Reverse Parking Radar with AT89C51

AU414 : MICRO-CONTROLLERS AND THEIR APPLICATIONS

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Introduction

All the source code used for this project, including the detailed files for managing the sensors, buzzer and LCD screen, is available on our GitHub repository at the following link:

https://github.com/Yomguy25/AU_414_microcontroller_project

Check the video of the system via the link :

https://youtu.be/PofF9yYSIIc

OBJECTIVE:

The main objective of this project is to design and develop a prototype proximity detection system, similar to a reversing radar for parking a vehicle, based on an AT89C51 microcontroller. The aim of this academic project is to implement theoretical concepts studied in class and apply them in a practical context, integrating electronic components and programming techniques to produce a functional system.

The detailed objectives are as follows:

- Understand and apply microcontroller concepts:

Exploit the capabilities of the AT89C51 microcontroller to manage the collection, processing and display of data from an external sensor.

Use C or Assembly programming techniques to control the various hardware components.

- Development of a Proximity Detection System:

Integrate an ultrasonic sensor (HC-SR04) to measure the distance to an obstacle in a given environment.

Efficient conversion of raw data into understandable, usable values.

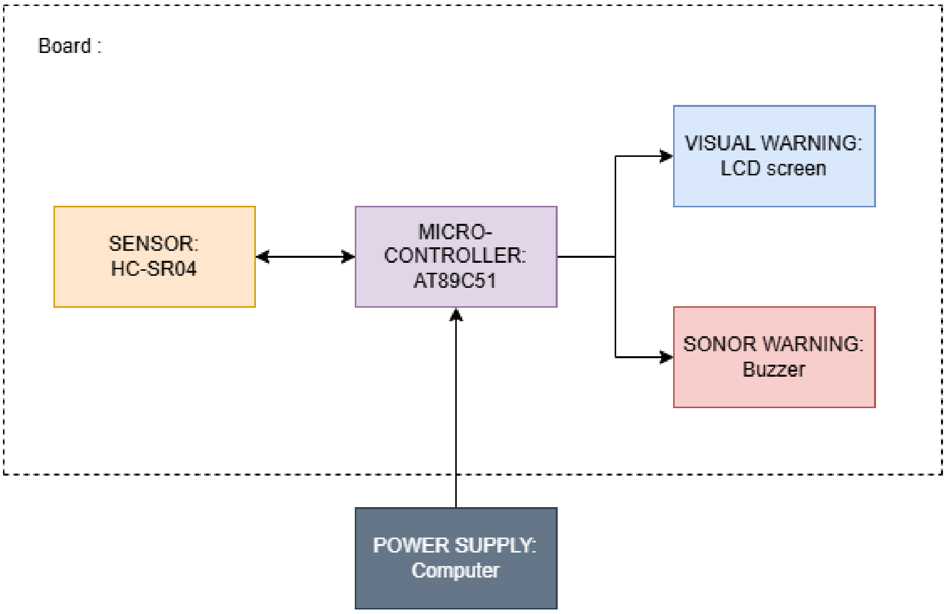
- Visual and audible warnings:

Provide audible feedback via a buzzer, depending on the distance thresholds detected. The sound should vary according to proximity, to illustrate the progression of the risk.

Set up a real-time display on an LCD screen to show measured distances.

Methods:

I - BLOCK DIAGRAM :



The block diagram shown illustrates the main components of the reversing radar system based on the AT89C51 microcontroller. It highlights the interactions between the HC-SR04 ultrasonic sensor, the microcontroller and the user feedback modules. The sensor detects the distance of obstacles and transmits the data to the microcontroller, which processes it to generate visual alerts via the LCD screen and audible alerts via a buzzer. The whole system is powered by a power source supplied by a computer. This diagram clearly reflects the modular structure of the system and the distinct roles of each component in the detection and warning process.

II - IMPLEMENTATION :

A) System initialisation

The code starts by configuring the pins and ports used to connect the sensor, buzzer and LCD screen. The pins on port P3 are used for the HC-SR04 sensor: pin P3.0 to send a 'Trigger' signal and pin P3.1 to receive an 'Echo' signal. The LCD display is connected to ports P2 (for control pins) and P0 (for data), while the buzzer is controlled by pin P2.5.

B) Distance measurement with the HC-SR04 sensor

The distance is measured using the capabilities of the HC-SR04 sensor, which sends out an ultrasonic pulse and measures the time it takes for the echo to return. The following sequence is implemented in the code:

1. A 10 µs pulse is sent via the Trigger pin to activate the sensor.
2. The echo time is measured in microseconds using a counter based on Timer 0 on the microcontroller.

3. The distance is calculated from the measured time using the formula :

$$Distance = \frac{echo\ time * sound\ speed}{2}$$

Division by 2 is necessary to take into account the round trip of the ultrasonic signal.

C) Visual and audio warning management

Once the distance has been calculated, it is displayed on the LCD screen in real time. A function is used to convert the numerical data into a character string before transmitting it to the LCD. If the distance detected is below a critical threshold (e.g. 15 cm), the buzzer is activated to emit an audible signal. The frequency and duration of the audible alert varies with the distance to give a clear indication of the level of risk. The LCD screen is also used to display the raw values (machine cycle) measured by the sensor and the calculated distances, making it easy to check and understand the results.

D) Programme structure

The code is structured in a modular way to make it easier to read and maintain. Each function has a well-defined role:

- `lcd_command` and `lcd_data`: Manage the sending of commands and data to the LCD.
- `send_trigger` and `measure_echo_time`: Control the sending of a trigger pulse and the measurement of the echo time.
- `buzz`: Activates the buzzer at a defined frequency and duration.
- `calculate_distance`: Calculates the distance as a function of the measured time.

This modular approach makes it easy to test and reuse each component of the code.

Discuss

The results of this project are broadly in line with our objectives. We are satisfied with the way the system works, which has demonstrated effective integration of the various components. The HC-SR04 sensor accurately measures the distance to obstacles, and the data collected is correctly processed and displayed in real time on the LCD screen. The LCD works perfectly, providing a clear and reliable reading of the distances measured.

The buzzer also plays its part, providing sound feedback proportional to the distance detected. However, we found that the volume is relatively low, which could limit its effectiveness in noisy environments. A potential improvement would be to use a more powerful or better adapted buzzer, guaranteeing better sound perception.

These performances show that our system is functional and could be used as a prototype for a real application, while leaving room for a few improvements to enhance its effectiveness and robustness.

Prospective

This project offers a number of opportunities for development and diversification. Here are a few ideas to take it further, such as:

- Improving the warning system:

Integrate an LED or a series of LEDs to provide additional visual feedback as a function of distance. Add a more powerful buzzer or a loudspeaker capable of modulating the sound to indicate different levels of risk.

- Connectivity and remote control:

Add a Bluetooth or Wi-Fi module to transmit distance data to an on-board computer. Develop a mobile app to record data for later analysis.

- Extended functionality:

Enable multi-angle detection using multiple HC-SR04 sensors to cover a wider field of view. Integrate a camera to provide a visual view of the rear of the vehicle, to complement the radar.

By developing these ideas, the system could become even more versatile and relevant, whether for automotive, robotics or even home automation applications. This project provides a solid basis for exploring these possibilities and continuing to innovate in a variety of contexts.

References

[1] STC89CXX--Datasheet.PDF

[2] Keil Manual.pdf

[3] HC6800-ES V2.0 新版.pdf