1.   Project title: Home Monitoring System

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2. Abstract

Sometimes it can be very handy to know more about the physical aspects regarding your home. It would be nice for example to be able to monitor the room temperature or the intensity of light. Or to be able to sense gas leaks or even to check the air humidity. Many applications that are using different types of sensors are and will be used more and more by people to monitor their home. Home monitoring systems will be widely used in the near future.

3. Introduction, project aims and objectives

Our project proposes a system that can monitor some characteristics from an inside room. It can sense the room temperature, light detection in the room and the detection of gas leak. The end user can view the change of these characteristics with the system's several LEDs that are used to interface the changes. A clear objective is to be able to detect the changes of these characteristics effectively and present them to the user.

4. System overview

The system is composed from the following hardware components:

- XMC4500 relax kit evaluation board
- MQ-2 gas sensor
- LM35 temperature sensor
- Photoresistor-based light sensor

- S18V20F12 voltage regulator
- TSOP31438 IR receiver module
- LED – based extension board
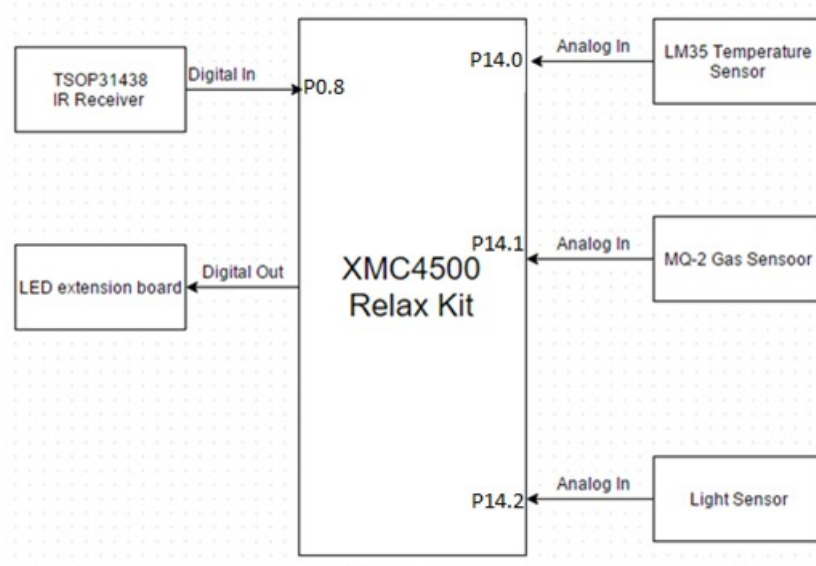- External battery
- Wires and headers

Fig. 1 System structure

5. Schematics and components

Our system is based on readings from three different sensors. The changes of these readings are visible on the LED-based extension board.

For all analogical readings we used the ADC from the XMC4500 Relax Kit board. This development board is produce by Infineon and is based on ARM Cortex M4F CPU running at 120MHz, 1MB Flash and 160KB RAM. This evaluation board offers a complete set of on-board devices and a HMI with buttons and LEDs. It also has an Ethernet port and allows equipping it with a microSD card slot. The most important thing is that it has an on-board debugger that can be used in application development. The low cost price, the set of on-board devices and the software support from Infineon makes this evaluation board perfect for academic projects development.

MQ-2 is a gas sensor that use a small heater inside and an electrochemical sensor. It is sensitive for a range of gasses like Methane, Butane, LPG and smoke. The output is an analog signal that can be read with an ADC from the development platform. As the sensor draws a quite lot of current an external battery and a voltage regulator is used for powering the sensor.

The sensor used in this project has it's own extension board which is based on the following schematic.
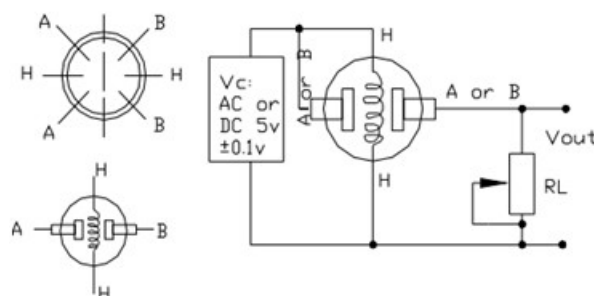
Fig. 2 MQ-2 schematic

LM35 is a temperature sensor is an integrated-circuit temperature device that can output a voltage linearly-proportional with the temperature. The analog output can be read with an ADC and transformed in Celsius grades by dividing the voltage given in mV by 10.

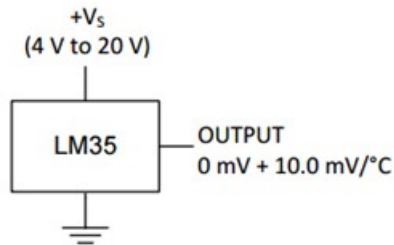For a temperature range of 2 – 150 Celsius grades the following schema is used.

Fig. 3 LM35 connection

The light sensor used in this project is based on a photoresistor circuit. A photoresistor or light-dependent resistor (LDR) is basically a resistor that changes its resistive value depending of the light exposure. The resistance of the photoresistor decreases with increasing light intensity.

The resistance can be read with an ADC by using the following schema. In this way a voltage value is read that is proportional inverse to the photoresistor resistance, which is in turn inversely proportional to light intensity.
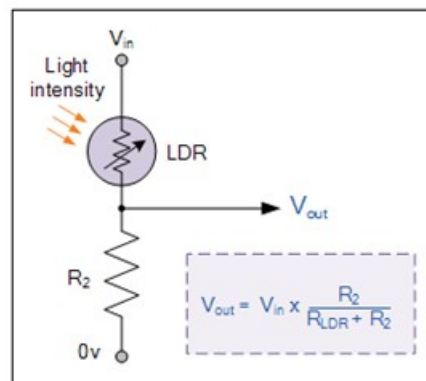

$$V_{out} = V_{in} \times \frac{R_2}{R_{LDR} + R_2}$$

Fig. 4 Light sensor schematic

6. Software

For project software development the Infineon Dave 4.1.4 development platform is used. This is a free eclipse-based IDE that can be use to develop applications oriented or component based programs for XMC development boards.
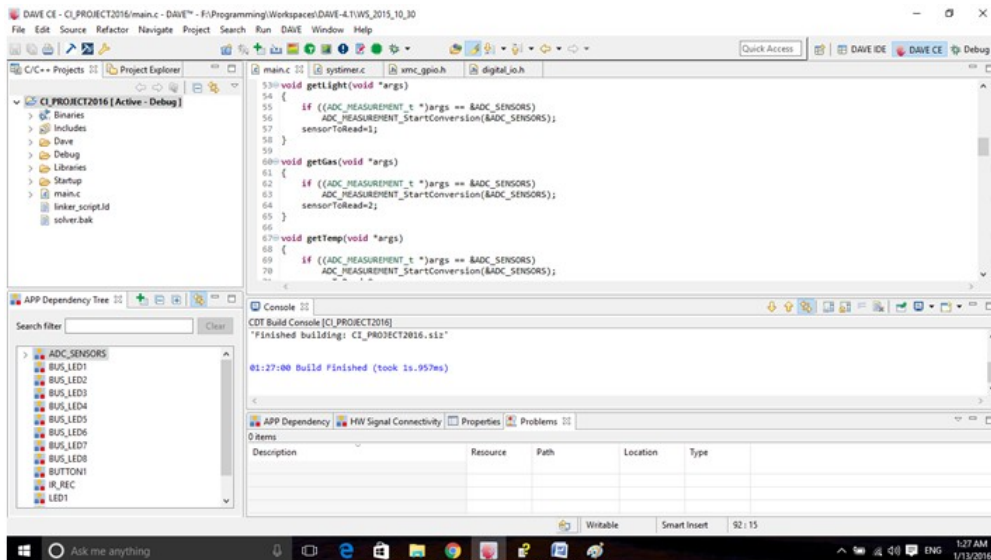
Fig. 5 DAVE development platform

From software point of view the following DAVE applications are used:

- ADC_MEASUREMENT

- DIGITAL_IO

- SYSTIMER

The implementation of the system is based on the ADC readings of the three sensors and the conversion of the voltage into necessary data. The ADC_MEASUREMENT app has associated three different channels for reading the outputs of the sensors. An interrupt service routine is executed when the measurement is ready and the data can be collected from the registers. We used three software timers to read the output from the sensors periodically. Each sensor has its own LED or LEDs associated where the changes of the characteristics can be observed. For the temperature 8 LEDs are used, so we have a resolution of 4 Centigrade per LED. For light switching a single LED is used to show that the lights are off.

For the gas sensor a limit value was set in order to light a LED when there is a gas leak. Also a digital input pin is used for receiving start command for the system from a common remote control using the IR receiver.

7. Project results & applications

A first prototype based on the project description was successfully built. We tested the system in different conditions and we verified that the readings from the sensors and the changes detected are according to room characteristics. One thing to mention is that we notice experimentally that the gas sensor needs some time to calibrate itself according to gas concentration in the room. So the first readings from this sensor may be wrong.

For future development we can expand our project by finding a way to show the reading from the sensor on a mobile application or a website. For this we could implement on our development board a web server. Another option is to use a wireless communication protocol to transmit the data from the sensors to a computer or mobile application. Also we could add other sensors to this project that can be used for home monitoring like humidity sensor or motion sensor.
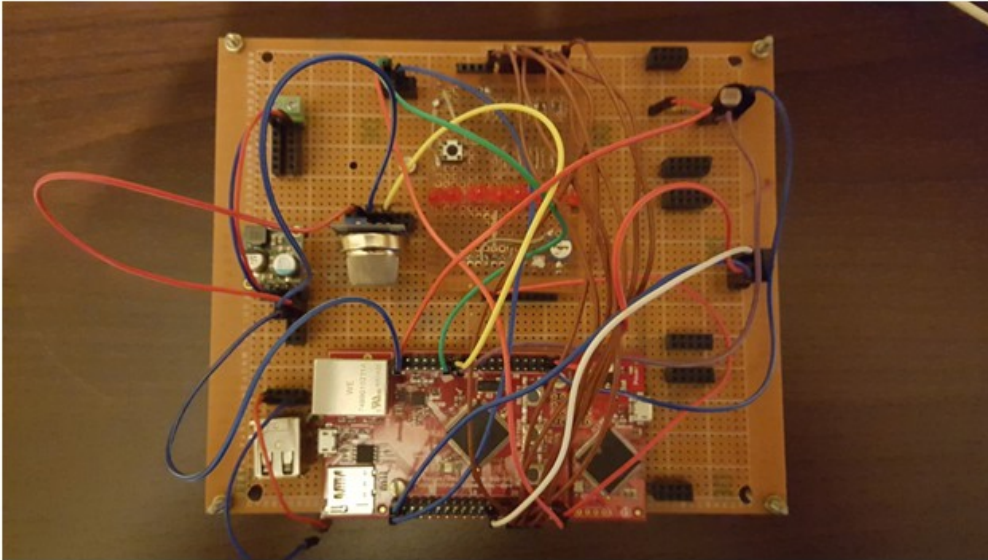
Fig. 6 Home Monitoring System

8. Reference

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