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Design and Implementation of Intelligent Vehicle System based on ARM Cortex

Anagha Vaidya [1], Mahesh T. Kolte[2]

ME student, Department of Electronics and Telecommunication, MITCOE, Pune, India [1]

Professor, Department of Electronics and Telecommunication, MITCOE, Pune, India [2]

Abstract: This paper gives the design and implementation of the intelligent vehicle system using ARM cortex M4 as core controller for the purpose of safe and comfortable driving. Since ARM cortex M4 comes with many different features such as high efficiency, low cost and low power consumption. The system uses the speech recognition principle to improve the interaction between the human and machine. The system gives experimental results for five voice commands that are forward, backward, left, right and stop. The highly accurate ultrasonic sensor is used to detect the objects around the car. The system uses the CNG sensor which is highly sensitive to natural gas to detect the leakage of CNG from CNG kit, which is mostly used in vehicle nowadays.

Keywords: Intelligent vehicle, ARM cortex, speech recognition principle, CNG sensor, ultrasonic sensor.

I. INTRODUCTION

The fast life of today makes us to arrive at our destination as soon as possible. So with this changing lifestyle the safety and comfort of vehicle is becoming an important factor. In the recent years, there has been tremendous increase in the development of technology that has allowed the concept of a intelligent vehicle system to emerge at an revolutionary scale. The support and effort in research from leading car developers shows that this concept has industrial support and can be expected to take a place in the future car. The terms smart car and intelligent vehicle are rather broad and can contain anything that has to do with making the car aware of and reacting to the environment.

The ARM cortex based embedded system has many different features such as high performance, architectural simplicity, cost sensitive and ultra low power consumption. So the ARM microprocessor is used in the control system for intelligent vehicle system. The ARM Cortex offers intensify debug attributes and a superior level of support block unification. The embedded system based on ARM has good performance and portability. Hence, it has been widely used in various industries nowadays [1].

To establish the communication between individuals and machine the highly popular medium is speech. Due to the popularity of speech recognition system, speaker recognition has achieved lot of importance in various fields such information processing, education, business applications, consumer electronics etc. Applying speech recognition technology to the car can makes car more intelligent and more users friendly. Voice controlled car is one of the typical application of speech recognition technology which is mostly used. By using the voice controlled system the driver can keep his hand on the steering wheel and eyes on road to avoid any accidents. This could be a way to enhance driving safety on the condition that the communication between the driver and the system works well.

The speech interface should provide the driver an easy way to communicate his message to the information system. The interface also has to provide the driver with comprehensible output [2].

The main focus is on automotive sensors in production of sensors. In recent years there are new 21 types of automotive sensors and 25 new features are available in automotive sensors. Along with this, there are 14 new automotive system applications for sensors are available.

There are six types of sensors based on rotational motion, four types of sensors for pressure, five types of sensors for position, and three types of sensors for temperature. Along with this there are also two types of sensors for mass air flow, five types of sensors for exhaust gas oxygen, one type of sensor for engine knock, four types of sensor for linear acceleration, four types of sensors for angular-rate, four types of sensors for comfort and convenience, two types of sensors for near distance obstacle detection, four types of sensors for far distance obstacle detection and ten types of emerging sensors are available [3].

Compressed natural gas (CNG) is used as a clean alternative fuel with many different advantage in resource, environment protection, economy and social security. CNG (Compressed Natural Gas) is a new ideal replaceable energy for vehicles. CNG has the advantage of low cost, high benefit, pollution-free and simple operation, it attracts more and more attentions from each parts of the society because of increasing serious environment questions. Recently, the natural gas automobiles are becoming more and more popular. But due to leakage of CNG there can be number of accidents. To avoid this a CNG sensor can be used. Similarly, the ultrasonic sensor is used to avoid obstacle and to avoid accident.

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Some of the existing intelligent vehicle systems based on voice recognition and different sensors are explained in section II.

II. RELATED WORK

Chunru Xiong et al. [1] designed a intelligent vehicle control system using voice-driven principle and LCD display which makes the car more user friendly and increase machine human interaction. The vehicle control system also uses a ultrasonic obstacle avoidance module with high accuracy for safety. The LPC2138ARM embedded microcontroller and real-time operating system is used for intelligent car control system. This system can be used in mobile robot, in intelligent toys, and other areas.

William J. Fleming et al. [3] focuses on the different area of automotive sensors. There are three main areas of automotive systems application for sensors i.e. power train, chassis, and body. The power train areas of sensors are handled by some rules such as low leakage, advanced fuel economy etc. The alternative power sources should be available. The chassis system need for sensors are handled by factors such as safety, less weight, multiple compatibility etc and rules such as collision avoidance and tire pressure. The body systems for sensors are handled by factors such as safety, comfort and convenience. The body system need. The speech interface should end for sensors include improved airbags, side crash protection etc.

Parichart Leechar et al. [4] designed a voice recognition system using radio controlled car. The similarity of the voice commands and the environment in which testing is done are important to test the correctness of voice recognition system. If the environment is noisy then the accuracy is low. The result also shows that the accuracy of noisy environment is low than the quiet environment and office room.

Ai Lin GAO Et Al. [5] focuses on the design of the intelligent vehicle system based on SPCE061A single chip. The hardware design includes SPCE061A as main controller and use transistors to make H-bridge driver control circuit board to control the motion of the car. The results shows that the car can be controlled by the voice commands such as moving left, moving right, moving forward, moving backward and stop.

III.SYSTEM DESIGN

This section introduces the approach of creating a system of an intelligent car controlled by using voice commands and different sensors. The fig.1 shows the block diagram of a system.

A. Block Diagram

The proposed system consists of an ARM cortex M4 controller which is use as core controller. The system consists of an CNG sensor use to detect leakage of compressed natural gas from the CNG kit. The buzzer is use for indication of leakage of gas. The ultrasonic sensor is placed in front of vehicle to detect the objects. The speech recognition is for identification and execution of the voice command. The DC motors are used as actuators to demonstrate the voice commands.

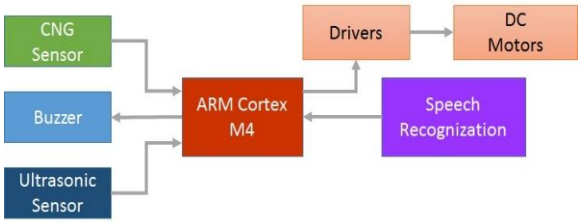

Fig1: Block diagram

B. Voice Identification And Flow Chart

The speech recognition is divided into two phases i.e training and identification phase. The traning phase include the training of the system with some basic voice commands which include forward, backward, right left and stop. The identification phase include the identification of voice command depend on certain criteria and parameters.

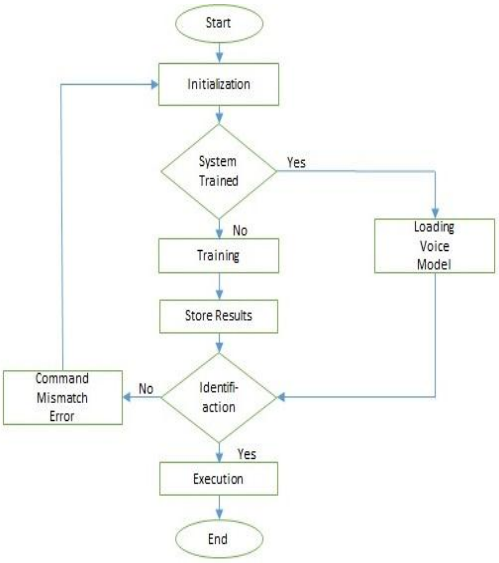

Fig2: Flow Chart Of Voice Identification

C. Experimental Setup

The fig.3 and fig.4 shows the experimental setup of the system. The fig 3 shows the different kind of sensor interfaced with ARM cortex

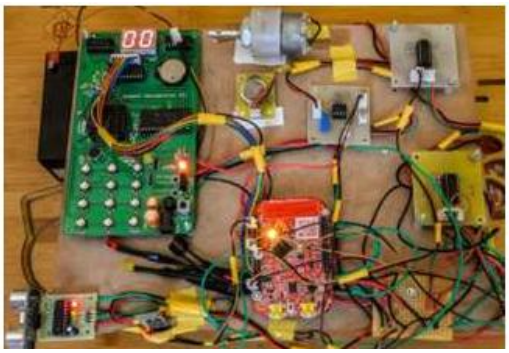

Fig 3: Top view of setup

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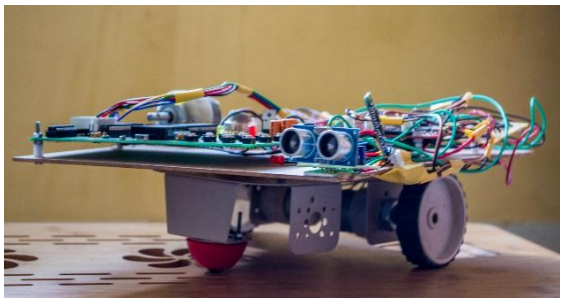

Fig 4: Front view of setup

D. CNG And Ultrasonic Sensor Implementation

There are many sensors available to detect a specific gas like methane, LPG etc. The most simple and cost effective sensors useful for sensing gases in the air is of MQ series. The gas sensor is use to detect the presence of gas as well as concentration of gas in air. The module can detect LPG, CNG in the air depending on the sensor used in the system [9].

Interfacing to the odd pin spacing of the sensor is simplified and also provides interface through header pins. The digital output is use to detect the presence of gas and analog output gives the concentration of gas in the air. The digital output gets triggered beyond the maximum gas concentration range set by the potentiometer. The presence of gas is indicated by led and buzzer present in a system. The digital output is interfaced to ARM cortex to detect the presence of the gas. The analog output is given to an ADC of a ARM cortex to detect the concentration of the gas in the air. The CNG sensor has a 4 pin interface i.e 5V, Gnd, Dout and Aout. The input 5V power is given to the 5V and the Gnd pin. The digital output of the module is given to the third pin i.e Dout. The analog output of the module is given to the fourth pin i.e Aout.

The ultrasonic sensor range from 3 cm to 400 cm and the ranging accuracy is upto 3 mm. The sensor include transmitter, receiver and control circuit. The sensors sends eight 40 kHz signals and detect whether there is pulse back signal. If there is pulse back signal then the time from sending signal to returning is counted. The distance between car and object is given by D = ct/2.

IV. CONCLUSION

The intelligent vehicle system uses voice control system which make car more user friendly and improves the human and machine interaction. The voice recognition correctness depends on the similarity of voice commands and on the environment in which testing is done. The accuracy of voice recognition is good in quiet room as compare to noisy room. The ultrasonic sensor is used to detect the obstacle and make the driving safe. The CNG sensor is also given to detect the leakage of compressed natural gas.

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BIOGRAPHIES

Anagha Vaidya received B.E. degree from RTMNU, Nagpur, India, in 2012. She is currently pursuing M.E. degree in VLSI and Embedded Systems from MIT College of engineering, Pune. She is interested in robotics, communication and automobile engineering.

Mahesh T. Kolte obtained his Bachelor's degree in Electronics Engineering from SGGS College of Engineering, Nanded, and Marathwada University. Then he obtained his Master's degree and PhD in Electronics and Telecommunication Engineering both from Amravati University, Maharashtra. Currently he is a Professor at Electronics and Telecommunication Engineering, MIT College of Engineering, Pune, having teaching experience of 22 years. His specializations include Embedded Systems and Signal Processing, Speech Signal processing, Image Processing.