

# . Framebuffer

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# Framebuffer

## . Framebuffer

### 1.1 LCD Framebuffer

LCD Framebuffer                      LCD Framebuffer    LCD    480000                      LCD  
4=960000    1.92MB                      1.92MB

FramebufferAPP\_Image00001

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Framebuffer                      LCD                      Framebuf

### 1.2 Framebuffer API

#### 1.2.1 open

FramebufferAPP\_Image00002

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```
#include <sys/types.h> #include <sys/stat.h> #include <fcntl.h>
```

- int open(const char \*pathname, int flags);
- int open(const char \*pathname, int flags, mode\_t mode);

- pathname
- Flags                      6
- ① O\_RDWR                      ;

```

② O_RDONLY      ;
③ O_WRONLY      ;
④ O_APPEND      ;
⑤ O_TRUNC
⑥ O_CREAT       O_EXCL

```

Mode flags O\_CREAT

-1

## 1.2.2 ioctl

FramebufferAPP\_Image00003

Image not found or type unknown

```
#include <sys/ioctl.h>
```

- int ioctl(int fd, unsigned long request, ...);

- fd
- request
- ... arg request

-1

## 1.2.3 mmap

FramebufferAPP\_Image00004

Image not found or type unknown

```
#include <sys/mman.h>
```

- void \*mmap(void \*addr, size\_t length, int prot, int flags,int fd, off\_t offset);

- addr NULL

- length
  - prot 4
    - ①PROT\_EXEC
    - ②PROT\_READ
    - ③PROT\_WRITE
    - ④PROT\_NONE
  - Flags
    - ①MAP\_SHARED
    - ②MAP\_PRIVATE
- 1

## 1.3 LCD

### 1.3.1 LCD

FramebufferAPP\_Image00005

Image not found or type unknown

‘A’ ‘1’ ‘0’ 8\*16

### 1.3.2 fb\_var\_screeninfo

fb0 LCD fb\_info

FramebufferAPP\_Image00006

Image not found or type unknown

ioctl xres(x) yres y bits\_per\_pixel

show\_ascii.c

```

4718     fd_fb = open("/dev/fb0", O_RDWR);
4719     if ( fd_fb < 0)
4720     {
4721         printf("can' t open /dev/fb0\n");
4722         return -1;
4723     }
```

```

4724         if (ioctl(fd_fb, FBIOGET_VSCREENINFO, &var))
4725         {
4726             printf("can't get var\n");
4727             return -1;
4728         }

```

LCD fb0 ioctl fb\_var\_screeninfo var var xres(x) yre

## 1.3.3 fb\_var\_screeninfo

fb\_var\_screeninfo var var

xres bits\_per\_pixel

show\_ascii.c

```

4730 line_width = var.xres * var.bits_per_pixel / 8;

```

bits\_per\_pixel

show\_ascii.c

```

4731 pixel_width = var.bits_per_pixel / 8;

```

xres yres bits\_per\_pixel

show\_ascii.c

```

4732 screen_size = var.xres * var.yres * var.bits_per_pixel / 8;

```

## 1.3.4 mmap

show\_ascii.c

```

4733 fbmem = (unsigned char *)mmap(NULL, screen_size, PROT_READ | PROT_WRITE, MAP_SHARED,
4734 fd_fb, 0);
4735 if (fbmem == (unsigned char *)-1)
4736 {
4737     printf("can't mmap\n");
4738     return -1;
4739 }

```

```
4739
4740 □/*      */
4741 □memset(fbmem, 0, screen_size);
```

mmap	PROT_READ   PROT_WRITE	MAP_SHARED	fb
------	------------------------	------------	----

### 1.3.5

show\_ascii.c

```
4641 void lcd_put_pixel(int x, int y, unsigned int color)
```

show\_ascii.c

```
4643 unsigned char *pen_8 = fbmem+y*line_width+x*pixel_width;
4644 unsigned short *pen_16;
4645 unsigned int *pen_32;
4646
4647 unsigned int red, green, blue;
4648
4649 pen_16 = (unsigned short *)pen_8;
4650 pen_32 = (unsigned int *)pen_8;
```

x y	1	2	4
-----	---	---	---

fbmem      mmap      fbmem

$$= \text{fbmem} + Y^* \quad + X^*$$

show\_ascii.c

```
4652 switch (var.bits_per_pixel)
4653 {
4654     case 8:
4655     {
4656         *pen_8 = color;
4657         break;
4658     }
```

```

4659 case 16:
4660 {
4661     /* 565 */
4662     red    = (color >> 16) & 0xff;
4663     green  = (color >> 8) & 0xff;
4664     blue   = (color >> 0) & 0xff;
4665     color  = ((red >> 3) << 11) | ((green >> 2) << 5) | (blue >> 3);
4666     *pen_16 = color;
4667     break;
4668 }
4669 case 32:
4670 {
4671     *pen_32 = color;
4672     break;
4673 }
4674 default:
4675 {
4676     printf("can't support %dbpp\n", var.bits_per_pixel);
4677     break;
4678 }
4679 }
4680 }

```

fb0    bits\_per\_pixel    pen pen\_8 pen\_16 pen\_32    color    pen

## 1.4 LCD

### 1.4.1 LCD

①                    c                    ASCII

show\_ascii.c

```

4693 unsigned char *dots = (unsigned char *)&fontdata_8x16[c*16];

```

②                    '1'                    '0'

Image not found or type unknown

LCD

16

8

8

show\_ascii.c

```

4697 for (i = 0; i < 16; i++)
4698 {
4699     byte = dots[i];
4700     for (b = 7; b >= 0; b--)
4701     {
4702         if (byte & (1<<b))
4703         {
4704             /* show */
4705             lcd_put_pixel(x+7-b, y+i, 0xffffffff); /* */
4706         }
4707     } else
4708     {
4709         /* hide */
4710         lcd_put_pixel(x+7-b, y+i, 0); /* */
4711     }
4712 }
4713

```

③ lcd\_put\_ascii

show\_ascii.c

```

4743 lcd_put_ascii(var.xres/2, var.yres/2, 'A'); /*      8*16  A*/

```

④ c show\_ascii.c

arm-linux-gnueabi-gcc -o show\_ascii show\_ascii.c

⑤ show\_ascii show\_ascii

./show\_ascii

‘A’



# 1.4.2 LCD

FramebufferAPP\_Image00008

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(HZK16)

①

show\_font.c

```
4760 fd_hzk16 = open("HZK16", O_RDONLY);
```

② hzk\_stat

show\_font.c

```
4793 if(fstat( fd_hzk16, &hzk_stat))
```

mmap

③ mmap

show\_font.c

```
4798 hzkmem = (unsigned char *)mmap(NULL , hzk_stat.st_size, PROT_READ, MAP_SHARED, fd_hzk16, 0);
```

hzkmem fbmem

④

HZK16 GB2312 16×16 HZK16 32 ‘ ’ D6D0 2

show\_font.c

```
4734 unsigned int area = str[0] - 0xA1;
4735 unsigned int where = str[1] - 0xA1;
4736 unsigned char *dots = hzkmem + (area * 94 + where)*32;
```

Image not found or type unknown

16

2

'1'

show\_font.c

```

4740 for (i = 0; i < 16; i++)
4741     for (j = 0; j < 2; j++)
4742     {
4743         byte = dots[i*2 + j];
4744         for (b = 7; b >=0; b--)
4745         {
4746             if (byte & (1<<b))
4747             {
4748                 /* show */
4749                 lcd_put_pixel(x+j*8+7-b, y+i, 0xffffffff); /* */
4750             }
4751             else
4752             {
4753                 /* hide */
4754                 lcd_put_pixel(x+j*8+7-b, y+i, 0); /* */
4755             }
4756         }
4757     }

```

⑤ lcd\_put\_chinese

show\_font.c

```

4810 printf("chinese code: %02x %02x\n", str[0], str[1]);
4811 lcd_put_chinese(var.xres/2 + 8, var.yres/2, str);

```

⑥ c show\_font.c

arm-linux-gnueabi-gcc -o show\_font show\_font.c

HZK16 show\_font.C

⑦ show\_font show\_font

./show\_font

‘A’ ‘ ’ ‘ ’

chinese code: d6 d0

## 1.5 freetype

### 1.5.1 freetype

#### ① freetype

```
tar xjf freetype-2.4.10.tar.bz2
```

#### ② freetype-2.4.10

```
cd freetype-2.4.10
```

#### ③ freetype-2.4.10

```
./configure --host=arm-linux-gnueabi --prefix=/home/book/100ask_imx6ull-sdk/ToolChain/gcc-linaro-6.2.1-2016.11-x86_64_arm-linux-gnueabi/libc/usr/
```

#### ④ internal

```
mkdir /home/book/100ask_imx6ull-sdk/ToolChain/gcc-linaro-6.2.1-2016.11-x86_64_arm-linux-gnueabi/libc/usr/include/freetype2/freetype/internal -p
```

#### ④

```
make
```

#### ⑤

```
make install
```

#### ⑥ freetype

```
mv /home/book/100ask_imx6ull-sdk/ToolChain/gcc-linaro-6.2.1-2016.11-x86_64_arm-linux-gnueabi/libc/usr/include/freetype2/freetype /home/book/100ask_imx6ull-sdk/ToolChain/gcc-linaro-6.2.1-2016.11-x86_64_arm-linux-gnueabi/libc/usr/include/
```

## 1.5.2 freetype

100ask      freetype      freetype

/home/book/100ask\_imx6ull-sdk/ToolChain/gcc-linaro-6.2.1-2016.11-x86\_64\_arm-linux-gnueabihf/arm-linux-gnueabihf/libc/usr/include/\*

/home/book/100ask\_imx6ull-sdk/ToolChain/gcc-linaro-6.2.1-2016.11-x86\_64\_arm-linux-gnueabihf/arm-linux-gnueabihf/libc/usr/lib/so

-d

# 1.6 freetype

## 1.5.1

① A

FramebufferAPP\_Image00010

Image not found or type unknown

②

FramebufferAPP\_Image00011

Image not found or type unknown

③ A

FramebufferAPP\_Image00012

Image not found or type unknown

1/2 2/4

## 1.5.2 Freetype

Freetype

API

freetype

glyph

Windows

FONTs

TTF

simsun.ttc

FramebufferAPP\_Image00013

Image not found or type unknown

Charmaps

GBK UNICODE BIG5

charmap

glyph

- ① 'A' 0x41 ' ' GBK UNICODE ,BIG5
- ② charmap glyph
- ③
- ④ glyph
- ⑤
- ⑥ LCD

FramebufferAPP\_Image00014

Image not found or type unknown

step1 step2 step3

freetype

- ① FT\_InitFreetype
- ② Face FT\_New\_Face
- ③ FT\_Set\_Char\_Sizes FT\_Set\_Pixel\_Sizes
- ④ charmap FT\_Select\_Charmap
- ⑤ charcode glyph : glyph\_index = FT\_Get\_Char\_Index face charcode
- ⑥ glyph\_index glyph FT\_Load\_Glyph face glyph\_index
- ⑦ FT\_Render\_Glyph
- ⑧ :FT\_Set\_Transform

## 1.5.2 LCD

## FramebufferAPP\_Image00015

Image not found or type unknown

C

### ① freetype

freetype\_show\_font.c

```
4872 error = FT_Init_FreeType( &library );  
/* initialize library */
```

### ② freetype FT\_New\_Face face &face

freetype\_show\_font.c

```
4875 error = FT_New_Face( library, argv[1], 0, &face );  
/* create face object */
```

### ③ face glyph

freetype\_show\_font.c

```
4877 slot = face->glyph;
```

### ④ 24\*24

freetype\_show\_font.c

```
4879 FT_Set_Pixel_Sizes( face, 24, 0 );
```

### ⑤

LCD x y freetype x y

## FramebufferAPP\_Image00017

Image not found or type unknown

‘ ‘ lcd ‘ ‘

x y ‘A’ xres/2 yres/2

- lcd\_x = var.xres/2 + 8 + 16 lcd\_y = var.yres/2 + 16
- :x = lcd\_x = var.xres/2 + 8 + 16 y = var.yres - lcd\_y = var.yres/2 - 16
- 1/64 64

## freetype\_show\_font.c

```
4888 pen.x = ( var.xres/2 + 8 + 16) * 64;
4889 pen.y = ( var.yres/2 - 16) * 64;
4890
4891 /* set transformation */
4892 FT_Set_Transform( face, 0, &pen);
```

## ⑥ glyph

```
4895 error = FT_Load_Char( face, chinese_str[0], FT_LOAD_RENDER );
4896 if ( error)
4897 {
4898     printf("FT_Load_Char error\n");
4899     return -1;
4900 }
```

## FramebufferAPP\_Image00018

Image not found or type unknown

FT\_Load\_Char 3

## example1.c

## freetype\_show\_font.c

```
4902 draw_bitmap( &slot->bitmap,
4903               slot->bitmap_left,
4904               var.yres - slot->bitmap_top);
```

## example1.c

## FramebufferAPP\_Image00019

Image not found or type unknown

3

- Width LCD x var.xres
- Height LCD y var.yres
- lcd\_put\_pixel image  
lcd\_put\_pixel(i, j, bitmap->buffer[q \* bitmap->width + p]);

⑥ C freetype\_show\_font.c

```
arm-linux-gnueabi-hf-gcc -finput-charset=GBK -fexec-charset=GBK -o freetype_show_font
freetype_show_font.c -lfreetype -lm
```

⑦ freetype\_show\_font simsun.ttc simsun.ttc freetype\_show\_font

```
./freetype_show_font ../simsun.ttc
```

‘ ‘

## 1.5.3 LCD

example1.c

FramebufferAPP\_Image00020

Image not found or type unknown

freetype\_show\_font\_angle.c

```
4894 /* use 25 degrees */
4894 angle = ( 1.0 * strtoul( argv[ 2], NULL, 0) / 360 ) * 3.14159 * 2;

4895 /* set up matrix */
4896 matrix.xx = (FT_Fixed)( cos( angle ) * 0x10000L );
4897 matrix.xy = (FT_Fixed)(-sin( angle ) * 0x10000L );
4898 matrix.yx = (FT_Fixed)( sin( angle ) * 0x10000L );
4899 matrix.yy = (FT_Fixed)( cos( angle ) * 0x10000L );
4900
4901 /* set transformation */
4902 FT_Set_Transform( face, &matrix, &pen);
```

```
arm-linux-gnueabi-hf-gcc -finput-charset=GBK -fexec-charset=GBK -o freetype_show_font_angle
freetype_show_font_angle.c -lfreetype -lm
```



freetype\_show\_font\_angle

freetype\_show\_font

simsum.ttc

./freetype\_show\_font\_angle ../simsum.ttc 90

‘ ’ 90