

. Framebuffer

- [Framebuffer](#)

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

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

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

- fd
- request
- ... arg request

-1

1.2.3 mmap

FramebufferAPP_Image00004

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```
#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

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‘A’ ‘1’ ‘0’ 8*16

1.3.2 fb_var_screeninfo

fb0 LCD fb_info

FramebufferAPP_Image00006

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ioctl xres(x) yres y bits_per_pixel

show_ascii.c

```

4718     fd_fb = open("/dev/fb0", 0_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-hf-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/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/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/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/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-gnueabi/f/arm-linux-gnueabi/f/libc/usr/include/*

/home/book/100ask_imx6ull-sdk/ToolChain/gcc-linaro-6.2.1-2016.11-x86_64_arm-linux-gnueabi/f/arm-linux-gnueabi/f/libc/usr/lib/so

-d

1.6 freetype

1.5.1

① A

FramebufferAPP_Image00010

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②

FramebufferAPP_Image00011

Image not found or type unknown

③ A

FramebufferAPP_Image00012

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1/2 2/4

1.5.2 Freetype

Freetype

API

freetype

glyph

Windows

FONTS

TTF

simsun.ttc

FramebufferAPP_Image00013

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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-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-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

simsun.ttc

./freetype_show_font_angle ../simsun.ttc 90

‘ ’ 90