A Design Problem : An Embedded System for controlling our behavior!

Design an embedded system by putting down requirements, specifications, a possible architecture and identifying required components for the following application. Specify important components of such a system. Discuss all the system components required to develop a complete product as much as possible using image sensors and other sensors if required. Do identify the algorithms which may need to be developed.

Application: A simple embedded system which watches what you eat from your plate and gives you feedback on balanced diet requirements and gives warnings if you tend to eat what may be not good for a preset number of health parameters prescribed by a doctor. Make suitable assumptions.

Example of an Embedded System

Blood Pressure Monitor Design Considerations

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Abstract: This application note presents the two main types of blood pressure monitors, various measurement techniques, the functions of electrical components, and some crucial aspects that designers must consider when selecting products.

Maxim Integrated Products

Example of an Embedded System

A blood pressure monitor, or sphygmomanometer, uses an inflatable air-bladder cuff and a listening device or pressure sensor to
measure blood pressure in an artery.

Monitoring can be performed by:

1. A manually inflated cuff with
a stethoscope for listening to arterial wall sounds (the auscultatory method)

2. A blood pressure monitor that contains a pressure sensor for sensing arterial wall vibrations (the oscillometric method).

Upper-arm blood pressure monitor.

Example of an Embedded System : A Wrist blood pressure monitor

Measurement Techniques

An automatic blood pressure monitor inflates a cuff surrounding an arm with sufficient pressure to prevent blood flow in the local main artery.

This pressure is gradually released until the moment that the blood begins to flow through the artery, the measurement of which determines the systolic pressure. Pulse rate is also sensed at this time.

The measurement taken when the blood flow is no longer restricted determines the diastolic pressure. This complete measurement cycle is performed automatically with a pump, cuff, valve, and pressure sensor.

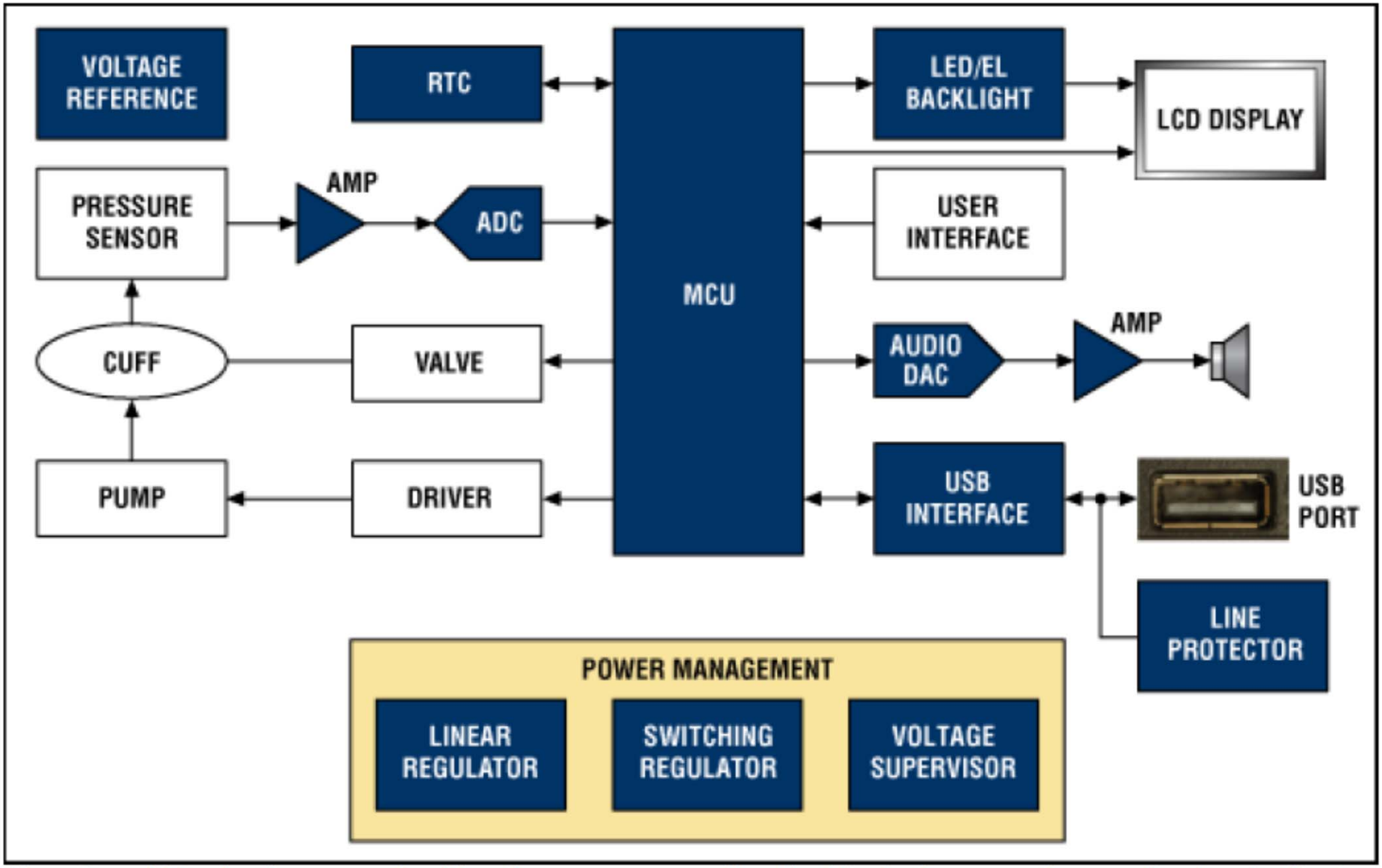
Measurement Techniques

The signal from the pressure sensor is conditioned with an op-amp circuit or by an instrumentation amplifier before data conversion by an analog-to-digital converter (ADC).

The systolic pressure, diastolic pressure, and pulse rate are then calculated in the digital domain using a method appropriate for the type of monitor and sensor utilized.

The resulting systolic, diastolic, and pulse-rate measurements are displayed on a liquid-crystal display (LCD), time/date-stamped, and stored in nonvolatile memory.

A Functional Block Diagram



Audio Indicators

Audible indicators in blood pressure monitors range from simple beepers to more advanced audio output.

A simple beeper can be driven by one or two microcontroller port pins that have pulse-width modulation (PWM) capability.

More advanced voice indicators can be achieved by adding an audio digital-to-analog converter (DAC) and speaker amplifier.

Display and Backlighting

Blood pressure monitors use a simple LCD with 100 segments or less that can be driven by a driver integrated within the microcontroller.

Backlighting can be added by using 1 or 2 white LEDs (WLEDs) or an electroluminescent (EL) source.

A discrete WLED driver can easily be added to a monitor design by using a switching topology for wrist monitors and a linear topology for upper-arm monitors.

Electrostatic Discharge

All monitors must pass IEC 61000-4-2 electrostatic discharge (ESD) requirements. Using circuitry with built-in ESD protection or adding ESD line protectors to exposed traces can help meet these requirements.

Moving Map for visually handicapped

Handheld device that displays as well as gives voice feedback for the user a map of terrain around the user's current position. The moving map obtains its position from a GPS, a satellite based system.

Functionality: This system is designed for blind navigation. The system should show major roads and landmarks available in standard topographical data bases.

User Interface: The screen should have at least 400x600 resolution. The device should be controlled by as few buttons as possible.

Performance: Map should scroll smoothly. Upon power up a display should not take more than one second to appear. The system should finish all calculations and display the current map within 10 seconds. Voice feedback must be pleasant

Moving Map for visually handicapped

Physical size and weight: The device should be comfortably fit in the palm of the hand and should have very less weight

Power consumption: The device should run for at least eight hours on 4 AA batteries.

Requirements

Name: GPS moving map for visually handicapped
Purpose: Consumer grade moving map for use
Inputs: Power button and three control buttons
Outputs: Back lit LCD display 600x400
Voice output: Clear audible voice output in a chosen language
Functions: GPS system with selectable resolutions. Displays current latitude and longitude
Performance: Updates screen within .25seconds upon movement
Manufacturing cost : Rs. 1000
Power: 100MW
Physical size and weight : No more than 2”x6”, 12 ounces

Specifications

Data received from the GPS satellite constellation

Map data base

User interface

Operations that must be performed to satisfy customer requests.

Background actions required to keep the system running and operating the GPS receiver.

Shall we design an Embedded System for Bombay Stock Exchange?

Embedded System for Stock Exchange

Bombay stock exchange requires an embedded system to help making calculations trillion times a second for all financial transactions
And calculate all indices and update its website and all displays outside.

A Problem With Today’s Computers

Uniformity: Today's computation with floating-point numbers might yield diverse results in different processors.

Embedded System for the Stock Exchange

Cost insensitive system that does financial calculations displays results on a display with very good resolution

Functionality: This system is designed for financial calculations at a very high speed.

User Interface: Good quality monitors

Performance: Upon power up a display should not take more than one second to appear. The system should finish all calculations correctly and display the results every second. Give good quality voice feedback if required on important indices.

Embedded System for the Stock Exchange

Problems with existing Embedded Systems

Binary Floating-Point (BFP) cannot exactly represent decimal fractions such as

$$10\% = \frac{10}{100} = (.1)_{10} = (0.00011001100110011001\ldots)_2$$

Loss of Precision

C program (compiled with Visual C++):

```
for (i=0.1; i<0.5; i=i+0.1) printf ("%f\n",100000000*i);
```

will print out:

100000001.490116
200000002.980232
300000011.920929
400000005.960464

□

Loss of Precision

Similarly, using C (compiled with Visual C++), the following two loops will not run the same amount of iterations due to rounding errors:

The loop:

```
for (num=1.1; num<=1.5; num=num+0.1)
printf ("%f\n",num);
```

prints:

1.100000
1.200000
1.300000
1.400000

Loss of Precision

The loop:

```
for (num=0.1; num<=0.5;
num=num+0.1)
printf ("%f\n",num);
```

prints:

0.100000
0.200000
0.300000
0.400000
0.500000

Loss of Precision: Gulf War:

On February 25, 1991, during the Gulf War, an American Patriot Missile battery in Dharan, Saudi Arabia, failed to track and intercept an incoming Iraqi Scud missile.

Specifically, the time in tenths of second as measured by the system's internal clock was multiplied by 1/10 to produce the time in seconds.

This calculation was performed using a 24 bit fixed point register. In particular, the value 1/10, which has a non-terminating binary expansion, was chopped at 24 bits after the radix point.

The small chopping error, when multiplied by the large number giving the time in tenths of a second, led to a significant error, and consequently caused severe damage and human casualties.

Managing Loss of Precision

To overcome this loss of precision, financial applications implement decimal arithmetic operations in software and run 100–1000 times slower than the corresponding binary operations.

Decimal Floating-Point (DFP) can be directly implemented in hardware and run order of magnitudes faster than the software computation. Some companies are already commercializing processors which include DFP units