J.D. Nicoud, CH-1092 Belmont
Email nicoud@didel.com, www.didel.com

The TSL1301 linear camera

Note:This is an 1999 document. The 1301 has been replaced by thee 1401 and the 2401 includes the A/D converter (both from TaosInc.com)

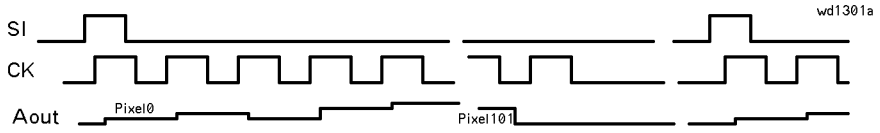
Introduction

Having a color camera on a robot is fascinating, but handling hundreds of thousands of pixels is not for the beginner. The linear camera TSL1301, from Texas Instrument provides 102 pixels on a single line, and is perfect for robots moving on a plane and having to search for a lamp or a candle at the same height.

On the TSL1301, the pixels are shifted out and their analogue value is converted to binary by the processor or by an A/D converter. Precision is a few percents with a linear response (our eye is logarithmic), but the range of sensivity can be adjusted by changing the integration time. The information is easy to acquire and handle, but the difficulty is to have a good contrast and be insensitive to the level of ambiant light: TV spots will be on to shoot the winners.

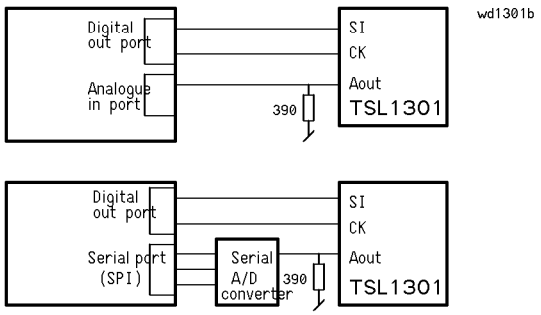
TSL1301 specifications

Detailed specs (6 pages) can be downloaded from the Web http://www.taosinc.com/|. The operation is quite simple (fig 1). A first clock with SI active load the analogue shift register with the sensor state and brings the first pixel out. One additional clock is required after pixel 102 has been shifted out before restarting a new cycle. A reset of all opto cells occurs during the first 18 clocks and then the light integration starts until the next SI.



Typical interface and program

The processor interface needs two output port lines and one analogue input which may or may not be included in the processor (fig 2). A 390 Ohm pull-down resistor is required on A0.



A microcontroller program will prepare a pointer in memory, generate the clock and store the data in memory. Processing for defining the shape and position of objects may be done while acquiring the pixels, or on the values stored in memory. The most efficient is to do it real time and not store the complete image, but frequently a combination of both is required.

Implementation examples

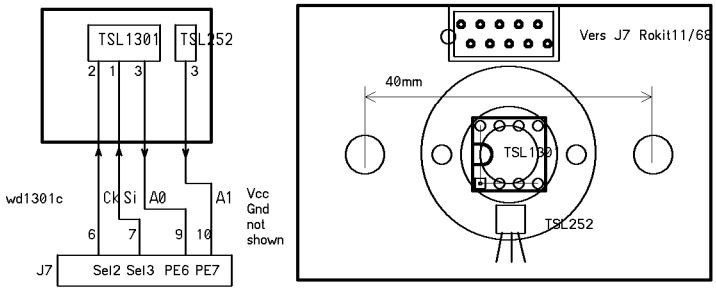
Smart camera module

Ane example of a smart camera module, interfaced on RS232/S- and on I^2C has been developed by R. Meier at ISR-DMT-EPFL. A Pic17C71 handles the camera and defines several parameters (minimum, maximum, maximum position, peak width, integration time). The parameters are transferred with a simple Ascii protocol.

%

RokLin module (HC11 processor)

The RolLin-C module is directly compatible with the Rok11 J7 connector. The SPI interface available on this connector is not used. The back of the camera must be well protected against parasistic light.



A first HC11 test program (Test 28 on Rok11c2), intended to check the correct operation with an oscilloscope, and adjust the focus, is given below. A sheet of black paper with a one cm wide slot, lighted from behind, is used to adjust the focus.

Routine **Read 102 pixels** 1 ms wait between scans

```
Scan1301:
          Bis       #2**bSI,PortG          ; SI positive edge load shift register
          Bis       #2**bCLK,PortG         ; Positive edge brings pixel
          Move      #102,B                 ; For 1302
W$:
          Bic       #2**bSI+2**bCLK,PortG  ; Clear clock and SI
          Bis       #2**bCLK,PortG         ; Start new clock
          Dec       B                      ; Finished?
          Jump,NE   W$                     ;
          Bic       #2**bCLK,PortG         ; Clear last clock

          Move      #300,IX                ; 1ms delay
   W$:    Dec       IX
          Jump,NE   IX
          Jump      Scan1301
```

Test 29 calls routine Scan102, which compute the light average and display it on Mubus+1, while the TSL252, which do the same with its sensor (but not on the same field of view) is shown on Mubus.

Test 2A calls for Scan34 routine, which average 3 pixels in order to save space. There is a firther compression in order to display the 34 pixels on the Mubus interface. One every two pixel is shifted into a 16-bit register, copied finally to Mubus. The analogue value is compared to the value in Mubus switches. If these switches are not displaced, only pixels with a value greater than 16´22 will light the corresponding LED.

System programming

Scanning the TSL1301 is ideally performed within an interrupt routine depending on a variable timer. Timer duration depends on the TSL252 or on the light average on the TSL1301.