper motor drive design

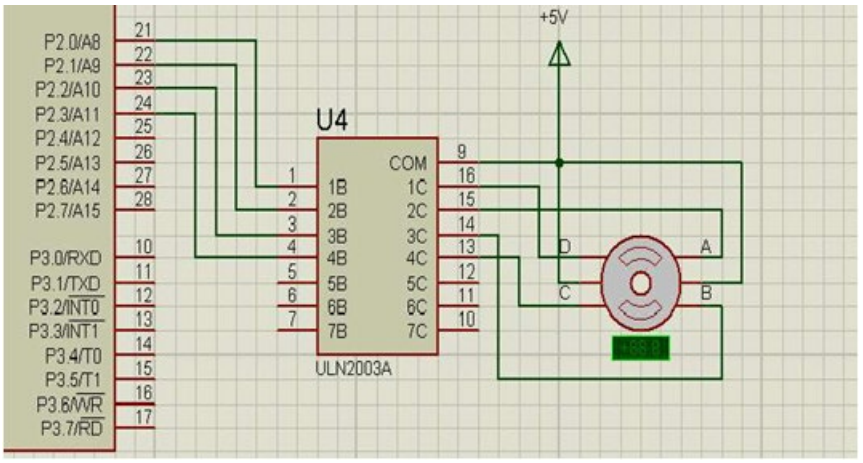
Using integrated chip ULN2003A.

Darlington tube ULN2003A can drive up to eight stepper motor, of course, using four or six lines is of no problem. This design I decided to use this method. The following describes the basic content of ULN2003A.

Single-chip software programming can make the complex control process to achieve automatic control and precise control, avoiding out-of-step, oscillation and other effects on the control accuracy. With software instead of ring splitter, through the single-chip set, with same circuit to more control and drive is achieved on the phase stepping motor, greatly improving the flexibility and versatility of the interface circuit. MCU's powerful features established organic combination of display circuit, keyboard circuit, reset circuit and other external circuit, greatly improving the system interactivity.

The pulse signal of P2.0-P2.3 output from the MCU is sent to the IN1-IN4 as input signal of ULN2003A, and the amplified output pulse signal of ULN2003A is used to drive the stepper motor. The COM end of the ULN2003A and the stepper motor COM1, COM2 are connected to the VCC. ULN2003A drive stepper motor module schematic diagram is shown in **Figure 6**:

Figure 6. schematic diagram of the ULN2003A drive stepper motor module



The method of adjusting the step pulse frequency of the output of the microcontroller:

A, software delay method to change the length of time delay can change the output pulse frequency, but this method allows CPU to wait for a long time and cannot carry out other work, hence there is no practical value. It can be used when demonstrating a stepper motor separately.

B, the timer interrupting method. In the interruption command, subroutine pulse output is operated and by adjusting the timer timing constant, speed control is achieved. This method takes less CPU time and it is a more practical speed control method.

With the microcontroller on the stepper motor speed control, is to control the time interval for each commutation. When the speed is increased, the pulse frequency is gradually increased and the deceleration is reversed. This design uses Scheme B.

4. Programming

The system is assigned a value by the initial value of the program and the initial value of the main function.

In this system, the use of software and hardware are combined with each other in order to achieve the corresponding circuit function, the use of the program is drive and control the hardware.

5. The system compiler

The use of large-scale programmable logic devices, such as FPGA, CPLD is allowed, but in current subject belongs to the control class. FPGA is acronym for the Field Programmable Gate Array. It is the further development in the basis of PAL, GAL, EPLD and other programmable devices. It is a kind of semi-custom circuit in the field of application specific integrated circuit (ASIC), which not only solves the shortage of custom circuit, but also overcomes the shortcomings of the limited number of original programmable device gates.

FPGA uses a new concept of logic cell array LCA (Logic Cell Array), including the configurable logic module CLB (Configurable Logic Block), output input module IOB (Input Output Block) and internal connection (Interconnect).

6. Conclusion

(1) Single-chip power supply: 7805 regulator chip and capacitor filter of the 5V regulator circuit as the main single- chip power supply

(2) Single-chip mini system: under the control of the single-chip control system, to complete the stepper motor rotation and the feedback signal of the sensor.

(3) Tracker design: photoresistor will be converting the intensity light of the intensity of the resistance, and then through the Wheatstone bridge the resistance changes are converted into voltage changes. Through the proportional op amp circuit converted into a suitable A / D analog input.

(4) Stepper motor drive circuit: driving solar panel rotation to ensure maximum utilization of solar energy.

(5) A / D acquisition circuit: used to convert a certain amount of analog to digital through a circuit

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