H.I.R.R.A.

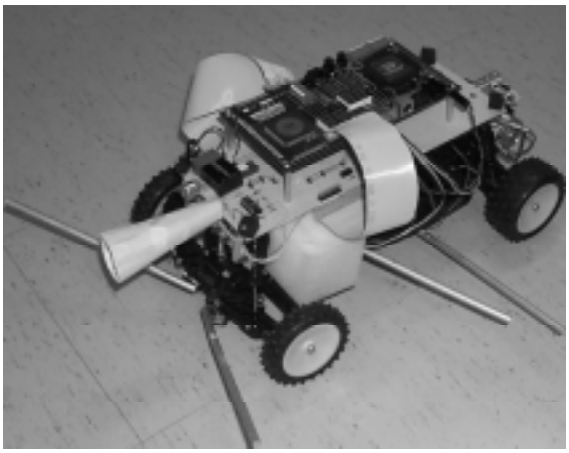
General Description

HIRRA is a fully autonomous system, which is comprised of a car chassis that carries and moves the electronics, an array of input sensors and an FPGA to control the motion of the car. The ultimate goal of HIRRA is to move towards the strongest source of light in its vicinity while avoiding obstacles in its path.

It accomplishes this task by detecting the direction of light using photocells, avoiding obstacles using sonar and whisker sensors and moving using the motor attached to the car.

Controlling the output is the job of the FPGA, an Altera EPF10K20RC240-4, which moves the car according to the input signals. Motion of the car is priority based, the highest priority is given to light level when it is equal on all four photocells.

Next are the whisker sensors, when touching they control the movement of the car. If the whiskers are not touching and light is measured from a given direction the sonar is given priority. Finally if none of those sensors are active the input from the photocells is processed into a direction for the car to move.



Power is supplied by a 7.2v dry cell on board the car. The FPGA is powered directly from the battery since it has it's own on board regulator. Two separate five-volt regulators are used, one to power the servomotors and one to power the ADC and sonar receiver circuits. A separate 9v battery was used to power the sonar transmitter.

An array of LEDs are supplied, which provide useful feedback for debugging.

Specifications

— Power Requirements
- Current drawn by FPGA – 200 mA
- Peak current drawn by servos – 1 A
- Current drawn by electronics – 20 mA

— Clock Frequency Requirements
- Input clock frequency – 25.175 MHz
- ADC clock frequency – 80 kHz

— Sonar
- Sonar detection threshold – 86 cm
- Sonar transmission frequency – 40 kHz

— Vehicle Specifications
- Nominal speed – 20 cm/s
- Turning radius – 60 cm
- Average run time – 10 min.
- Width – 25 cm
- Length – 41 cm
- Height – 19 cm

— Logic Requirements
- Total Logic Cells – 639

— ADC Specifications
- ADC max per conversion time – 0.9ms

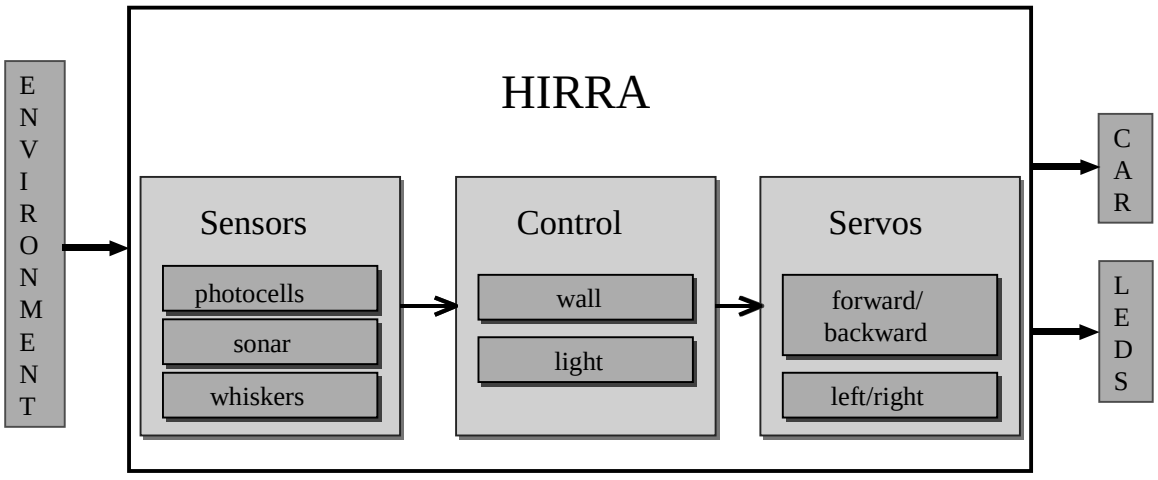


Figure 1. Data flow diagram

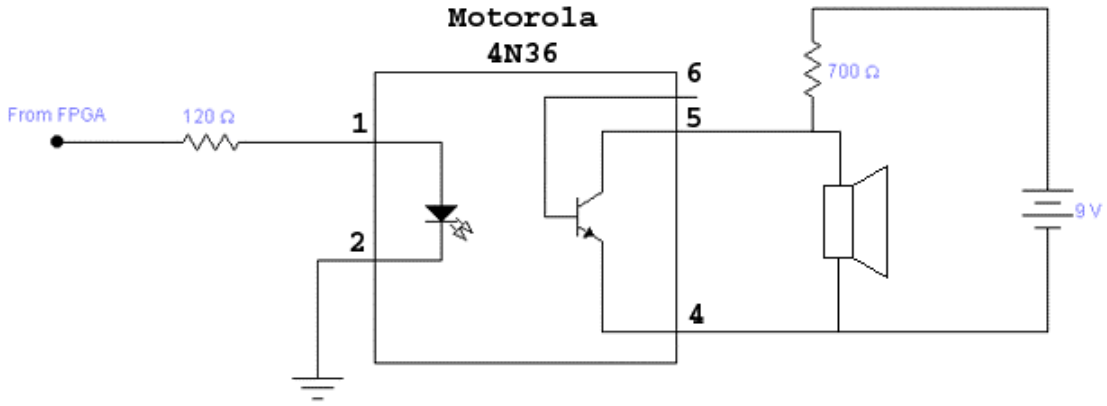


Figure 2. Sonar Transmitter Circuit

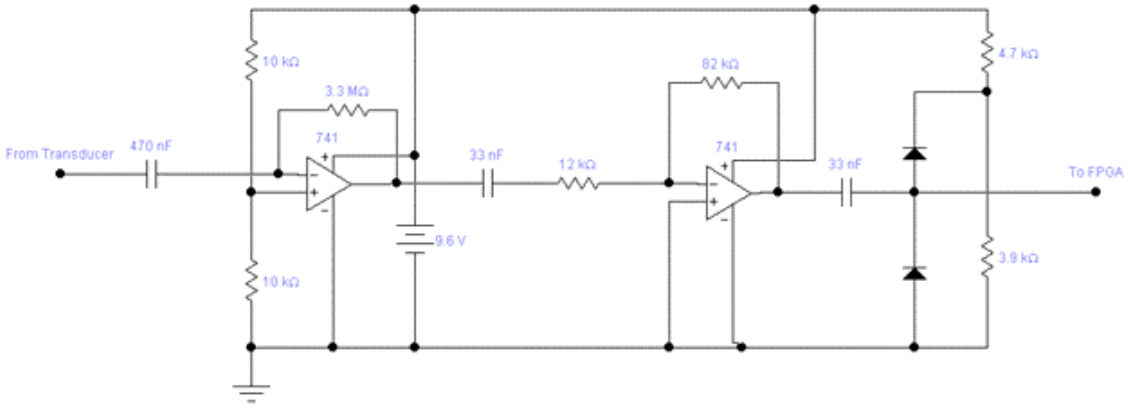


Figure 3. Sonar Receiver Circuit

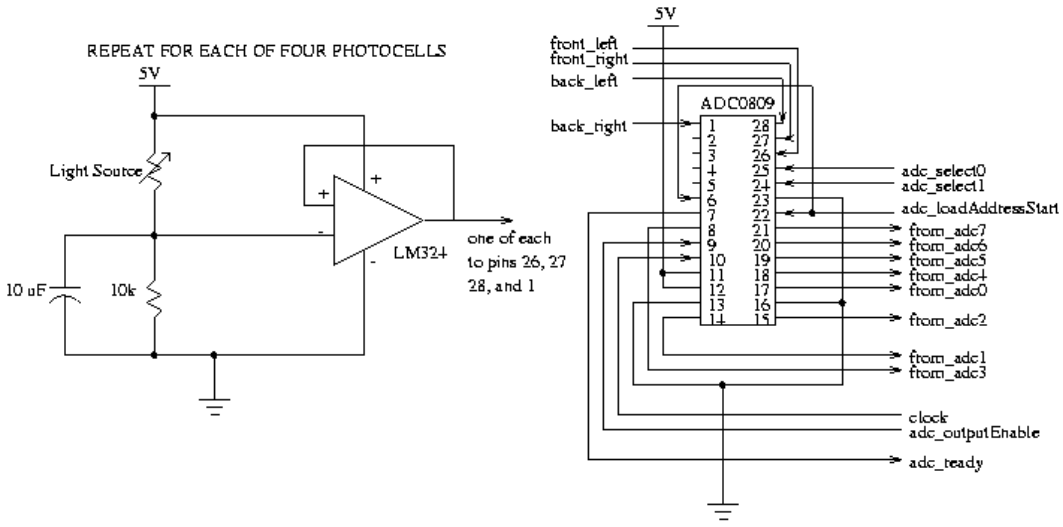


Figure 4. Photocell Support Circuitry

Label	**Description**	*Pin Number*	*Expansion Slot/Hole*
INPUT			
Enable_button	System active high enable toggle	28	Push Button 1
Reset	System active low enable	29	Push Button 2
Analog to Digital Converter			
from_adc0	LSB of digital light level from ADC.	45	A / 15
from_adc1	Bit of Digital light level from ADC.	46	A / 16
from_adc2	Bit of Digital light level from ADC.	48	A / 17
from_adc3	Bit of Digital light level from ADC.	49	A / 18
from_adc4	Bit of Digital light level from ADC.	50	A / 19
from_adc5	Bit of Digital light level from ADC.	51	A / 20
from_adc6	Bit of Digital light level from ADC.	53	A / 21
from_adc7	MSB of Digital light level from ADC.	54	A / 22
from_adc_DataReady	Signal to show end of conversion	55	A / 23
Whisker Sensors			
from_whiskers0	Left rear whisker sensors	61	A / 25
from_whiskers1	Left whisker sensors	62	A / 26
from_whiskers2	Left front whisker sensors	63	A / 27
from_whiskers3	Right front whisker sensors	64	A / 28
from_whiskers4	Right whisker sensors	65	A / 29
from_whiskers5	Right rear whisker sensors	66	A / 30
SONAR			
from_sonar	From the receiver of the SONAR	71	A / 34
OUTPUT			
Direction Servomotor			
left_right_out	Output to control the direction servo	175	C / 15
Speed Servomotor			
fwd_back_out	Output to control the speed servo	188	C / 23
Control Lines for the ADC			
adc_select0	LSB of the address select lines	198	C / 31
adc_select1	MSB of the address select lines	199	C / 32
adc_clock	Output to ADC clock line	217	C / 43
adc_ loadAddressStart	Output to pulse the load address and the start pins of the ADC	218	C / 44
adc_ outputEnable	Output to enable the latches of the ADC output	219	C / 45
Knight Rider LEDS			
led_out0	Leftmost LED, facing the car. Active high.	201	C / 34
led_out1	Bit of the led_out vector. Active high.	202	C / 35
led_out2	Bit of the led_out vector. Active high.	203	C / 36
led_out3	Bit of the led_out vector. Active high.	204	C / 37
led_out4	Bit of the led_out vector. Active high.	206	C / 38
led_out5	Bit of the led_out vector. Active high.	207	C / 39
led_out6	Bit of the led_out vector. Active high.	208	C / 40
led_out7	Rightmost LED, facing the car. Active high.	214	C / 41
SONAR			
SONAR_out	Line to the transmitter of the SONAR.	215	C / 42

Figure 5. List of I/O Pins