Abstract:

This paper describes an embedded monitoring system based on μC/OS II operating system using ARM7. It deals with the porting of Micro C/OS-II kernel in ARM powered microcontroller for the implementation of multitasking and time scheduling. Here a real time kernel is the software that manages the time of a microcontroller to ensure that all time critical events are processed as efficiently as possible. Different interface modules of ARM7 microcontroller like UART, ADC, LCD are used and data acquired from these interfaces is tested using μC/OS-II based real time operating system. It mainly emphasizes on the porting of μC/OS-II.

A real-time operating system (RTOS) is key to many embedded systems today and provides a software platform upon which to build applications. Not all embedded systems, however, are designed with an RTOS. Many embedded systems, however, with moderate-to-large software applications require some form of scheduling, and these systems require an RTOS. In this project we are going to perform multitasking simultaneously. We going to perform tasks like LED blinking, LCD message display, serial communication (UART0 and UART1), buzzer simultaneously using Micro C/OS-II kernel based RTOS.

II. MICRO C/OS II :

μC/OS II (pronounced “Micro C O S 2”) stands for Micro-Controller Operating System Version 2 and can be termed as μC/OS-II or μC/OS-II). It is a very small real-time kernel with memory footprint is about 20KB for a fully functional kernel and source code is about 5,500 lines, mostly in ANSI C. It's source is open but not free for commercial usages. μC/OS-II is upward compatible with μC/OS V1.11 but provides many improvements, such as the addition of a fixed-sized memory manager; user-definable callouts on task creation, task deletion, task switch, and system tick; TCB extensions support; stack checking; and much more.

A. μC/OS II using ARM :

μC/OS-II, The Real-Time Kernel is a highly portable, ROMable, scalable, preemptive real-time, multitasking kernel (RTOS) for microprocessors and microcontrollers. μC/OS-II can manage up to 250 application tasks. μC/OS-II runs on a large number of processor architectures and ports. The vast number of ports should convince that μC/OS-II is truly very portable and thus will most likely be ported to new processors as they become available. μC/OS-II can be scaled to only contain the features you need for your application and thus provide a small footprint. Depending on the processor, on an ARM (Thumb mode) μC/OS-II can be reduced to as little as 6K bytes of code space and 500 bytes of data space (excluding stacks).
The execution time for most of the services provided by μC/OS-II is both constant and deterministic. This means that the execution times do not depend on the number of tasks running in the application.

B. Choosing μC/OS II:
μC/OS II is chosen for the following features.

1. Portable
Most of μC/OS-II is written in highly portable ANSI C, with target microprocessor specific code written in assembly language. Assembly language is kept to a minimum to make μC/OS-II easy to port to other processors. Like Micro C/OS, Micro C/OS-II can be ported to a large number of microprocessors as long as the microprocessors provide a stack pointer and the CPU register can be pushed onto and popped from the stack. Also, the C compiler should provide either in-line assembly or language extension that allows you to enable and disable interrupt from C. μC/OS-II can run on most 8-, 16-,32 or even 64-bit microprocessors or microcontrollers and DSPs.

2. ROMable
μC/OS-II was designed for embedded application. This means that if you have the proper tool chain (i.e. C compiler, assembler and linker/locator), you can embed Micro C/OS-II as part of a product.

3. Scalable
μC/OS-II is designed such a way so that only the services needed in the application can be used. This means that a product can use just a few μC/OS-II services. Another product may require the full set of features. This allows to reduce the amount of memory (both RAM and ROM) needed by μC/OS-II on a per product basis. Scalability is accomplished with the use of conditional compilation.

4. Preemptive
μC/OS-II is a fully preemptive real time kernel. This means that Micro C/OS-II always runs the highest priority task that is ready.

6. Deterministic:
Execution time of all μC/OS-II functions and services are deterministic.

This means that one can always know how much time μC/OS-II will take to execute a function or a service. Furthermore except for one service, execution time all C/OS-II services do not depend on the number of tasks running in the application.

7. Robust and Reliable:
μC/OS-II is based on μC/OS which has been used in hundreds of commercial applications. μC/OS-II uses the same core and most of the same functions as μC/OS yet offers more features.

C. Starting μC/OS-II:
In any application μC/OS-II is started as shown in the figure 1. Initially the hardware and software are initialized. The hardware is the ARM core and software is the μC/OS-II. The resources are allocated for the tasks defined in the application. The scheduler is started then. It schedules the tasks in preemptive manner. All these are carried out using specified functions defined in μC/OS-II.

Figure 1: Starting μC/OS-II
Intializing μC/OS-II

Figure 2: Initializing μC/OS-II

μC/OS-II can be initialized as shown in the figure 2. The detailed steps are shown in the figure. Below shows the sample program for the steps shown in the figure.

```c
void main (main)
{
    /* user initialization */
    OSInit(); /* kernel initialization */
    /* Install interrupt vectors */
    /* Create at least 1 task (start task) */
    /* Additional User code */
    OSStart(); /* start multitasking */
}
```

E. Task Creation

To make it ready for multitasking, the kernel needs to have information about the task: its starting address, top-of-stack (TOS), priority, arguments passed to the task, other information about the task.

You create a task by calling a service provider by μC/OS-II:

```c
OStaskCreate(void (*task) (void *parg),
    void *parg, Address of the task,
    OS_STK *pstk, Pointer to task’s Top-Of-Task',
    INTSU prio); — Priority of task (0–64)
```

You can create task:
before you start multitasking (at initialization time) (or) during run time.

F. Implementation through μC/OS-II

In embedded systems, a board support package (BSP) is implementation specific support code for a given (device motherboard) board that conforms to a given operating system.

In Micro C/OS-II maximum number of tasks is 64. In the figure shown above the application has six tasks. Depending on the required application the number of tasks may vary.

To perform a sample experiment to understand the porting of μC/OS-II we can perform simple tasks like Temperature sensor (i.e., ADC), Graphical LCD (i.e., degree to graphical Fahrenheit), UART (i.e., digital data displaying), LED toggle (i.e., 8-bit data flow control) Buzzer (i.e., alarm device).

The ARM runs the Real time operating system to collect information from the external world. Here RTOS is used to achieve real time data acquisitions. Micro C/OS-II kernel is ported in ARM powered microcontroller for the implementation of multitasking and time scheduling as shown in previous sections.

Keil IDE is used for implementation. Keil IDE is a windows operating system software program that runs on a PC to develop applications for ARM microcontroller and digital signal controller. It is also called Integrated Development Environment or IDE because it provides a single integrated environment to develop code for embedded microcontroller.
Conclusion:

The project is been designed and implemented with Atmel LPC2148 MCU in embedded system domain. Experimental work has been carried out carefully. Here we have designed a simple, low-cost controller based implementing uC/os - ii kernel based rtos using ARM7 TDMI (lpc2148) based controller

REFERENCES:

