

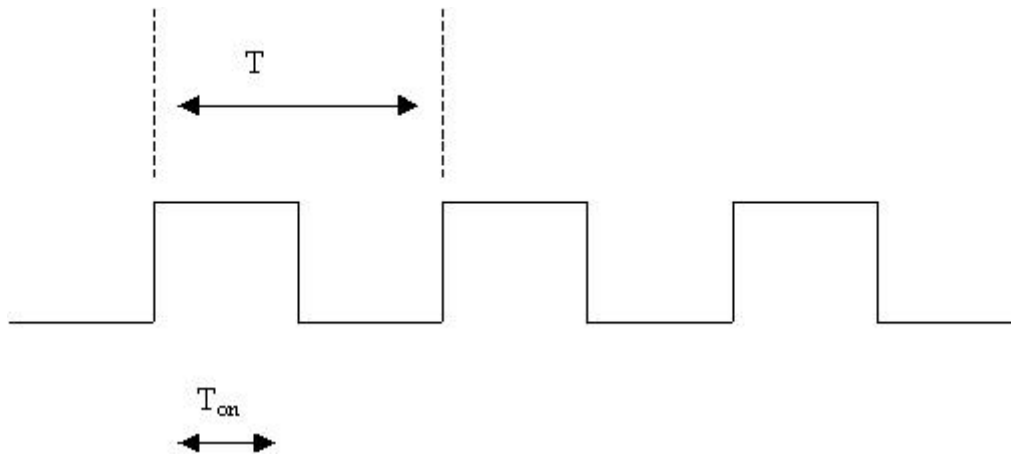
Ejemplos con RTAI

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Modulación de ancho de pulso (Pulse Wide Modulation)



Definiendo el factor de uso α como :

$$\alpha = T_{on}/T$$

Control de Servos:

Se pretende controlar un servomotor empleando software de tiempo real sobre un PC empleando RTAI y COMEDI.

Dicho control está basado en PWM de forma que las acciones a realizar se limitan a generar una señal de control periódica con un ancho de pulso dependiente del factor de uso que se quiera conseguir.

La posición del servo está relacionada con el ancho del pulso.

Por ejemplo para un servo determinado existen unos valores de α para los cuales el servo no se mueve, existe un T_s mínimo a partir del cual el servo empieza a responder, de igual forma existe un valor de α para el que el servo ha llegado a su límite de giro y a partir de dichos valores, el servo no puede girar más, en estos valores puede sobrecalentarse el servo o vibrar en exceso. Dichos valores se pueden calcular empíricamente como se comentará posteriormente.

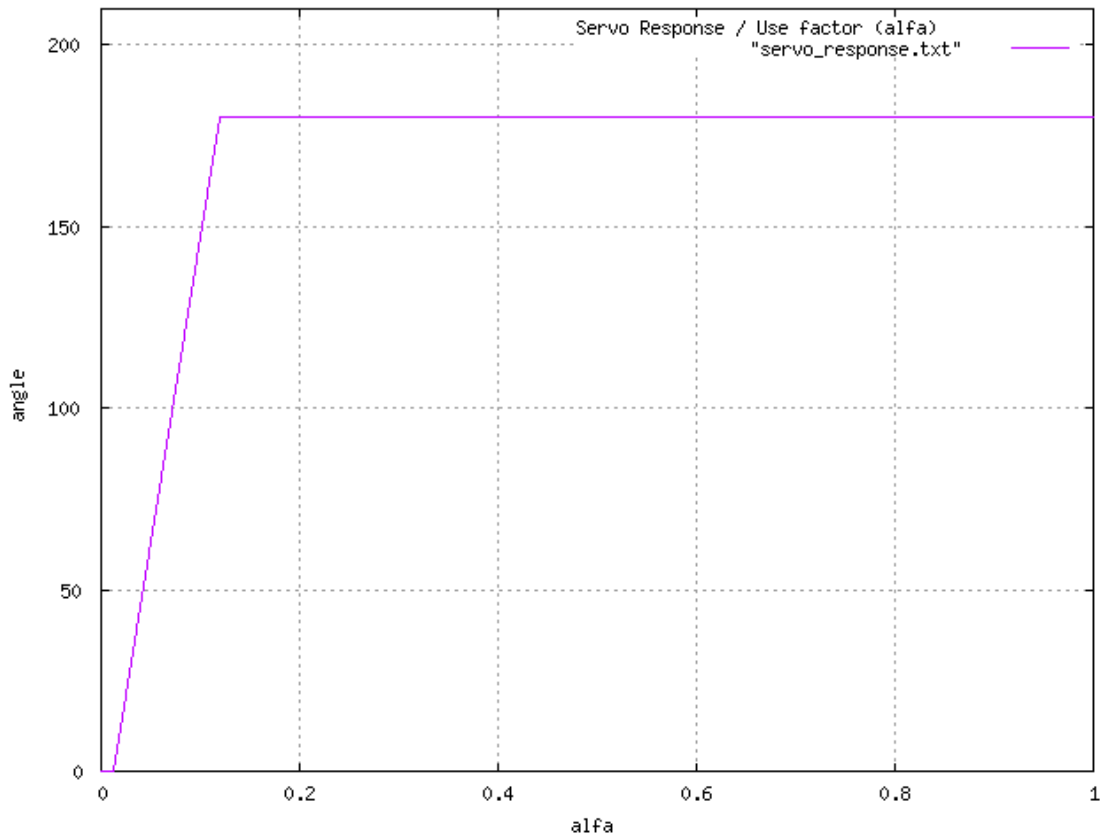
Para controlar un servomotor necesitamos generar una señal de control mediante PWM teniendo en cuenta el rango de frecuencia en la que opera o puede operar el servo. En nuestro caso el 50 Hz (hitec HS-303 standard II) con lo que tenemos $T = 20$ ms .

Una vez obtenido T debemos generar la tarea que genere dicha señal de control periódica de período T .

Para esto podemos recurrir a un thread que realiza ciertas operaciones detalladas posteriormente y duerme hasta el siguiente periodo. Es deseable que no se quede haciendo espera activa, y también es deseable que no se produzcan desvíos producidos por dormir al thread empleando tiempos relativos. Si empleamos tiempos absolutos se pueden corregir ciertas desviaciones, esto se consigue con la primitiva `rt_sleep_until(RTIME t)`.

El servo tendrá un rango de factores de uso para los cuales funcione de acuerdo a una función, mientras que para otros valores no se consiga que el servo realice movimiento alguno, bien porque Ton no es suficiente o bien porque el servo ha llegado al tope de su rango de giro.

Para obtener dicha curva podemos calcularla empíricamente tomando valores del ángulo para ciertos α y después interpolamos los valores calculamos generando una gráfica de aspecto similar a la que hemos producido, teniendo en cuenta que cada servo puede tener un comportamiento diferente.



Para obtener dicha curva podemos emplear Gnuplot la siguiente manera:

Generamos un fichero con los valores adquiridos formando tuplas (α, θ) (siendo θ el ángulo obtenido para el factor de uso α).

Podemos realizar una interpolación lineal de la siguiente forma:

```
$:>gnuplot
$gnuplot>plot "fichero_datos" w l
```

Si queremos obtener otras interpolaciones, ver help bsplines, csplines etc. en la ayuda de gnuplot. Si se desea almacenar la imagen resultado en un formato jpeg, gif o png realizar lo siguiente:

```
$gnuplot> set terminal png
$gnuplot> set output "fichero_salida.png"
$gnuplot> plot "fichero_datos" w l
$gnuplot> show output
```

Implementación:

Podemos optar bien por una tarea en un proceso pesado o generar un thread.

Todas las implementaciones realizadas se han realizado empleando LXRT, debido a que parece más sensato para realizar estos ejemplos no tener que implementar módulos del kernel .

Se ha empleado el driver pcl812 que se ofrece en COMEDI así como las librerías que se distribuyen con dicho paquete.

El esqueleto de la tarea de control de un servo es el siguiente:

Inicialización del dispositivo (en nuestro caso la tarjeta PCL812pg de Advantech)

Establecimiento del planificador (política , prioridad , etc.)

Inicialización de la tarea de control.

/*Cuerpo de la tarea*/

```
t1=rt_get_time();
```

```
While (1)
```

```
{
```

```
rt_sleep_until(t1); // dormimos hasta el siguiente periodo
```

```
t1=t1+PERIODO; // PERIODO = 20 ms
```

```
escribir '1'
```

```
rt_sleep( $\alpha$ *PERIODO); //Dormimos Ton nanosegundos
```

```
escribir '0'
```

```
}
```

Para poder comunicar o hacer interactivo el control del servo nos podemos apoyar en un proceso y memoria compartida si empleamos procesos pesados (fork ()) o bien variables globales si empleamos threads.

En el código que se puede encontrar en la misma dirección que el presente documento se encuentra un ejemplo de interacción aunque no es el mejor que se puede realizar, ya que la interacción del usuario introduce perturbaciones en el funcionamiento de la tarea de control.

En caso de querer monitorizar tiempos u otros valores se debería optar por una tarea que se comunique mediante una cola de mensajes donde las tareas de tiempo real almacenen las salidas y la tarea monitor vaya imprimiendo dichas salidas.

Se han realizado dos implementaciones, en ambos casos no se han empleado mecanismos de sincronización ni de exclusión mutua en el acceso a las variables que indican el factor de uso, esto puede provocar falta de interacción en algunas situaciones con un número de tareas elevado:

-Empleando memoria compartida y procesos pesados:

-Empleando threads:

Nota: Las pruebas se han realizado con un PC Intel Pentium III a 450 MHz . Se han podido lanzar hasta 63 Threads para controlar 63 servos, aunque debido al número de salidas digitales que ofrece la tarjeta PCL812PG (16) no se ha podido experimentar con tal número de servos.

Para poder ejecutar los ejemplos seguir los siguientes pasos:

Los módulos siguientes han de estar cargados previamente:

- Rtai
- Rtai_sched
- Rtai_fifos
- Rtai_shm
- Rtai_lxrt
- Rtai_pthreads
- Rtai_utils
- Rtai_utils
- Comedi
- Pcl812

Una vez cargados dichos módulos, (es necesario tener permisos para dicha carga), compilamos los ejemplos :

Para servo_threads.c -> gcc -I/usr/src/rtai/incluye -Wall -lpthread -lcomedi -o "salida" servo_threads.c

Para main y servo -> gcc -I /usr/src/rtai/incluye -Wall -lcomedi -o servo servo.c
gcc -I /usr/src/rtai/incluye -Wall -lcomedi -o salida main.c

Nota: Se pueden usar otras opciones de compilación como -g -O(N) etc

Una vez compilados ejecutar "salida" , el interfaz de ambos es similar, una tarea se queda esperando a que se introduzca el índice del servo a mover, por ejemplo el 1, se pulsa 1 , enter y para poder aumentar o disminuir el factor de uso (tanto por 1000) se pulsa 'a' o 'd' respectivamente seguido de enter.

En el caso de procesos pesados, debe existir "servo" en el mismo directorio que "salida", en este caso el número de servos esta limitado a 8 por el interfaz.

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