An electronic equipment-based nursing homes using "care dog" device

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Abstract - This article highlights the innovative concept and practical benefit of converting an intelligent automobile into an electronic "nursing dog" for a nursing home. The system was pre-analyzed. Then we constructed a software platform based on ARM core STM32F103 single chip microcomputer control automated control system, comprising the primary programme of automatic control, sensor data processing, voluntary obstacle avoidance, and robotic arm grasping method. The system also uses three communication technologies: wireless WIFI, Bluetooth, and infrared.

Finally, the system's stability and practicality were validated by collaborative debugging of the equipment's photovoltaic-assisted power production, autonomous driving, remote control, video transmission, and robotic arm intelligence. Grabbed and awaited relevant research.

Keywords: *STM32; photovoltaic; PID control; manipulator*

I. Introduction

Robots are now extensively employed in various sectors as mechanical structures that mimic human actions. Robots are high-tech products that combine several disciplines such as mechanical design and automated control. Researchers employ numerous sensors to acquire exterior information for the robot to increase its capacity to cooperate with the external world. Its huge and comprehensive data gathering, non-contact measurement, and wide application range make the vision sensor one of the most significant sensors. In recent years, increasing numbers of robots have been fitted with vision systems to improve intelligence and support the development of autonomous mobility technology.

The nursing home's computerised "dog buddy" technology may provide considerable physical and mental joy. It employs green energy solar power and can partially replace conventional accompanying dogs, overcome their drawbacks such as expensive training expenses, lengthy training time, and excrement pollution, and meet the goal of energy saving and emission reduction. It employs a cell phone for remote control and may aid older persons with bad legs. It employs the robotic arm's intelligent grasp to help the elderly and the camera image capture and WIFI data transmission module to monitor their safety in real time.

With precise remote control, solar auxiliary power supply, robot arm grasping, and video transmission, the basis is laid for future replacement of conventional escort dogs. The computerised "accompanying dog" equipment will someday penetrate our everyday lives, improving the quality of life and enjoyment of the elderly. Using STM32F103ZET6 as the control core, the following work was done:

Engineered the STM32F103ZET6 microcontroller-based electronic "accompany dog" device's construction. The concept of photovoltaic-assisted power production is presented.To complete obstacle detection and remote control, the technique of composite detection of many sensors is adopted, and the comprehensive processing technology of multiple sensors is researched.

With the use of three-dimensional stereo vision, the robot arm can swiftly gather two-dimensional information about the item, and the design may be based on real manufacturing. It can self-set the grasping technique and gripping object characteristics to achieve 360-degree intelligent gripping.

II. Design Scheme

The functions are independent of each other, allowing for future development. Figure 1 depicts the system's general block diagram.

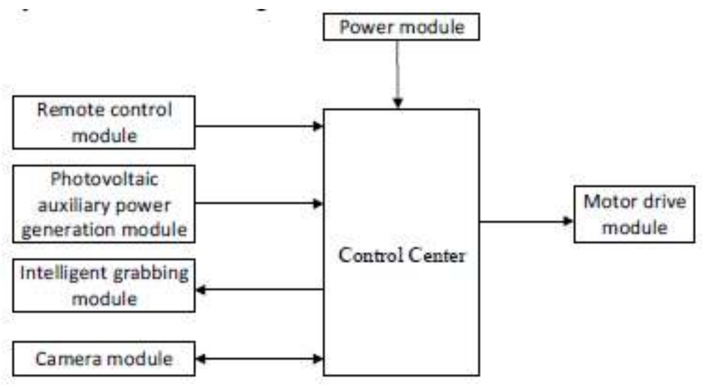

Figure 1. Overall system block diagram

III. Working Principle And Performance Analysis

A. *Working principle and performance analysis*

A solar photovoltaic panel, a controller, and a battery make up the majority of the photovoltaic auxiliary power supply module. In order to power the electronic "dog companion" equipment, the battery serves as the primary source of energy. Battery life may be extended and energy saved while also reducing emissions using a solar photovoltaic panel when sunshine is available. Due to environmental conditions including light intensity and temperature, a maximum power point tracking (MPPT) is needed for solar panels in order to verify that they operate normally and efficiently.

Using two solar photovoltaic panels linked in series, the auxiliary power supply module used in this work has each output power of 5V / 250mA, as illustrated in Figure 2.

Figure 2. Solar photovoltaic panels

Selecting an SPV1040 dc-dc converter to monitor the greatest power point and increase solar energy's conversion efficiency is done to maximise solar energy's use.

B. Remote control module

Using an Android phone as the Bluetooth remote control device's control terminal, you'll need to download an APP to your phone and use it to move the Bluetooth remote control device.

Instead of using a standard remote control, this approach creates communication control software for mobile phones. As long as the APP is running, pressing the control key can conveniently control the device to move forward, backward, turn left, and turn right, saving hardware costs and improving anti-interference performance.

C. Camera acquisition module

A lens, an image sensor, a PCB board, and a DSP chip are the essential components of the camera. During the time the subject is illuminated, the image sensor collects a charge proportional to the intensity of the light, which is discharged regularly to form an electrical signal that represents a frame of picture. This electrical signal is turned into a digital picture signal by the analog-to-digital converter, which then sends it to a single-chip computer for further analysis.

D. Degrees of Freedom Robotic Arm Module

For the 6-DOF mechanical arm, the most important components are an aluminium alloy bracket and an aluminum alloy claw. The robot arm can execute a variety of tasks when connected to a controller. An automated tool that can mimic the movements of human hands and arms in order to grip, transport, or operate tools in accordance with a predetermined process.

PWM servo and bus servo versions of the 6-DOF robot arm are available. The bus servo version is used in this piece of equipment. Six high-precision digital servos and controllers are included in the system. The PC graphical interface may be used to debug and save operations, and it can perform tasks such as grabbing things. Figure 3 depicts the 6-DOF mechanical arm bus servo version.

Figure 3. Manipulator bus servo

IV. Theoretical Design Calculations

A. PV module parameter selection

1) Chip Introduction

(1). Structure and working principle of SPV1040

The ST company's SPV1040 is a solar charger IC. It has an MPPT algorithm built-in, which makes use of the Perturb & Observe method. As a result of this, the charger's input impedance may be dynamically adjusted so that it perfectly fits the solar cell. The system's total energy efficiency and the efficiency of the transmission of energy between the battery and the battery.

Table 1 Charger status displayed by LED

Charging state	Describe	ST_1	ST_2
Charging	Precharge and fast charge	Bright	Extinguish
Charging completed	Charging current lower than I_{ENDTH}	Extinguish	Bright
Waiting	Input voltage below VBAT-50mV	Extinguish	Extinguish
Over / under temperature	The temperature is not within the setting range, too high or too low	Bright	Bright
Battery extraction	It is not possible to detect that the battery output voltage drops to V_{ABS} and T_{DETECT} has expired	Bright	Bright
Charging timeout	T_{MAXTH} or $T_{MAXPENCH}$ detected has expired	Bright	Bright

includes a solar panel boost circuit and a lithiu

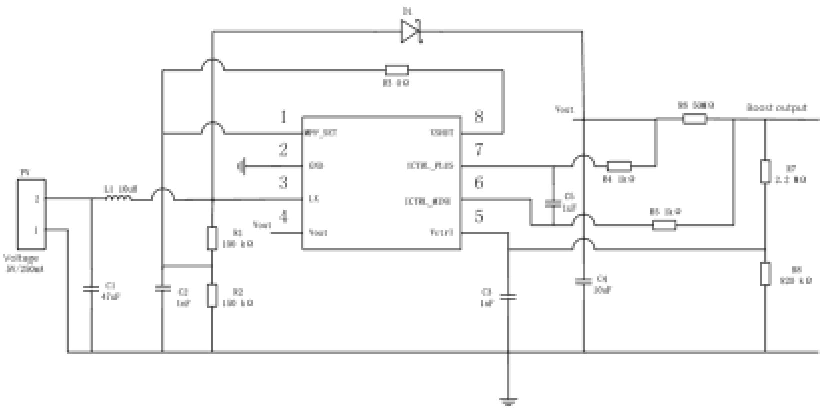

Figure 4. Solar panel boost circuit

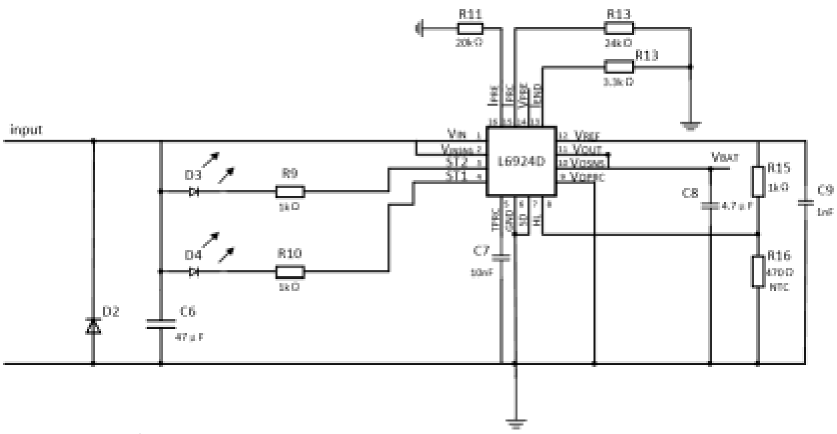

Figure 5. Lithium battery charge management circuit

Setting a low voltage The VOPRG terminal may be used to set the output voltage. A floating VOPRG outputs 4.1 volts, whereas a grounded VOPRG outputs 4.2 volts. Charging current may be set to remain constant. The IPRG terminal should be connected to GND through a resistor RPRG (R13 in Figure 5). The constant current charging current value ICHG may be changed by setting RPRG, and its size is calculated by the formula (4.1).

$$R_{PRG} = V_{BG} * \frac{K_{PRG}}{I_{CHG}} \quad (4.1)$$

Setting a consistent charging current is the first step. It is recommended to leave the VPRE terminal unconnected and to use the factory preset pre-charge voltage of 2.8 V. Pre-charge RPRE and pre-charge voltage are set to default values of 2.8 V in the RPRE and RPRE, respectively. In this case, volts is the grounded end value. An equation is used to calculate the RPRE value (4.1).

$$R_{V_{PRE}} = R_{PRG} * \frac{V_{PRETH}}{V_{PRETHdefault}} \quad (4.2)$$

Pre-charging at 10% of the continuous charge current is standard. Adding a resistor between IPRE and ground or the reference voltage VREF will set the pre-charge current value. The pre-charge current should be set higher than the default value, and a resistor should be connected between IPRE and ground. Equation calculates the additional resistance RPRE (4.1).

$$R_{PRE} = \frac{V_{BG}}{\frac{I_{PRECH}}{K_{PRG}} - \frac{V_{BG}}{R_{PRG}}} \quad (4.3)$$

A resistor is put between IPRE and the reference voltage VREF, lowering the pre-charge current value. When it comes to access resistance, we may use Equation to figure it out (4.1).

$$R_{PRE} = \frac{V_{PEF} - V_{BG}}{\frac{V_{BG}}{R_{PRG}} - \frac{I_{PRECH}}{K_{PRE}}} \quad (4.4)$$

Among them V_{REF} = 1.8V, K_{PRE} = 950, V_{BG} = 1.23V.

Constant voltage charging current can be considered complete when it reaches IENDTH. Connecting a resistor REND to the IEND terminal will allow you to connect IENDTH to GND. For REND's resistance, we may use equation (4.5).

$$I_{ENDTH} = V_{MIN} * \frac{K_{END}}{R_{END}} \quad (4.5)$$

Among them V_{MIN} is 50mV, K_{END} is constant 1050

B. Information fusion of obstacles

An APP on a smartphone or tablet may be used to take control of the device. The camera can avoid impediments by utilising its remote control device, which is controlled by the central processor and mobile phone app, when it detects an obstruction in its path. Various sensors are used to process different sorts of obstacles. They mostly employ ultrasonic, laser, infrared and other measures at that time.

These inexpensive and easy-to-use ultrasonic sensors have evident flaws in their practical application, such as a lack of focus and the inability to gather information about barriers' boundaries or distances. Directivity of the infrared light is excellent but it can only tell whether there are obstacles and cannot tell how far away they really are.

A mix of infrared photoelectric sensor, ultrasonic sensor, and camera capture is used to identify obstacles in this design.

C. Ultrasonic sensors

HC-SRO4 satisfies the standards of this article in every way. The time-of-flight technique of ultrasonic range is used in this design.

Figure 6 . HC-SRO4 ultrasonic sensor

Figure 6 depicts the ranging module's physical layout. The transit time technique is used to measure the speed of a vehicle. The range module receives a transmission signal from the main controller. The echo signal is first detected after the ultrasonic waves are sent by the module. An echo signal is picked up by this device, which then passes it to a single-chip microprocessor. The microcomputer then uses this information to determine how far away an obstacle is by pausing its programme and measuring the time difference t between sending and receiving an echo. (4.6) shows the computation formula:.

$$D = \frac{c\Delta t}{2} \quad (4.6)$$

c is equal to 331.4 m/s, which is the sound speed in air at normal pressure.

1) In addition, a portion of the sound waves may be communicated straight from the transmitter to the receiver after the ultrasonic sensor has transmitted ultrasonic waves. Ultrasonic sensors may also produce a so-called "blind zone" by transmitting a portion of the ultrasonic waves straight from transmitter to receiver, rather than waiting for an obstruction to be present or an obstacle to be present, which forms a blind zone. It's as simple as that:

2) Set the suitable distance between the transmitting and the receiving sensors;

3) 3) Use software to optimise. Calculate the arrival time of the interference wave depending on the location of the receiving/transmitting ultrasonic sensor during software processing. Interference may be efficiently prevented by disabling the interrupt at this time, which means the received signal data is lost.

4) Most of the ultrasound will skip the impediment if it is less than the length of the ultrasound. The ultrasound's distance information will be inaccurate at this point, and the results cannot be relied. As a result, we decided to use infrared photoelectric sensors as a secondary detecting method.

D. Infrared photoelectric sensor

To determine the item's location, the infrared photoelectric sensor measures the amount of infrared light reflected off the object.

The infrared light emitted by the sensor is reflected by the object and received by the sensor after it emits infrared light. Judging the strength and existence of light received, the target is identified. The HJ-IR2 photoelectric sensor is displayed in Figure 7 of this text. High and low level digital signals are sent out by the sensor as long as it is operational. In addition, the sensor is not sensitive to sunlight and may be utilised in the daytime without converting from digital to analogue.

Figure 7 . HJ-IR2 infrared detection module

The ultrasonic sensor and infrared photoelectric sensor work together to identify obstacles in this design. Figure 8 illustrates the sensor configuration mode.

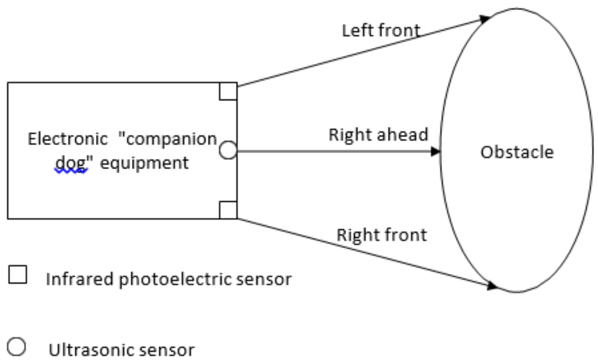

Figure 8. "Companion Dog" Sensor Setting

The gadget travels normally if the three sensors are unable to detect any obstacles. There are three ways in which the ultrasonic sensor detects obstacles:

1) There is no obstacle information on the left and information on the right, then:

$$d=\min(d_R, d_C) \qquad (4.7)$$

At this time, the device runs near the obstacle and turns left;

2) There is no obstacle information on the right side and information on the left side, then:

$$d=\min(d_L, d_C) \qquad (4.8)$$

At this point, the device runs near the obstacle and turns right;

3) There is obstacle information on both sides;

At this point the device backs off a certain distance and turns left

E. Robot Arm Configuration

1) Overview of steering gear

The motor is controlled by the control circuit board, which receives the signal from the signal line. Upon deceleration, the motor transmits to the output steering wheel through a sequence of gear sets. The position feedback potentiometer is attached to the servo's output shaft. The position feedback potentiometer is powered by the rotation of the steering wheel. The control circuit board receives feedback from the potentiometer through a voltage signal. There is a halt in the route and speed to the destination. Control signal to control circuit board to motor rotation to gear set deceleration to steering wheel rotation to position potentiometer to control circuit board feedback.

TBS-2701 digital servo, TBSN-K15 digital servo, and TBS-K20 servo make up the mechanical arm PWM servo version. TBSN-K15 digital anti-burning steering gear is used on the robot arm claw, for example. We utilise TBSN-K15 digital servos on the claws since the servo will stall if the claws need to grab anything. There are also digital servos, such as the TBS-2701 model, and servos, such as the TBS-K20 model. The robotic claw arm is one of them.

V. Innovation And Application Value

A novel electronic "accompanying dog" gadget has been created by combining photovoltaic power generation technology, remote control technology, video transmission technology, and intelligent grasping technology of the robotic arm.

Its innovations are:

1) Lithium-ion batteries can last longer if they are helped by photovoltaic power production, reducing the need for lithium battery replacement. It also saves energy and has environmental benefits.

2) Instead of a standard remote control, this system utilises a mobile phone-based communication control programme. It's easy to regulate the device's operation, save money on hardware, and increase anti-interference performance by hitting the control key when the APP is operating at all times.

3) Real-time video monitoring is possible, as is photo documentation of the immediate surroundings, thanks to the device's camera and WIFI data transfer module. It's possible to keep an eye on the well-being of the elderly by analysing the surrounding environment using the video footage that's been archived.

4) 6-degree-of-freedom Robotic arm intelligent grasping: The robotic arm may significantly enhance the quality of life of the elderly and the happiness index of the elderly by adapting the gripper size to the size of the item.

VI. Summary

"Humanistic care and concern for the weak have become the dominant theme in society. As the percentage of the population over the age of 65 rises, it is more important than ever to pay attention to the physical and mental well-being of the elderly. Elderly individuals in nursing facilities are less happy since they don't have the company of their children. In the past, accompanying dogs had to undergo extensive training that was costly and time-consuming, and they had to feed and drink Lazars on a regular basis, consuming not only food but also excrement. While "energy saving and emission reduction" is a popular tagline, it does not include the requirement for cleaning.

A few benefits may be gained as a result of the nursing home's electronic "care dog" technology

1) First, a solar panel can automatically charge the lithium battery, extending the battery's life and reducing costs and environmental damage; second, it can convert solar energy into electrical energy to power equipment, greatly reducing up energy consumption; and third, it can convert solar energy into electrical energy to power equipment.

2) This feature makes it easier for the elderly with limited mobility to regulate the electronic companion dog's actions.

3) Video transmission may also be used to monitor the health and safety of the elderly in real time.

4) The remote control module and the robotic arm's intelligent grasping module may work together to make everyday tasks easier and more precise.

Finally, the electronic "escort dog" is concerned about the physical and mental health of disadvantaged groups in terms of humanities and improves the happiness index of the daily life of the elderly; it can not only provide more convenience to the elderly's daily life, but also help their families monitor the elderly's safety. It's a win-win situation since it conserves food and reduces pollution. Because of the lower production costs, it can be used more widely in the economy. The nursing home's electronic "care dog" technology may increase the elderly's happiness quotient as well as their everyday lives, and can be extensively employed in their daily lives.

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