

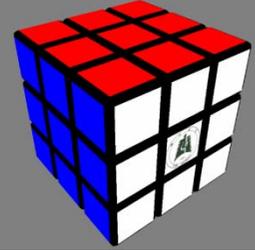
Speedy Cube-solving Robot

School: Hubei University

Team members: Lei.Sun Yangyang.Zhang Ke.Wu

Instructor: Shi.Lu

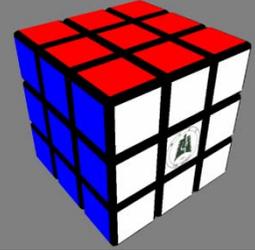
Time: 2015.7.11



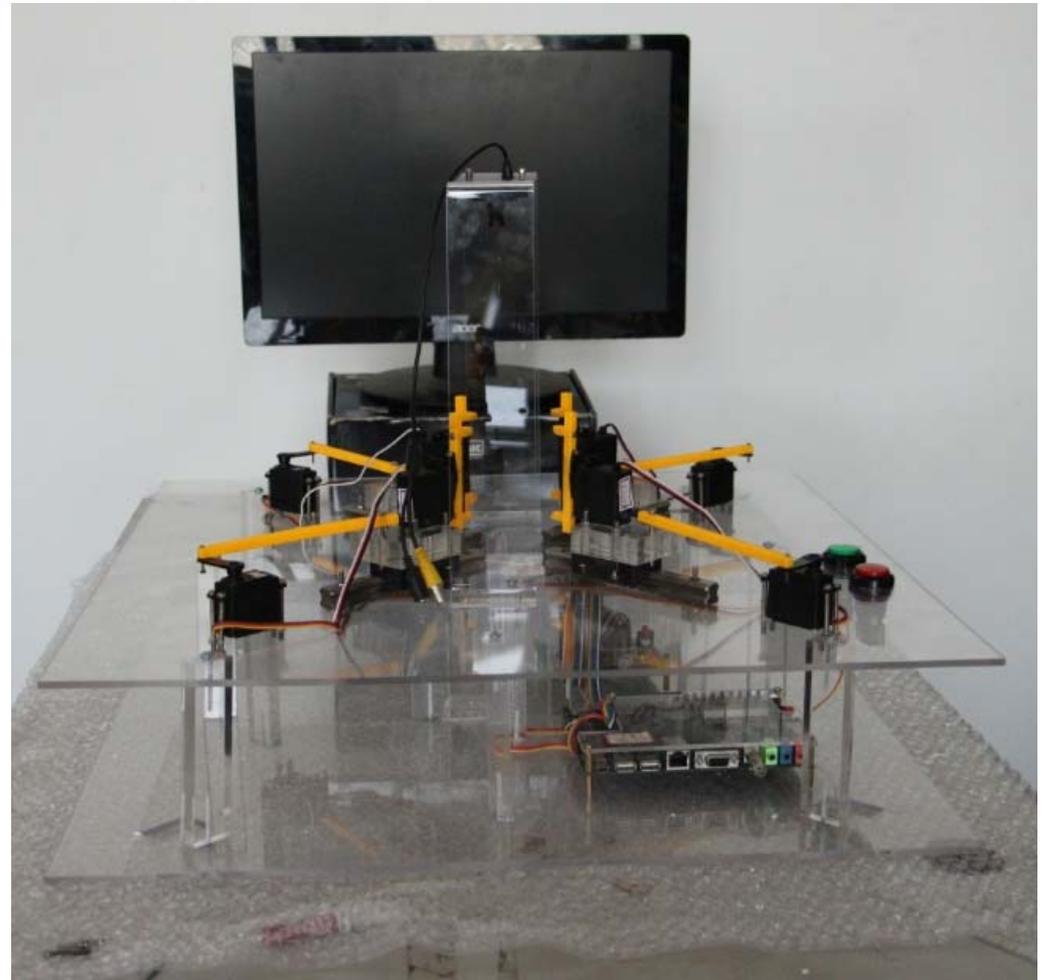
NO.1 What we do

NO.2 How we do

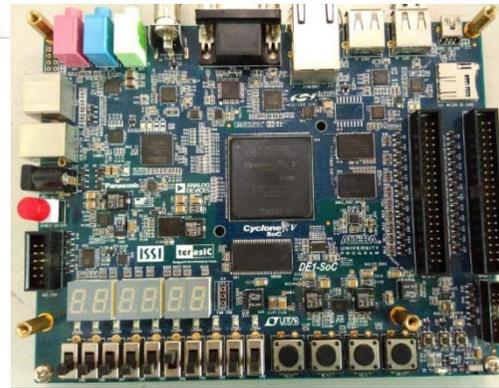
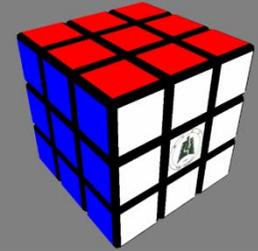
NO.3 What we get



The design is a set of intelligent cube-solving platform which is based on FPGA-HPS data interaction with Linux operating system.



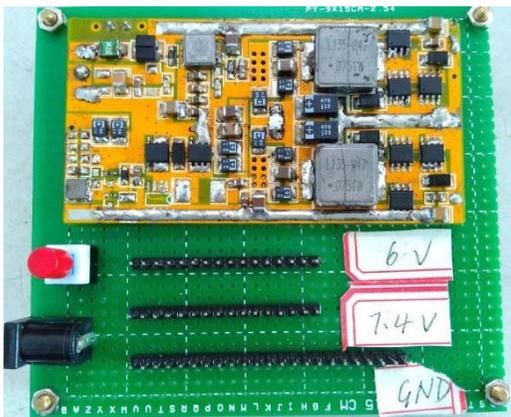
overall structure



LCD screen



servo



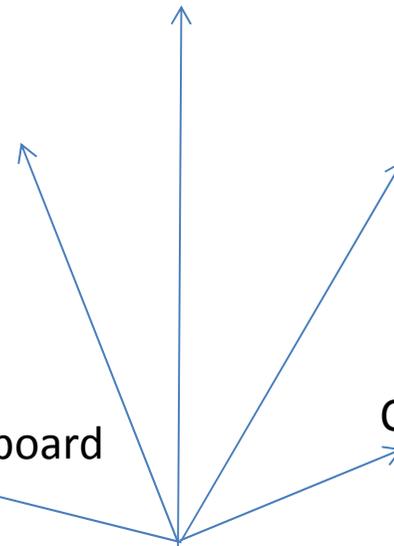
power supply board

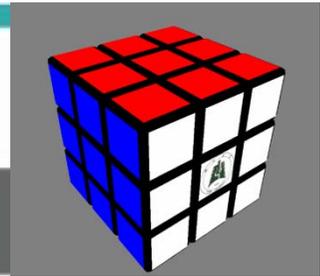


CCD camera

DE1-SoC

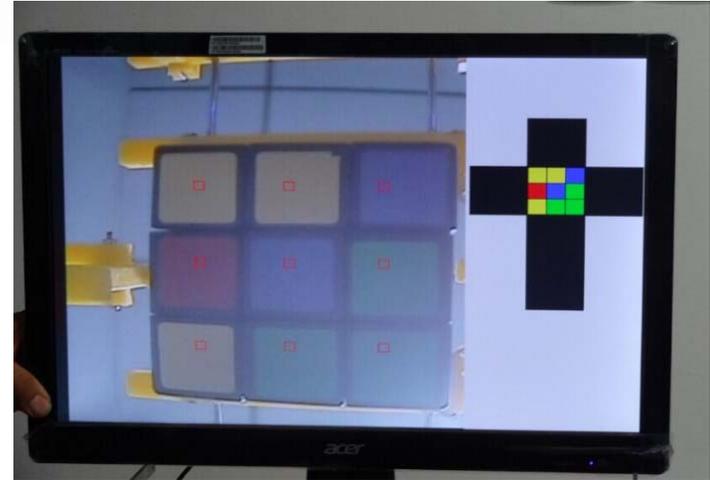
Components





camera image acquisition

Function description

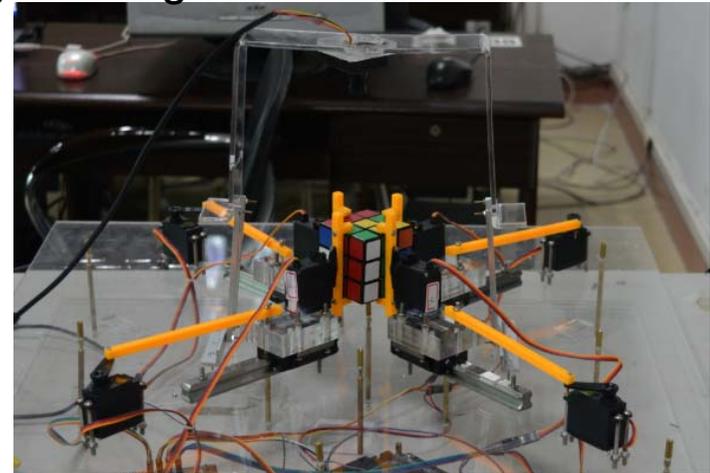


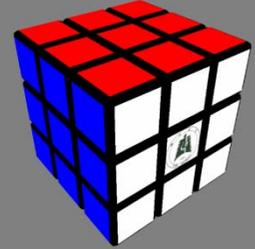
Multifunctional VGA display

Real-time display of digital tube

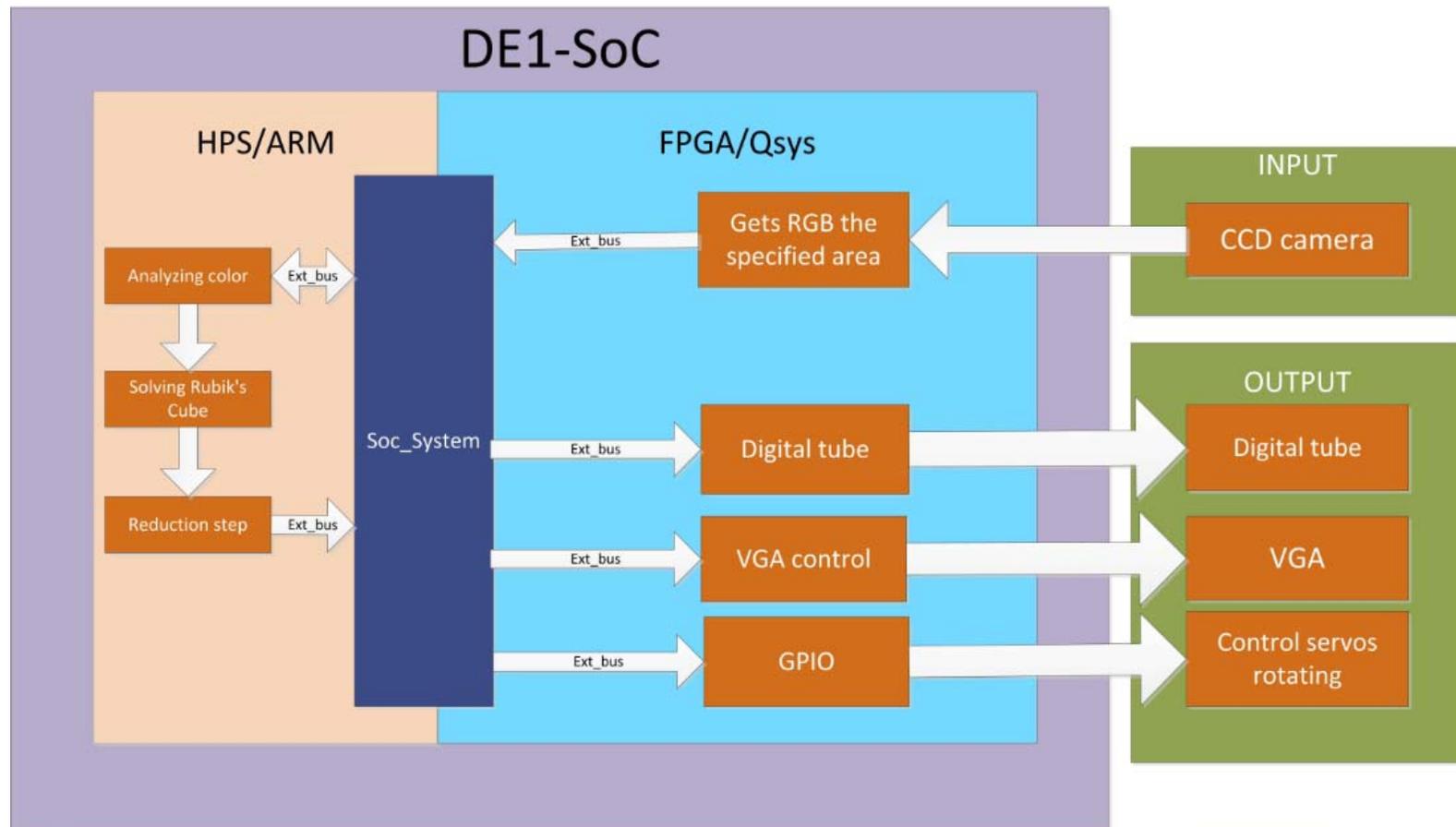


Eight-linkage servo for cube reduction





Composition principle

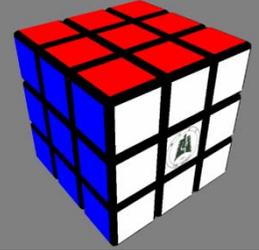




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NO.2 How we do

NO.3 What we get

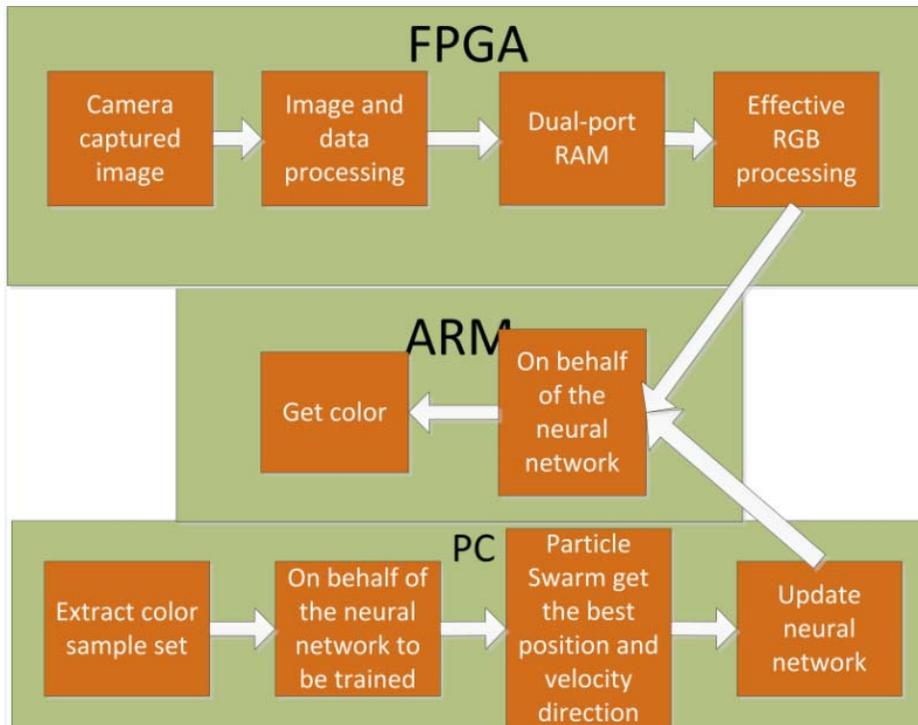
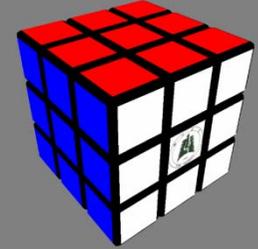


1. Color analyzing technology

2. Reduction algorithm for Rubik's cube

3. Eight-linkage servo control

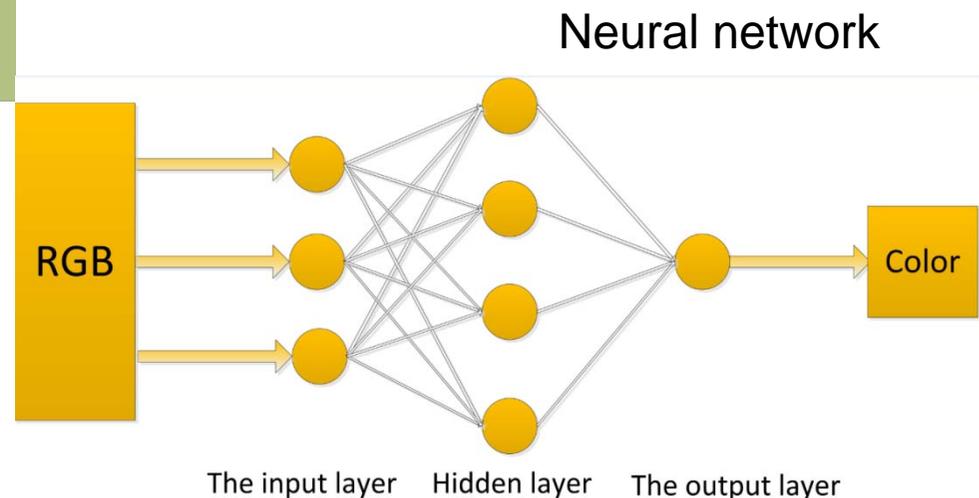
4. FPGA communication with HPS



1. Color analyzing technology

algorithm features:

The use of particle swarm algorithm to train a neural network with three layers can distinguish the cube's six colors in different environment.



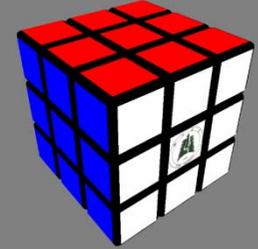


1. Color analyzing technology

2. Reduction algorithm for Rubik's cube

3. Eight-linkage servo control

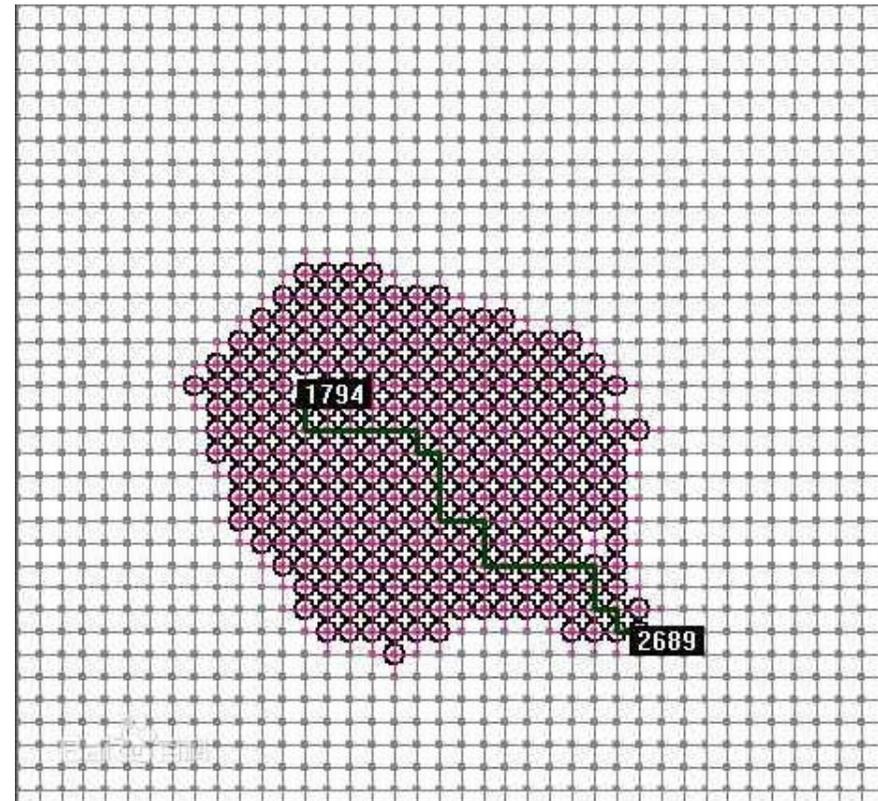
4. FPGA communication with HPS



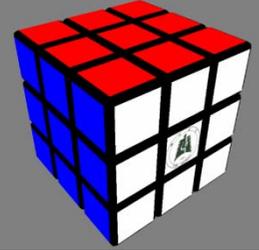
2.Reduction algorithm for Rubik's cube

A* algorithm:

A* (A-Star) is a direct search method for the shortest path in the static network. The closer the assessment value is to the actual value, the better the evaluation function is.



algorithm features: By constantly trying to find the optimization solution to solve the Rubik's cube, steps from more than 100 reduced to about 25 .

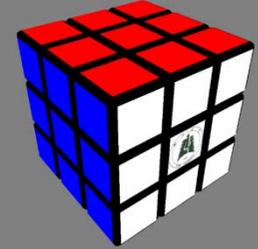


1. Color analyzing technology

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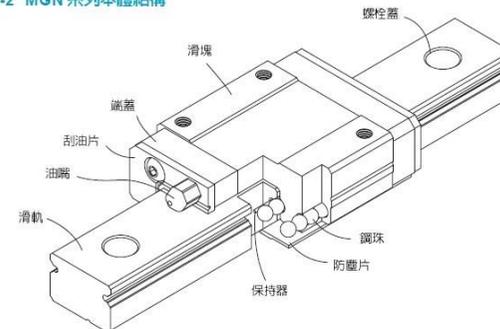


Crank slider mechanism

3. Eight-linkage servo control



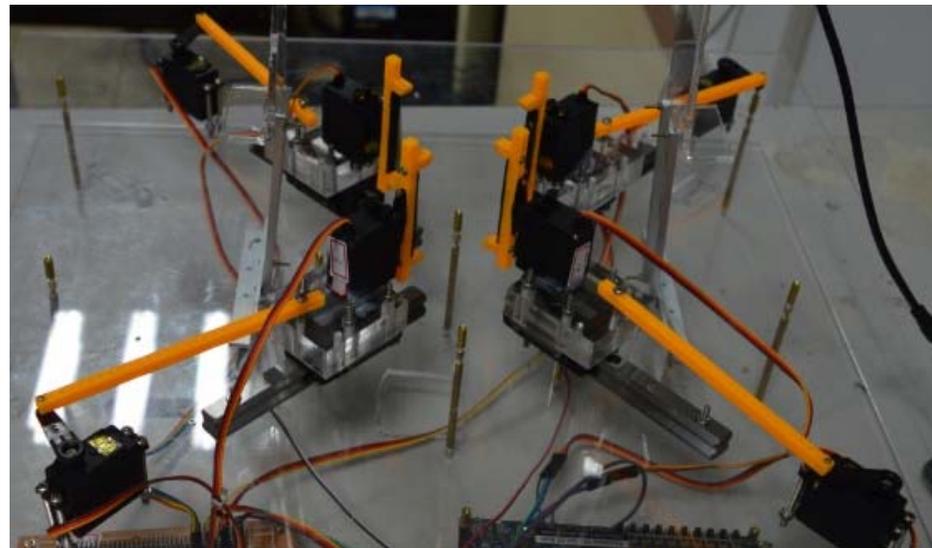
2-3-2 MGN 系列本體結構

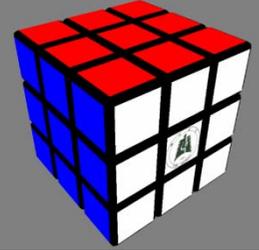


- ▶ 滾動循環系統：滑塊、滑軌、齒蓋、鋼珠、保持器。
- ▶ 潤滑系統：MGN15 齒蓋側附有油嘴，提供客戶注油，而 MGN7、9、12 則於齒蓋側預留注油孔，可使用注射器將油或油脂打入滑塊內部以潤滑。
- ▶ 防塵系統：刮油片、防塵片(12,15 規格選配)、螺絲蓋(12,15 規格)。

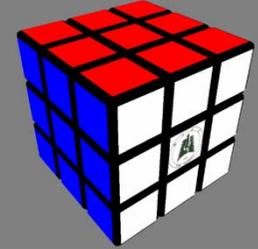
structure features:

- Simple mechanical structure
- Low cost
- Good mechanical reliability





1. Color analyzing technology
2. Reduction algorithm for Rubik's cube
3. Eight-linkage servo control
4. FPGA communication with HPS



4. FPGA communication with HPS

ext_bus

altera_generic_tristate_controller

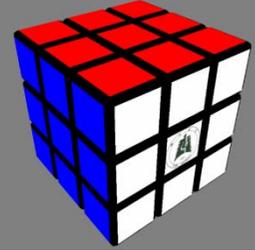
Address width:

Data width:

Byteenable width:

Bytes per word:

		ext_bus		Generic Tri-State Controller	
	clk			Clock Input	Double-
	reset			Reset Input	Double-
	uas			Avalon Memory Mapped Slave	Double-
	tcm			Tristate Conduit Master	Double-
		Base	End		
ick to	clk_0	0x0003_0000	0x0003_ffff		
ick to	[clk]				
ick to	[clk]				
ick to	[clk]				



The FPGA part (By ext-bus to read and write mem)

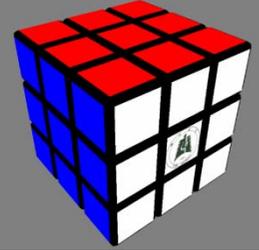
```
case (addr)
  16'h0000: mem[0] <= data;
  16'h0004: mem[1] <= data;
  16'h0008: mem[2] <= data;
  16'h000c: mem[3] <= data;
  16'h0010: mem[4] <= data;
  16'h0014: mem[5] <= data;
  16'h0018: mem[6] <= data;
  16'h001c: mem[7] <= data;
  16'h0020: mem[8] <= data;
```

The HPS part (Use mmap find the device address of the operation)

```
h2p_lw_extBus_addr = virtual_base + ( ( unsigned
long )( ALT_LWFPGASLVS_OFST + EXT_BUS_BASE ) &
( unsigned long )( HW_REGS_MASK ) );
```

features:

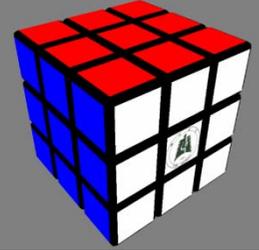
Use bus principle, the ext-bus data readable and writable, compared to the direct use PIO, more convenient.



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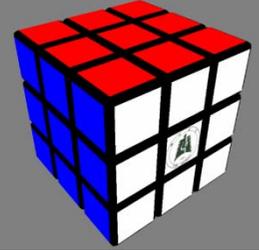
NO.3 What we get



In the process of the competition, we got much technical support, from Altera company's .We learned a lot from this data, such as, how to realize the bridging between the FPGA and HPS and how to use the hardware to get the camera's data software for data analysis, etc. It's a worth that we have a deep understanding of the idea of the hardware to do the collection and the software to do the algorithm.

Through this competition, my team becomes more and more united. Our efforts made us reach this level from the initial unfamiliarity with FPGA , also because of our insistence,we gained many skills.

At last, thanks to the support from the Altera and Terasic and useful resources provided by Hubu and Altera EDA/SOPC united laboratory . Thanks to the guidance and company of Teacher Lu.



Thanks