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REMOTE-CONTROLLED ROBOTIC ARM USING RF

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Abstract

Within this compendium, we shall delve into the intricacies of a novel appendage devised with six versatile planes of movement. This innovation enables the user to pick up items at specific weights and transport them efficiently to desired locations. Robotic arms have become quite essential in today's modern scientific developments as well as space exploration missions. The novelty behind this implementation lies within its remote-control capabilities powered by radio frequency technology which guarantees ease of use while preventing human workers from carrying out dangerous tasks themselves. With their high degree ranges, robotic arms are optimal for industrial applications including arc welding processes, material handling methods or even machine tending/packaging. This paper aims at designing an affordable yet highly efficient robot arm specifically designed for educational purposes; it should be able not only to sort but also place objects accurately whenever needed ultimately increasing efficiency levels among learners/instructors on orientation activities. Robots can relieve humans from various hazardous activities allowing people other opportunities like interfacing directly with customers instead! The three components that make-up these robots include: receiver-transmitter-and-robotic-arm itself all working together cohesively under RF control serving multiple sectors such astronomy industries (mining). One major benefit offered here includes less dependence upon line-of-sight communication delivery systems promoting versatility amongst users alike! Pick & Place patterns prove extremely useful since most manufacturing/logistics revolves around quickly delivering goods thus making robotics crucial tools within supply chain management dynamics therefore beneficial industry-wide regardless region/marketing arena involved assuring growth remains steady into future generations too!

Keywords: Robotic Arm, Object transportation, RF remote, RF transmitter, and receiver, Degree of freedom, Modern manufacturing, Logistics, Remote control, Radiofrequency technology, pick and place robots

Introduction

Science and technology possess a broad impact on current civilization, including areas like defence, the business, healthcare, transportation, modern agriculture, industrial manufacturing, and many others. Science and technology's fruits pervade every element of our daily lives. Science and technology have vital functions in today's world. Science and technology are required in every aspect of our lives to create fresh avenues of learning. Science and technology contribute to the improvement of education.

The goal of this project is to develop and build a low-cost, high-efficiency object transportation robot for educational and orientation purposes. Despite the fact that several types of robotic arms are currently in use in the field of industrial manufacturing, this project is all about item transportation using robotic arms.

Embedded System

The embedded system approach is used to complete this project. This robot has three basic components: a receiver, a transmitter pair, and a robotic arm. An embedded system is a set of computer hardware, software, and sometimes other mechanical or other components designed to fulfil a certain purpose. An embedded system is a microcontroller-based, software-driven, dependable, real-time control system that is autonomous, human- or network-interactive, acts on a variety of physical variables, functions in a variety of settings, and is offered in a competitive and cost-conscious market.

Micro-controller

In this project, a 2051 microcontroller (AT89C2051) is employed. The 2051 is now an 8051 having 20 pins. It is a low-voltage, high-performance CMOS 8-bit microcomputer with 2K bytes of programmable and erasable read-only memory in Flash. The MCS-51 instruction set is compatible with the 2051. The 2051 is a powerful microcontroller that integrates a programmable 8-bit CPU and Flash on a single system. It delivers a very customizable & cost-effective solution to many embedded control applications.

The mechanical structure of a robotic arm

This paper's robotic arm is comprised of two primary elements: a basic structure and then a wrist. The first five links (body) of this robotic arm are the base, waist, shoulder, arm, elbow, and forearm, while the other link is its wrist or hand. A robot link is a solid mechanical structure that links two joints. The basic objective of robot links is to keep the joints at their ends in a stable connection. A robot manipulator is made up of links that are joined by joints which are operated by independent motors. The wrist is intended for directing the end effector to perform a task or grip an item.

Degree of Freedom

The degrees of freedom of robotic systems determine them (DOF). Each degree of freedom symbolizes a joint on the arm, enabling it to bend, swivel, or translate. The number of actuators on the robot arm is frequently employed to estimate the number of degrees of freedom. Each degree necessitates the use of an actuator, frequently an encoder, as well as progressively complex algorithms. This paper's robotic arm has degrees of freedom.

Overview of links

- Link 1: At J1, the waist is adjusted into the hollow cylindrical portion of the base. Link 1 (J1) allows waist rotation (θ1) about the y-axis.
- Link 2: At J2, two gears are coupled. A motor has used for the angular movement of the arm using gears as a power transmission medium. link 2 (J2) allows arm rotation (θ2) about an axis that is perpendicular to the y-axis which means the z-axis.
- Link 3: At J3, for the angular movement of the forearm, power is transmitted through the chain & sprocket system. The motor which is used for the angular movement of the forearm, has been in such a way that its shaft meets at the same level as the motor shaft which is used for link 2. link 3 (J3) allows rotation (θ3) of the forearm along elbow about an axis which is parallel to the z-axis.
- Link 4: At J4, wrist is linear in rotation (θ4) along y-axis to grasp an object.
- Link 5: At J5, the shoulder can be moved through the waist with a sliding motion. Here rack & pinion are used as the power transmission medium. link 5 (J5) allows a linear movement (L1) of the shoulder along the x-axis.
- Link 6: At J6, the base can be moved in an upward and downward direction along with slots into the rectangular box. To facilitate this vertical motion an automotive lifting system has been used at J6. link 6 (J6) allows upward and downward movement (L2) of the base along an axis that is parallel to the z-axis.

Workspace of a robotic arm

The robot workspace (also known as accessible space) is a collection of places that the end effector (robot arm) can reach. The workspace is determined by the DOF angle/translation constraints, arm link lengths, the angle at which an object must be picked up, and so forth. The workspace is highly reliant on the robot design. The vital structure's movement range-

• hand and wrist 360°

• Shoulder-Linear(L1)-0L18 inch

• Base-Linear(L2)-0L212 inch

Ease of maintenance

During a heavy-load operation, any part of this robotic arm may be impeded or need to be updated. Due of its modular construction, each component of this robotic arm's structure is ego. As a result, a professional person is not allowed to reassemble or assemble the entire framework of this robotic arm. As a result, anyone can work on any part of the construction without bothering the others. Its robotic arm's economical design allows for simple lubrication. Its automated hand's design also simplifies the scope if any updates are required for the robotic arm to cope with any new sophisticated process designs or to facilitate.

Implementation process

The actual product development is split into two stages: creating the motherboard for the robotic arm to drive the motor and building the wireless controller for the wirelessly stick to remotely command the robotic arm.

Robot motherboard

Gateway for Programming

The robotic arm was programmed using Keil, an ARM Corporation, and the KEIL MICRO VISION IDE (Integrated Development Environment) board. Keil is a cross-compiler. It is a microcontroller board based on the AT89C2051. A 20-pin variant of the 8051 is the 2051. It is a low-voltage, high-performance CMOS 8-bit microcomputer with 2K bytes of Flash programmable and erasable read-only memory, a USB connection, a power connector, an ICSP header, and a reset button. A free Vision2 is also available for programming the board that was used for developing and uploading the hex code to the microcontroller. C is the programming language used by IDE.

Wireless joystick (RF modules)

Regarding wireless transmission, a Radio Frequency (RF) Transceiver Module is deployed. An RF Module is a tiny electrical circuit which permits rf signals to be broadcast and/or retrieved on one of multiple carrier frequencies. Because of the difficulties in developing radio circuits, RF Modules are frequently utilised in electrical design, and they are easily available on the market. Because of the complexity of radio circuits and the accuracy of components and layouts required for function at a specific frequency, good electronic radio design is notoriously tricky. RF is becoming nearly synonymous with wireless and high-frequency communications, defining anything from AM radio between 535 and 1605 kHz to work computer LANs at 2.4 GHz.

Features

- Range in open space (Standard Conditions) : 100 Meters
- RX Receiver Frequency: 433 MHz
- RX Typical Sensitivity: 105 Dbm
- RX Supply Current: 3.5 mA
- RX IF Frequency: 1MHz
- Low Power Consumption
- Easy For Application
- RX Operating Voltage: 5V
- TX Frequency Range: 433.92 MHz
- TX Supply Voltage: 3V ~ 6V
- TX Out Put Power: 4 ~ 12 Dbm

Description

- **Standard Connections To 8051 Series Micro Controller**

Some standard connections are required for the ATMEL family of 8051 microcontroller families. The exact identifier of the Microcontroller might be "89C51", "89C52", "89S51", or "89S52", and in the 20-pin form multiple "89C2051". The four sets of I/O ports are employed based on the project requirements. Every microcontroller requires a timing reference for internal program execution, hence an oscillator with a required frequency must be operational to acquire the timing reference as t =1/f.

A crystal with a frequency range of 2 to 20 MHz must be used at PINs 18 and 19 for the internal oscillator. It must be observed that the crystal is not to be viewed as a crystal oscillator. This is kind of a crystal that, when attached to the relevant pin of the microcontroller, causes the microcontroller to perform oscillator functions. Most circuits using 8051 series microcontrollers use an 11.0592 MHz crystal. As demonstrated in the circuit schematic, two tiny value capacitors of 33pF each are chosen as common connections for the crystal.

RESET

Pin 9 has a re-set arrangement made up of an electrolytic capacitor and a register that forms an RC time constant. When the switch is turned on, the capacitor charges and acts as a complete short circuit from positive to PIN 9. After the capacitor has been fully charged, the current quits to flow and PIN 9 hits low, which itself is dragged down to earth by a 10k resistor. This layout of reset at pin 9 going high at first and subsequently to logic 0, i.e., low, permits the code to restart at the beginning. Throughout the elimination of this, code could have occurred at any point in the oversee implementation. A button switch is linked across the capacitor, which can be touched at any time to drain the capacitor. While freeing the capacitor, it proceeds to charge again, and PIN 9 goes high and thereafter back to low, letting the system to run from the start. The operation of the reset pin from high to low takes a few seconds, as determined by the time variables R and C.

For illustration, a 10F capacitor and a 10k resistor would give PIN 9 a 100ms length of time spanning logic high to minimal, after which PIN 9 would remain low.

External Access (EA):

To access the data via the integrated memory address, pin 31 of 40 pins 8051microcontrollersr should be coupled to 5V. If it is grounded, the controller reads the data from secondary storage. But, we're using internal memory, it's always powered to +5V.

L293D MOTOR DRIVER

1. As shown in the diagram, the L293D has two pairs of structures: each with input 1, input 2, output 1, and output 2, while the other has input 3, input 4, output 3, and output 4.

2. If enable 1 and PIN 2 both are high but PIN 7 is low, then motor drives forward.

3. If enable 2 and PIN 10 both are high and PIN 15 is low, the motor drives forward.

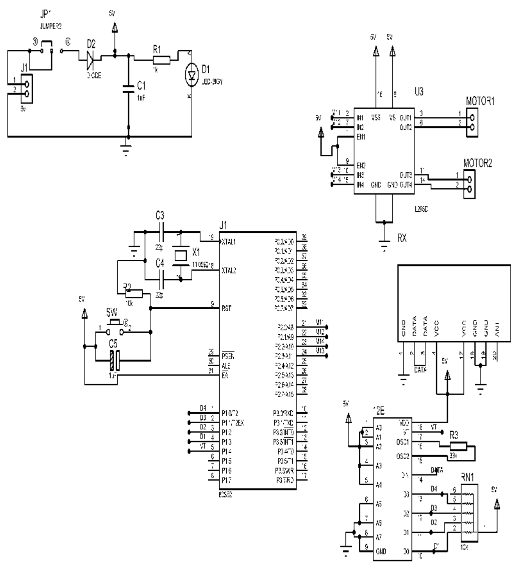
4. If enable 1 and PIN 2 both are low and PIN 7 is high, the motor turns in the other direction.

5. If enable 2 and PIN 15 both are high and PIN 10 is low, the motor drives forward.

ENCODER AND DECODER

The ENCODER IC inside this work is HT12E, while its DECODER IC is HT12D. The CMOS-based ICs function at variation exists between 2.4V to 12V. Its HT12E encoder has 8 address/data lines in altogether. Information is placed on these lines and serially delivered after the transmission enabled (TE) pin, pin 14, shifts from high to low. The data is transmitted four times in a succession and is made up of various durations of both positive and negative pulse. Pins 15 and 16 are utilized to set the oscillator frequency of RC time constant, where C is built in and we just need to change R by putting a resistance between the pins to control the oscillator frequency. The decoder IC has an internal oscillator frequency that is 50 times that of the encoder. The frequency setting in the decoder IC is set at around 51kohms, however various values can be chosen depending on the graph. When the encoder gets a transmission enable (TE) signal, it begins a c1-word transmission cycle. If the transmission enable (TE) remains low, the above procedure will repeat continuously. The encoder output will stop working once the transmission enable (TE) turns to a happy voltage.

Schematic Diagram: -



Operation Explanation

TRANSMITTER:_ The voltage supply's 5v output is linked to the MC's 20th pin, while GND is linked to its 10th pin. Pins 1-3 of MC are connected to a set of buttons. The Reverse, Stop, Forward, Left, and Right buttons are wired to MC pins 7,

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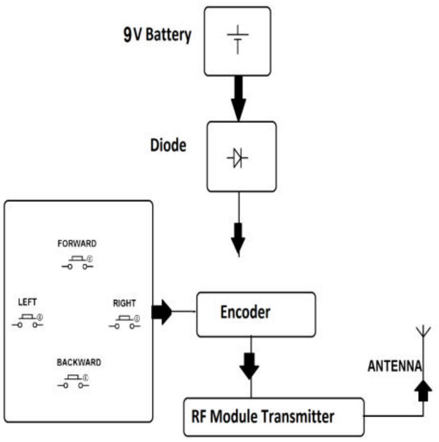
8, 9, 3, and 12. Pins 19, 18, 16, and 15 of the MC are linked to Pins 10, 11, 12, and 13 of the encoder HT12E. GND gets connected to HT12E encoder's pins 1-9.

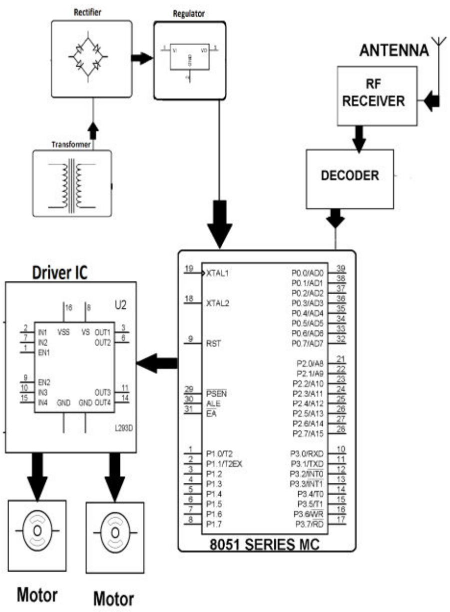
RECEIVER: Pins 1–4 of MC are linked to pins 13–10 of a HT12D Decoder. Pin 10 of MC is linked to Pin 17 of HT12D Decoder. The HT12D Decoder's 14th pin is wired to the Receiver's DATA pin. Pins 28 and 27 of MC are linked to Pins 7 and 2 of L293D. MC pins 26, 23, 28, and 21 are linked to L293D Driver pins 1, 9, 10, and 15. Motors 1 and 2 receive L293D pins 3, 6, 11, and 0014.

Block Diagram: -

Transmitter



Receiver

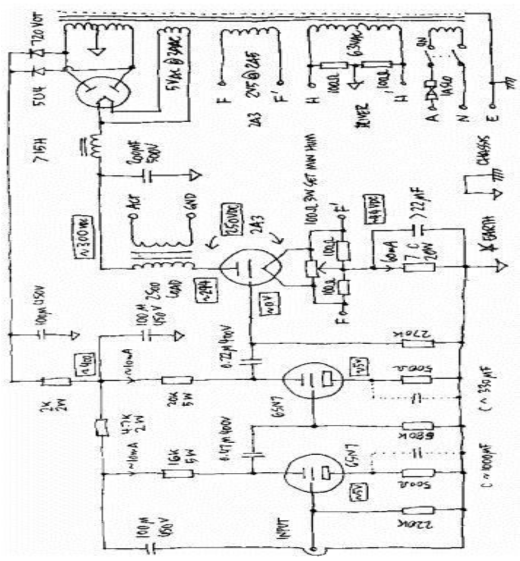


WORKING:

An HT12E encoder has been utilized in this work to decode 4-bit data streams via pins 10, 11, 12, & 13 to sequential data at pin 17. As stated earlier, this data is subsequently sent to the RF module for transmission to a receiver RF module. This received output is sent to the serial decoder IC HT12D, and even the 4-bit similar data is sent to controller Pins 19, 18, 16, & 15. The transmitting end MC is attached to port 3 of the 20-pin MC AT89C2051. And hence, when a specific button is hit, the code executes and provides good 4-bit data, then it is serially sent as stated earlier. The received data at receiver of port 1 drives the motor through the motor driver IC L293D, that is connected to the microcontroller output port 2.

This transmitter is fuelled by 6v battery connected in series with a silicon diode, which assures a 0.6v drop to provide 5.4v for microcontroller circuit demands. Despite the fact that this voltage is greater than the suggested voltage of 5v, the tolerance factor aids in the MC's operation. The receiver is powered by a 6v battery connected in series with a silicon diode to guard the circuits from unexpected reverse battery connection and emits about 5v dc out of the 6v available from the battery, which is sent to the controller, decoder, and the motor driver IC L293D pin 8 for operation as stated earlier. A detector circuit is employed, that includes a tuned occurring with a 25-turn coil of 12 ” diac of 30 SWG in conjunction with two capacitors C2 and C3, with Q4 defining the oscillator's precise frequency. A 5k potentiometer, i.e., p1, is used to modify the sensitivity. The output of this resonant circuit is sent to Q2, which is in emitter follower configuration with suitable filtering to forward bias Q3, which causes Q4 to be in condition stage, so the alarm connected from positive supply to Q4's collector doesn't really obtain any power so it does not produce sound. As the coil encounters a metallic item, the frequency drifts away, reducing the control voltage to Q3, that in then switches on Q4 for the buzzer to grab power and sound appropriately, in addition to the L, LED growing to signal the presence of the metal target. Metal detectors are fuelled by a 9V battery.

Circuit Diagram: -



Hardware testing

Continuity Test:

Following the completion of hardware setup and soldering, this test is run. Finding electrical open channels in the circuit after soldering is the goal of this test. The loss of electrical continuity in a circuit frequently results from poor soldering, inappropriate handling of the PCB, improper use of the soldering iron, component failures, and flaws in the circuit diagram. For this test, a multimeter is employed. While still in buzzer mode, we connect the multimeter's ground wire to the ground. Throughout the path that has to be examined, we link the two terminals. You'll hear a beep if there is a continuation.

POWER ON TEST:

This test is used to determine whether or not the voltage at various terminals meets the requirements. The voltage mode is selected on the multimeter. First, check the voltage throughout the battery terminal to verify whether it is completely charged or not; the battery in this project is 12V, so contact the 'red terminal' of the battery with the 'red probe' of the multimeter and the 'black terminal' of the battery with the 'black probe' of the multimeter; if 12V is displayed on the multimeter screen, we may proceed to the following stages.

Case study

Results and discussions

Conclusion

Using an embedded system-based AT89C2051 microcontroller board, we constructed a robotic arm in this article that can be steered in a variety of ways. We substituted geared motors for highly-reduced brushless or brushed motors since they have a high torque at low speeds. For the envisioned target application of robots interacting with unstructured surroundings such as a normal house or office, where the safety of intrinsic mechanical compliance is a key design factor, these design trade-offs were made.

These robots have several industrial and medical uses, including pick-and-place robots, surgical robots, etc. The gripper has the ability to lift items. To some extent expand it, more complex tools and materials, such as spot or arc welding guns, spray painting guns, drilling spindles, grinder wire brushes, and heating torches are to be utilised for installing the instruments that are gripped by mechanical grippers. Then, in addition to the automobile sector, it will be suitable for ceramic, paint, and foundry businesses.

The specific work we have finished is as follows:

In order to ensure smooth motor control, we examined and refined the development board and verified the electrical connection between the microcontroller and the motor driver.

We managed to build the software to detect the input signal sent by the transmitter and control the dc and servo motors with the Microcontroller after adding the RF-Module.

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