

# **EEL5666C IMDL Summer 2005**

**Student: Wai Ping Lau**

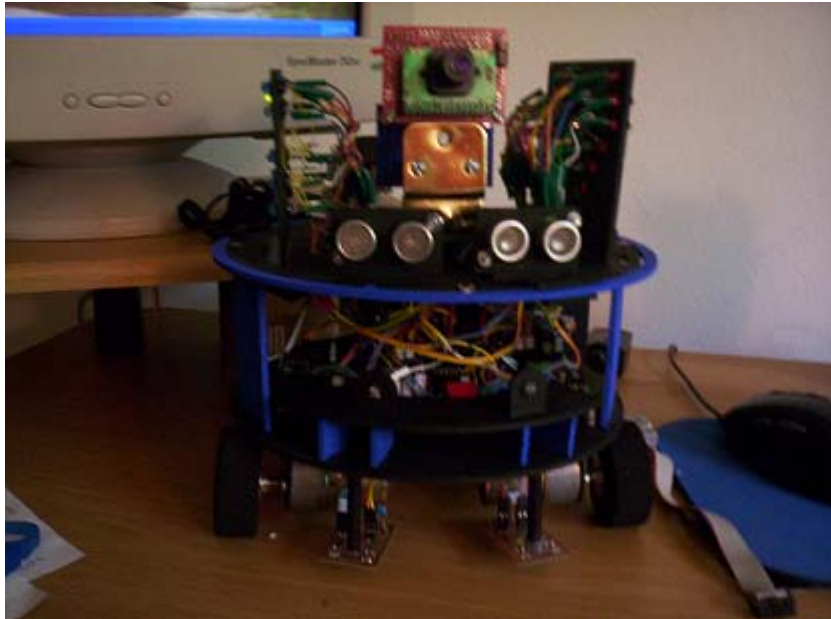
**Elray's just a love machine**

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Instructors: A.A. Arroyo and E.M. Schwartz

Final Report

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## **Abstract**

Wouldn't you like to have a pet that will love you forever and always?...a pet that won't run away or make a mess? Well, meet E.L.R.A.Y., Electronic Love Robot Attracted to You. He will love you if you're wearing a solid colored shirt and allow him to take a reading from your shirt. You say you can't wear the same color shirt everyday, No Problem! Elray is equipped to adjust to your color, just reset him and he will take another reading of your shirt and love you all over again. Fresh love is the best!

Demonstrations will use colored boxes.

## **Executive Summary**

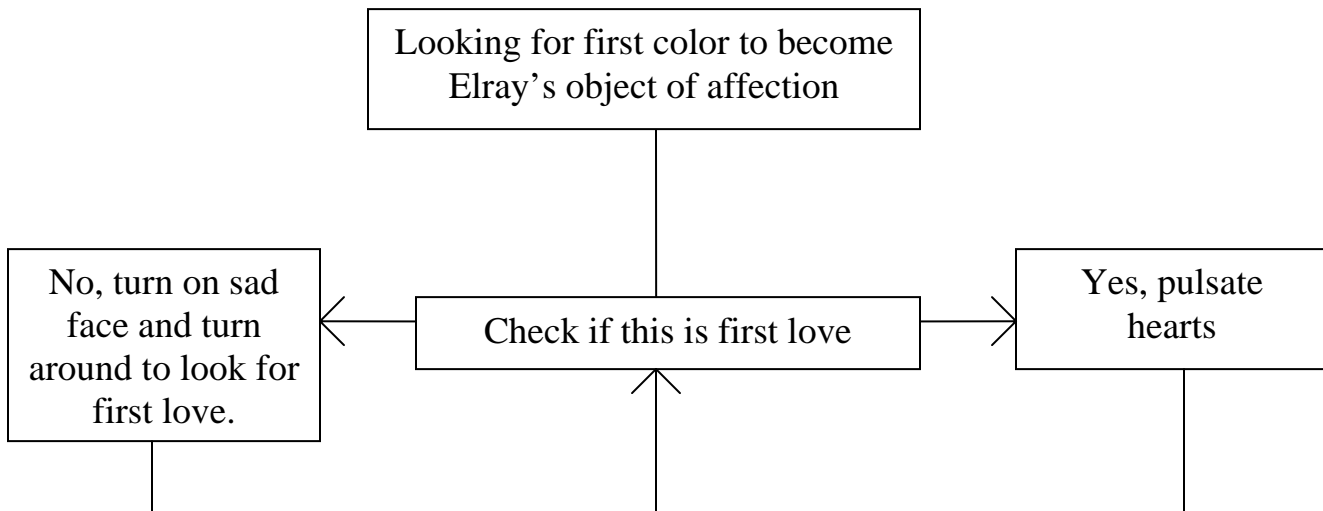
Meet Elray, he is the robot that loves to love. The first color he sees, he will love and adore it. He will follow that color 'till the ends of the Earth. Elray is very faithful, if another color comes around, he will turn around and not love that color. Elray will be confined to a 6x8 feet rectangle. This space will be made of black poster board with a red and white border. The border will keep Elray from leaving. If Elray happens to see its love and hits the border, Elray will ram the border because it is trying to get to his love. That's E.L.R.A.Y., Electronic Love Robot Attracted to You.

On his body, there are two hearts made of red LEDs, a big heart and a small heart. There will also be a sad face of LEDs to show when Elray not seeing its love. Upon start up, Elray is initially sad and his sad face will light up. The face has 2 eyes made out of

yellow LEDs and a wooden mouth. When Erray sees his love, his hearts will pulsate and I will use PWM to control the brightness of the LEDs. As soon as his love leaves the area, Erray will become sad and the sad face on his body will light up. The sad face will not blink. The sad face will be left on until he senses another color. Erray can only love one color when he is on. When he starts up, he can love any color but that he is faithful and will only love that color. If someone is close-by walking around the border, he will still love you but will be bounded by the red and white border.

## Integrated System

This how Erray thinks:



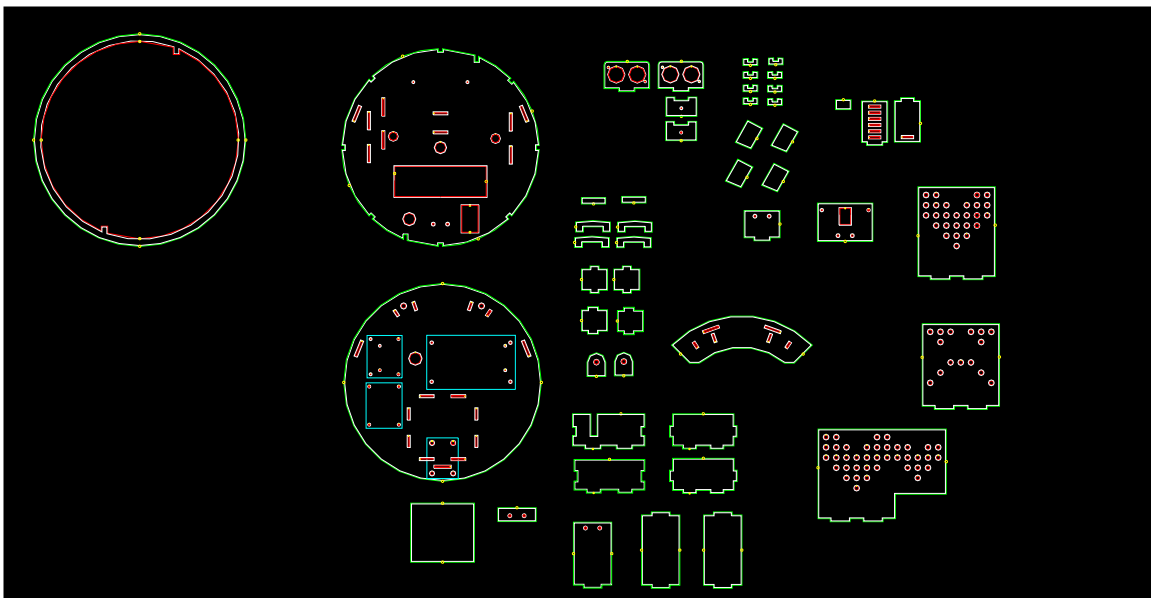
Erray is simple minded with complicated hardware.

Elray may seem like a pet but he is actually a love machine.

## Mobile Platform

Elray was modeled after a small TJ in the Machine Intelligence Lab. His body is circular (diameter 8 inches) and he will have two eyes. His eyes will act as an indication that Elray is on. His eyes will consist of two yellow LEDs. Elray's love will be powered by Nickel Metal-Hydride batteries.

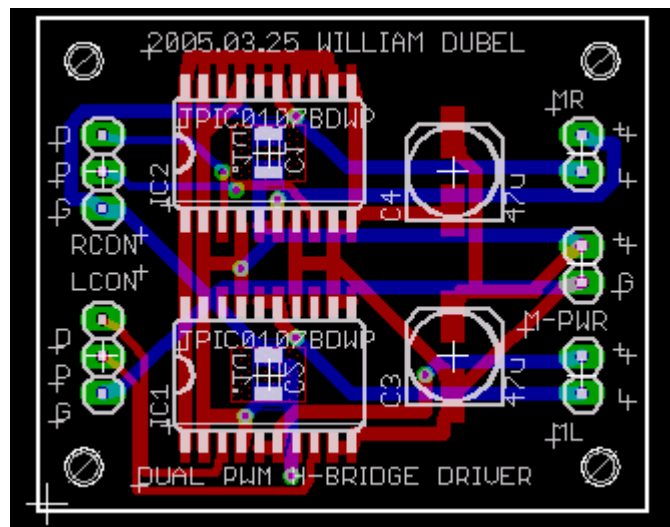
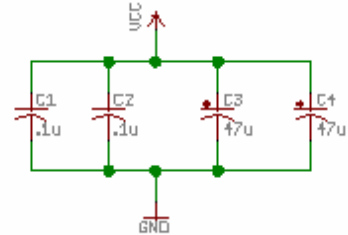
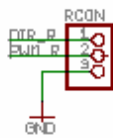
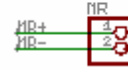
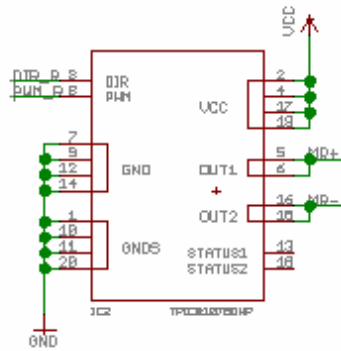
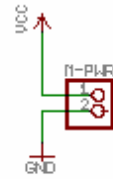
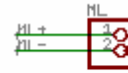
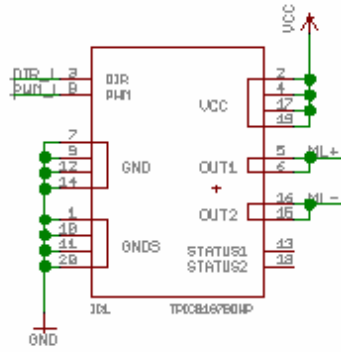
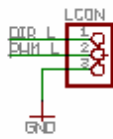
Here is a picture of the AutoCad drawing:



## Actuation

The only actuation I have are the motors. I am using Pulse Width Modulation to control the speed of Elray.

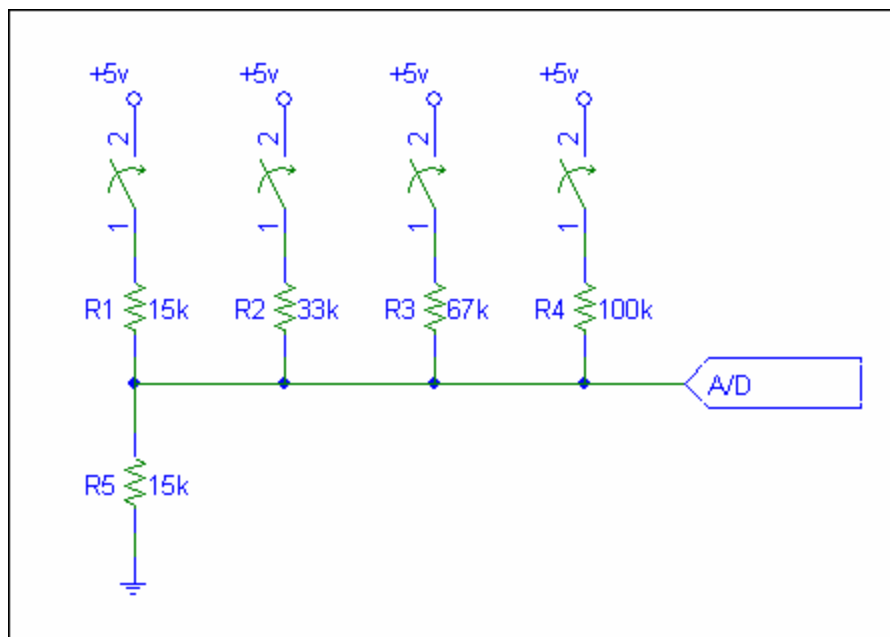
Here is a picture of William Dubel's motor driver board:



## Sensors

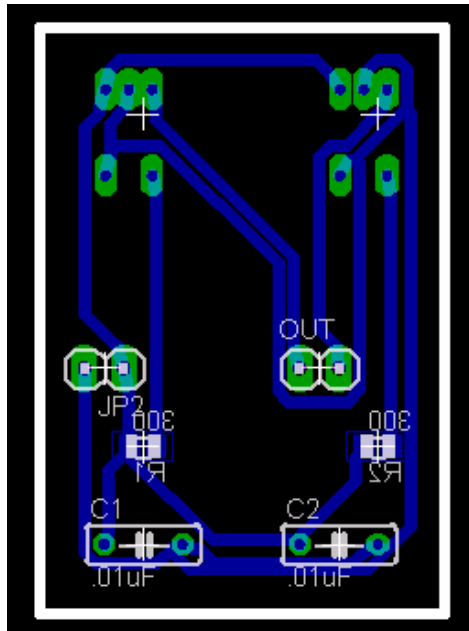
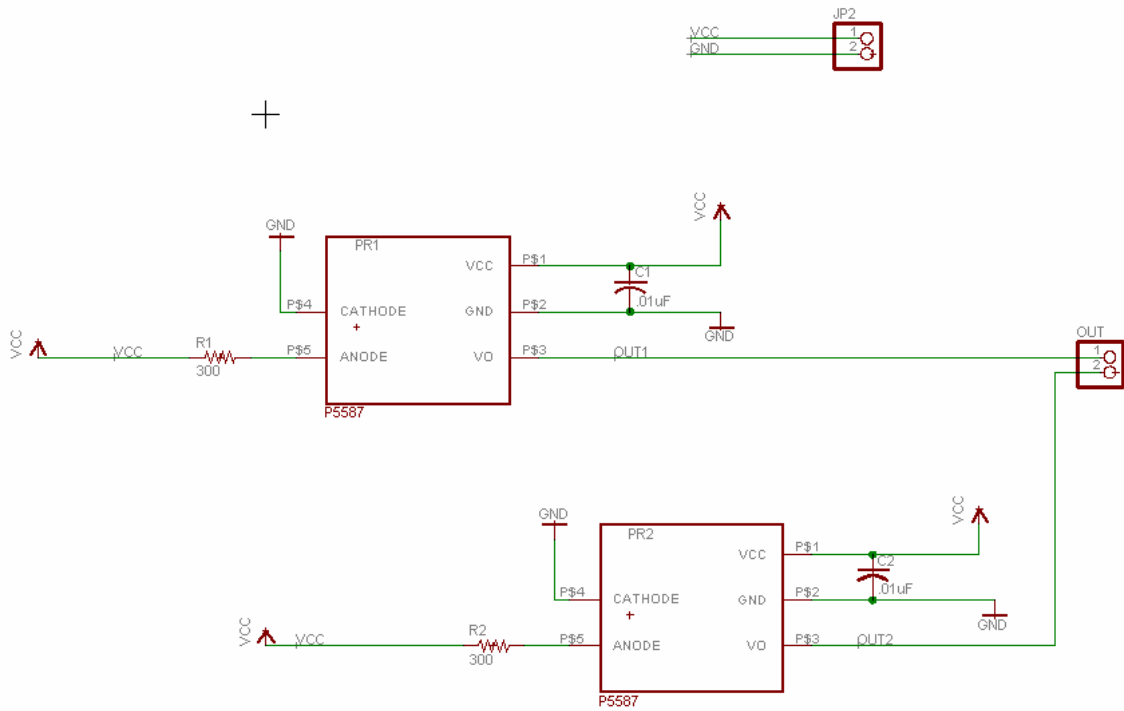
The four sensors I am using are bump switches, sonar, photo reflectors, and a CMUcam.

**Bump Switches:** If something hits Elray on the sides or back, Elray will do obstacle collision. Analog to digital hits conversion was suggested by Steven Pickles and will be used to determine which bump switch was hit and save port pins. By using A/D conversion, I am only using one of Port F's pins. The alternate was using external interrupts but that would have wasted four pins.



**Ultra Sonic Range Finders:** The SRF04 will be used for obstacle avoidance. This method is preferred over IR sensors because the sun emits a lot of IR. The sonars will help detect still objects and walls so Elray does not crash into them. Also, the sonars can detect when its love is in its range for the CMUcam. I am using an external interrupt to calculate how long the echo pulse is high. When the echo pulse goes from low to high, I poll the line until it becomes low again. The closest value it can detect is 4 and when I point Elray to the sky, I get a sonar value of 864. The optimal range of sonar values is 23 to 50 which is about 5 to 20 inches.

**Photoreflectors:** Digital Hamamatsu photoreflectors will be used to keep Elray in the love rectangle. It is pretty simple to use, logic 1 reads white and logic 0 reads black.



**CMUcam:** The CMUcam will be used for color detection. Elray will fall in love with the first color it sees. I tested blue, yellow, green, and red poster board to see what color means I receive in different lighting. Here are my testing results in the Intelligence Machine Design Lab room and in the Machine Intelligence Lab.

Using Track Window, I can see the color means for the object presented in front of the camera. The first set of numbers is the CMUcam's raw bytes. The second set is it converted into usable data (S: Red Mean, Green Mean, Blue Mean)

**In the IMDL room:**

**Blue:** FF 53 **7E 9A AB** 07 07 06 FF 4D 30 44 0A 01 50 8F FE B7 3A  
S 126 154 **171 = Saw blue**

FF 53 **7F 9A AB** 07 07 06 FF 4D 30 43 0A 01 50 8F FE C0 3A  
S 127 154 **171 = Saw blue**

**In the MIL:**

**Blue:** FF 53 **2E 40 9E** 03 03 05 FF 4D 2D 37 09 01 50 82 FE B9 3A  
S 46 64 **158 = Saw blue**

FF 53 **2E 40 9F** 03 03 05 FF 4D 2D 37 09 01 50 7D FE C1 3A  
S 46 64 **159 = Saw blue**

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**In the IMDL room:**

**Yellow:** FF 53 **C3 9E 10** 05 04 00 FF 4D 31 46 11 01 50 8E FE B2 3A  
S **195** 158 16 = **Saw red**

FF 53 **C2 9F 10** 05 04 00 FF 4D 31 46 10 01 50 8E FE B6 3A  
S **194** 158 16 = **Saw red**

**In the MIL:**

**Yellow:** FF 53 **C4 B1 10** 05 04 00 FF 4D 30 3B 11 01 50 80 FE B4 3A  
S **196** 177 16 = **Saw red**

FF 53 **C5 B1 10** 05 04 00 FF 4D 30 3B 13 01 50 80 FE BA 3A  
S **197** 177 16 = **Saw red**

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**In the IMDL room:**

**Green:** FF 53 **29 B7 14** 02 05 02 FF 4D 2F 4A 0B 09 50 8F FE DE 3A  
S 41 **183 20** = **Saw green**

FF 53 **29 B7 14** 02 05 02 FF 4D 2F 4A 0A 09 50 8F FE DC 3A  
S 41 **183 20** = **Saw green**

**In the MIL:**

**Green:** FF 53 **15 BB 29** 02 05 02 FF 4D 30 34 0F 01 50 75 FE C7 3A  
S 21 **187 41** = **Saw green**

FF 53 **15 BC 2A** 02 05 02 FF 4D 30 34 0F 01 50 76 FE C1 3A  
S 21 **188 42** = **Saw green**

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**In the IMDL room:**

**Red:** FF 53 **AC 10 10** 06 00 00 FF 4D 33 42 11 01 50 8F FE C9 3A  
S **172 16 16** = **Saw red**

FF 53 **AB 10 10** 05 00 00 FF 4D 33 42 10 01 50 8E FE CC 3A  
S **171 16 16** = **Saw red**

**In the MIL:**

**Red:** FF 53 **BB 10 10** 06 00 00 FF 4D 31 34 12 01 50 7A FE C3 3A  
S **187 16 16** = **Saw red**

FF 53 **BA 10 10** 06 00 00 FF 4D 31 34 12 01 50 77 FE C6 3A  
S **186 16 16** = **Saw red**

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Most cameras are red biased and the CMUcam is not an exception. With different lighting, blue had a high red and green mean value but it barely passed as blue in the IMDL room. In the MIL, blue worked fine. Yellow is a mix of red and green so it is no surprise to find a high red and green mean value. Every reading I have taken, yellow has

had a higher red mean value than green. Green and red are my strongest colors, the CMUcam can always detect red and green without a hitch.

The CMUcam manual suggests that I make my color mean channel +/- 30 because using TW can give me different readings so a large threshold is needed. By doing this, Elray will see similar colors like red and pink. If I keep the threshold smaller, Elray will not see its first love all the time due to different camera angles and variable lighting. There is no win-win situation so I decided to keep the bigger threshold.

## **Behaviors**

1. When Elray is turned on, he will love the first color it sees and stay with it.
  - a. His hearts will pulsate twice.
2. When another color is in view, Elray will turn on his sad face and he will turn around.
3. When Elray hits the border and sees his first love, Elray will back up, turn on his hearts and ram the border. He will ram the border until the object is in range again. If the object is too far, Elray will turn away because the camera is not in view.

## **Problems**

The CMUcam was originally thought to have motion detection but that is in the CMUcam2 line. The Middle Mass function was in use and the according to the middle mass x coordinate, Elray would move left or right. Elray and that function did not mix and could not get that to operate correctly. Elray sometimes did it correctly but not always, by having that mistake the camera would not be looking at the object directly.

The sonars had to be timed correctly to get a reading. I tried polling, real time interrupt and external interrupt and I found that I liked external interrupt the best to use for the sonars.

## **Conclusion**

Elray was a tough project to make but in the end, I believe he is successful in determining the love of his life. I have integrated four sensors: the bump switches, ultrasonic range finders, photoreflectors, and CMUcam (which I dreaded to use). I actually applied what I learned from my classes and was successful. The summer cuts out 3 weeks from the regular semesters so everything had to be on schedule.

If I could redo Elray, I would make his platform bigger and taller so everyone can see his emotions better. I would have also made a question mark led to show that Elray is thinking. If I bought an extra sonar, I would have make edge of the world detection so he can love on a table without having to make an area for it. I would make the thresholds smaller if I could make the area with even lighting.

Elray is painted black and blue as of right now, if I could repaint him, he would have two blues, one dark and one light. Elray is a bit scary right now but he's just a love machine who had no say on the colors painted on him. Don't discriminate, it's all love when it comes to Elray.

## **References**

The Atmel ATmega128 Manual.

[http://www.atmel.com/dyn/resources/prod\\_documents/doc2467.pdf](http://www.atmel.com/dyn/resources/prod_documents/doc2467.pdf)

The CMUcam website

<http://www-2.cs.cmu.edu/~cmucam/Downloads/CMUcamManual.pdf>

<http://www-2.cs.cmu.edu/~cmucam/qanda.html>

## Pictures

