



# C-Band: A Flexible Color Ring Tag System

## Overview

C-Band is a new visual tag system for [camera-based user interface](#).  
 C-Band has several flexibilities that cannot be achieved by the existing visual tag systems:

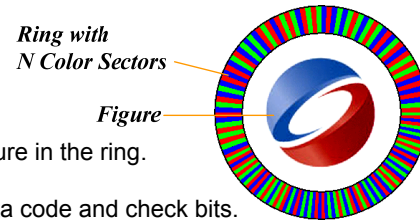
- The tag may be any convex shape, and contain any figure,
- The tag provides a size-scalable code containing an n-bit ID or a short URL.

With these features, C-Band has the potential for widespread use.

## C-Band System

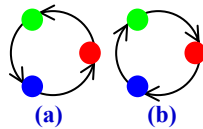
### Tag Structure

A C-Band tag consists of a color ring and a figure in the ring.  
 The ring is divided into  $N$  color sectors.  
 The color differences on the ring express a data code and check bits.

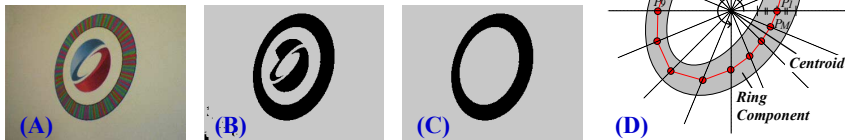


### Color Difference Based Data Encoding

When using 3 colors of RGB, color changes (a) indicate '0', color changes (b) indicate '1'.

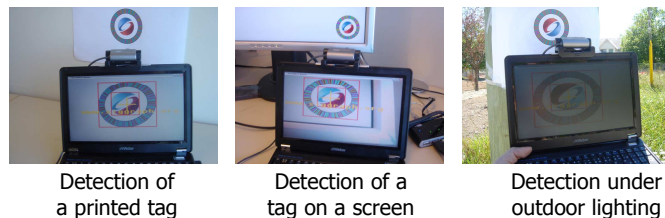


### Detection Process Overview



- 1) A scanner transforms a captured image (Fig. A) into a binary image (Fig. B).
- 2) A candidate for a ring component is selected (Fig. C).
- 3) A sequence of  $M$  ( $\gg N$ ) points on the ring component is obtained by the 'radial scan' (Fig. D).
- 4) The color pattern in the point sequence is converted into a binary sequence.  
 And, every possible code in the binary sequence is checked.

### Performance of Trial System



## Potential Applications

### Hot Frame – Physical URLs

A C-Band ring surrounding a printed or displayed picture can work as an indicator of a linked hot spot as well as containing the actual link information.



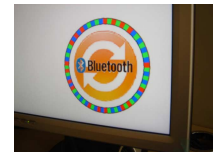
### Printed Keypad

C-Band tags arranged as keys on a keyboard can act as an interesting input device for small camera phones.



### Graphical Tag for Screen Interactions

C-Band based graphical tags displayed on screens can be used for some of the phone camera based screen interaction techniques.



Etc.

### Future Work

- Investigate the performance under various lighting conditions.
- Develop suitable algorithms for improved detection of C-Band tags to support thinner rings and larger data using high resolution images.
- Install a C-Band system in commercial camera phone devices.