Linux G2D

开发指南

版本号: 2.3
发布日期: 2023.3.8

版本历史

版本号	日期	制/修订人	内容描述
1.0	2020.6.30	AWA1572	创建该文档
2.0	2020.11.18	AWA1639	更新适配 linux5.4
2.1	2021.4.10	AWA1693	添加输出宽度限制说明
2.2	2022.7.11	AWA1836	更新适配 linux-5.10
2.3	2023.3.8	AWA2072	更新适配 linux-5.15

目　录

插　　图

1 前言

1.1 文档简介

本文主要介绍 sunxi 平台 G2D 模块的功能、驱动结构及模块的配置和调用方法。

1.2 目标读者

- G2D 驱动开发人员/维护人员
- 应用层的 G2D 模块使用者

1.3 适用范围

表 1-1: 适用产品列表

内核版本	驱动文件
Linux-4.9	drivers/char/sunxi_g2d/
Linux-5.4	drivers/char/sunxi_g2d/
Linux-5.10	bsp/drivers/g2d/
Linux-5.15	bsp/drivers/g2d/

2 模块介绍

G2D 驱动主要实现图像旋转、数据格式、颜色空间转换、图像压缩, 以及图层合成功能 (包括 alpha、colorkey、rotate、mirror、rop 和 maskblt) 等加速功能。

2.1 模块功能介绍

G2D 硬件特性如下：

- Input format: iYUV422/PYUV422UVC/PYUV420UVC/PYUV411UVC/ARGB8888/XRGB8888/RGB888/ARGB4444/ARGB1555/RGB565
- Output format: iYUV422/PYUV422UVC/PYUV420UVC/PYUV411UVC/ARGB8888/XRGB8888/RGB888/ARGB4444/ARGB1555/RGB565/Y8
- Any format convert function, R/B swap
- 1 channel scaling pipelines for scaling up/down
- Programmalbe source image size up to 2048*2048 pixels
- Programmalbe destination image size up to 2048*2048 pixels
- 4 tap scale filter in horizontal and 2 tap in vertical direction
- 32 programmable coefficients for each tap
- Color space conversion betwwen RGB and YUV
- Clipping support
  - Straight line/Rectangle/Point
  - Block fill
- Rotate and mirror
  - Rotation 90/180/270 counter-clockwise
  - Mirror horizontal/vertical
- ROP
  - BitBlt
  - StretchBlt
  - MaskBlt

- Colorkey support
  - Source colorkey
  - Destination colorkey
- Alpha blending support
  - Pixel alpha blending
  - Plane alpha blending
  - Multi alpha blending
  - Output alpha configurable support

2.1.1 矩形填充 (fill color rectgngle)

填充矩形区域功能可以实现对某块区域进行预订的颜色值填充，如下图就填充了 0xFF0080FF 的 ARGB 值，该功能还可以通过设定数据区域大小实现画点和直线，同时也可以通过设定 flag 实现一种填充颜色和目标做 alpha 运算。

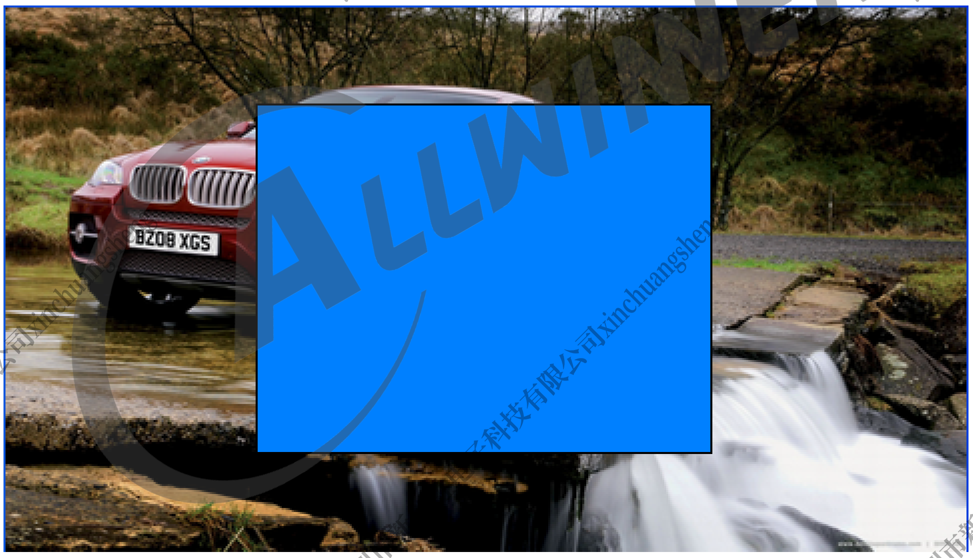


图 2-1: fill rectangle

2.1.2 旋转和镜像 (rotate and mirror)

旋转镜像主要是实现如下 Horizontal、Vertical、Rotate180°、Mirror45°、Rotate90°、Mirror135°、Rotate270° 共 7 种操作。

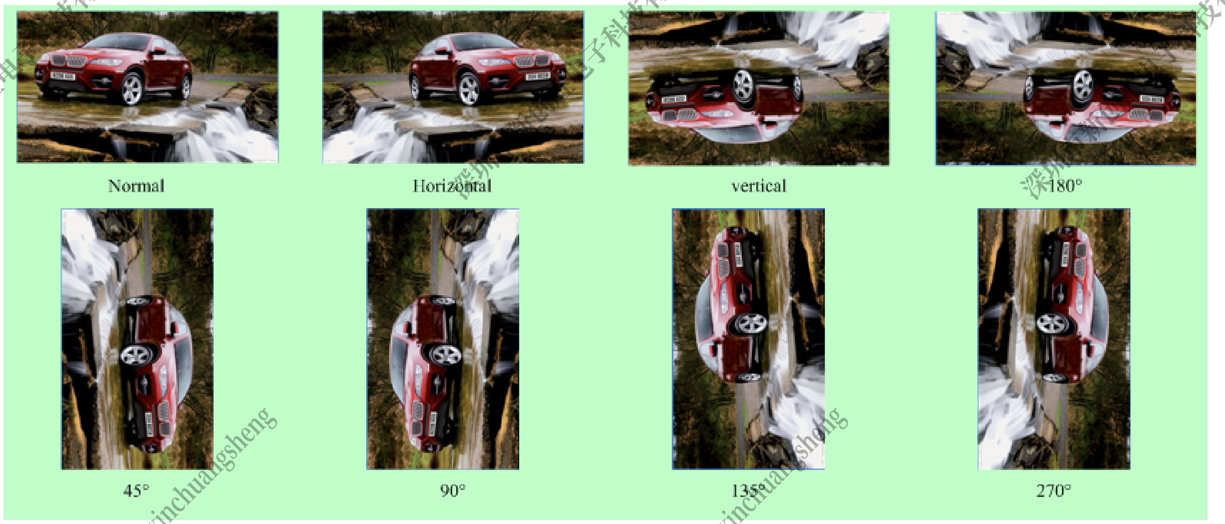


图 2-2: rotate and mirror

2.1.3 alpha blending

不同的图层之间可以做 alpha blending。Alpha 分为 pixel alpha、plane alpha、multi alpha 三种：

pixel alpha 意为每个像素自带有一个专属 alpha 值；

plane alpha 则是一个图层中所有像素共用一个 globe alpha 值；

multi alpha 则每个像素在代入 alpha 运算时的值为 globe alpha*pixel alpha，可以通过 G2D 驱动接口的 flag 去控制。

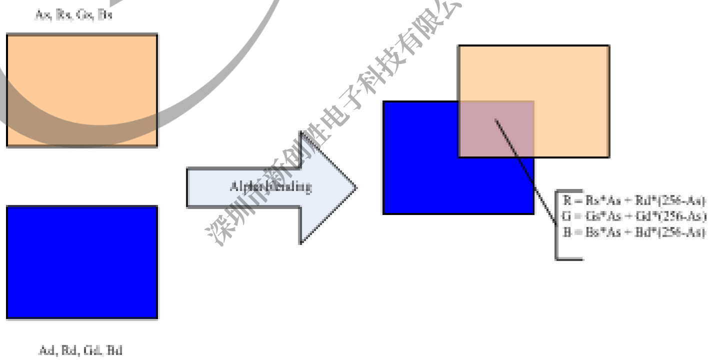


图 2-3: alpha blending 1

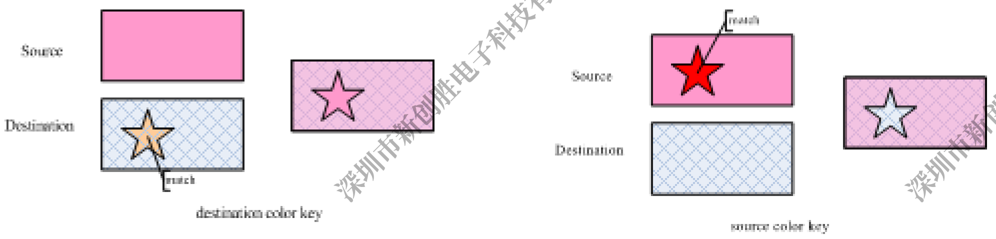


图 2-4: alpha blending 2

2.1.4 colorkey

Colorkey 技术是作用在两个图像叠加混合的时候，对特殊色做特殊过滤。符合条件的区域叫 match 区，在 match 区就全部使用另外一个图层的颜色值；不符合条件的区域就是非 match 区，非 match 区就是走普通的 alpha 混合。Alpha 值越大就是越不透明。

不同 image 之间可以做 colorkey 效果：

- 左图中 destination 的优先级高于 source，destination 中 match 部分（橙色五角星部分），则被选择透过，显示为 source 与 destination 做 alpha blending 后的效果图。
- 右图中 source 的优先级高于 destination，则 source 中 match 部分（深红色五角星部分），则被选择透过，直接显示 destination 与 source 做 alpha blending 后的效果图。

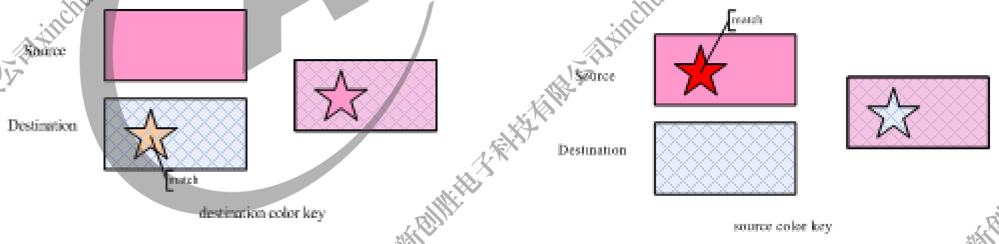


图 2-5: colorkey

2.1.5 缩放 (Stretchblt)

Stretchblt 主要是把 source 按照 destination 的 size 进行缩放，并最终与 destination 做 alpha blending、colorkey 等运算或直接旋转镜像后拷贝到目标，此接口在 1.0 版本上使用可以旋转和缩放一起用，但是 2.0 版本以后，缩放和旋转不可以同时操作。

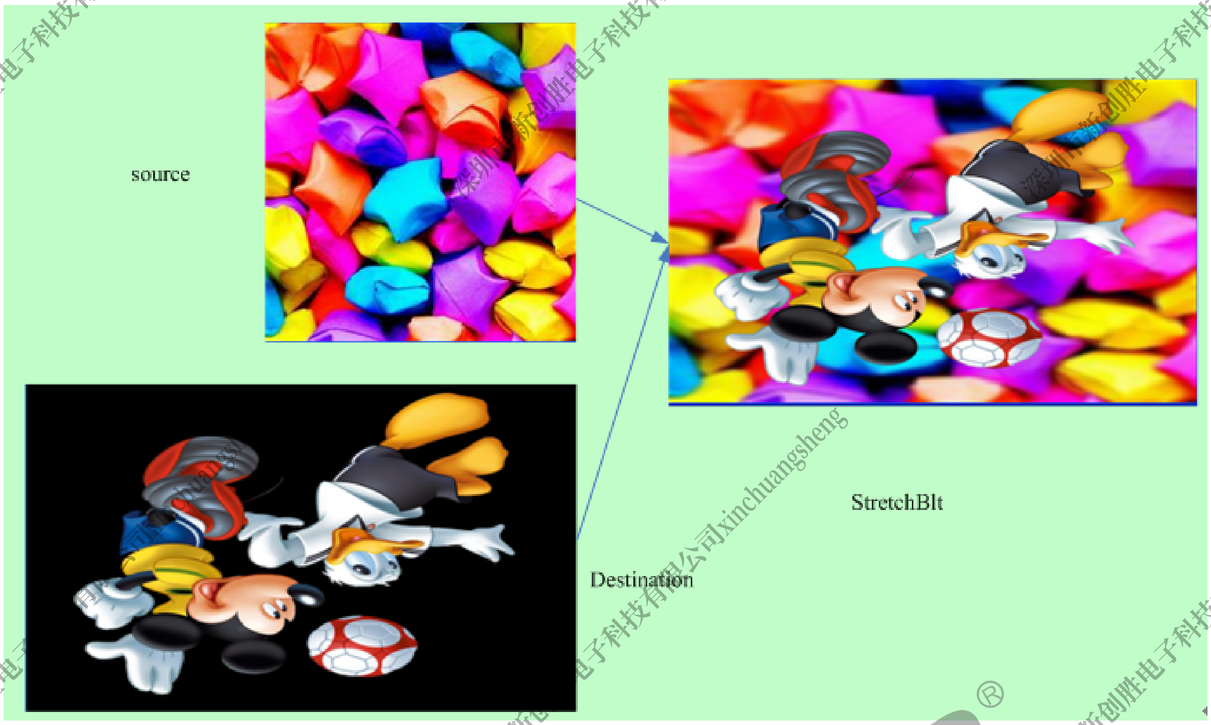


图 2-6: scale and alpha blending

2.1.6 二元光栅操作 (rop2)

我们在画线和填充区域的时候将画笔和目标像素组合得到新的目标像素。

二元操作码中的**二元**指的就是**图像原来的颜色**和**当前颜色**。“**当前颜色**” 是指通过 **setcolor() 或 setfillcolor()** 设置的用于当前绘制或填充的颜色。当我们在上面绘制时，就根据这两个颜色和位操作模式计算得出最终的颜色。

二元光栅操作的本质是对两个颜色进行 **与、或、非、取反、异或**的位操作。例如，**R2_MERGEPEN**，就是将两个颜色进行或运算。红色是 **0xFF0000**，蓝色是 **0x0000FF**，或运算之后，得到紫色 **0xFF00FF**。

后面还有个**三元光栅操作**，是用于图像处理的。

2.1.7 三元光栅操作 (maskblt rop3)

对于图像有同样光栅操作用于生成各种特殊效果, 我们要处理的有三种像素: 源图像像素, 目标图像像素, 画刷像素 (模板图像像素)。如下图所示, 从左上到右下分别是源图像目标图像模板图像生成图像。

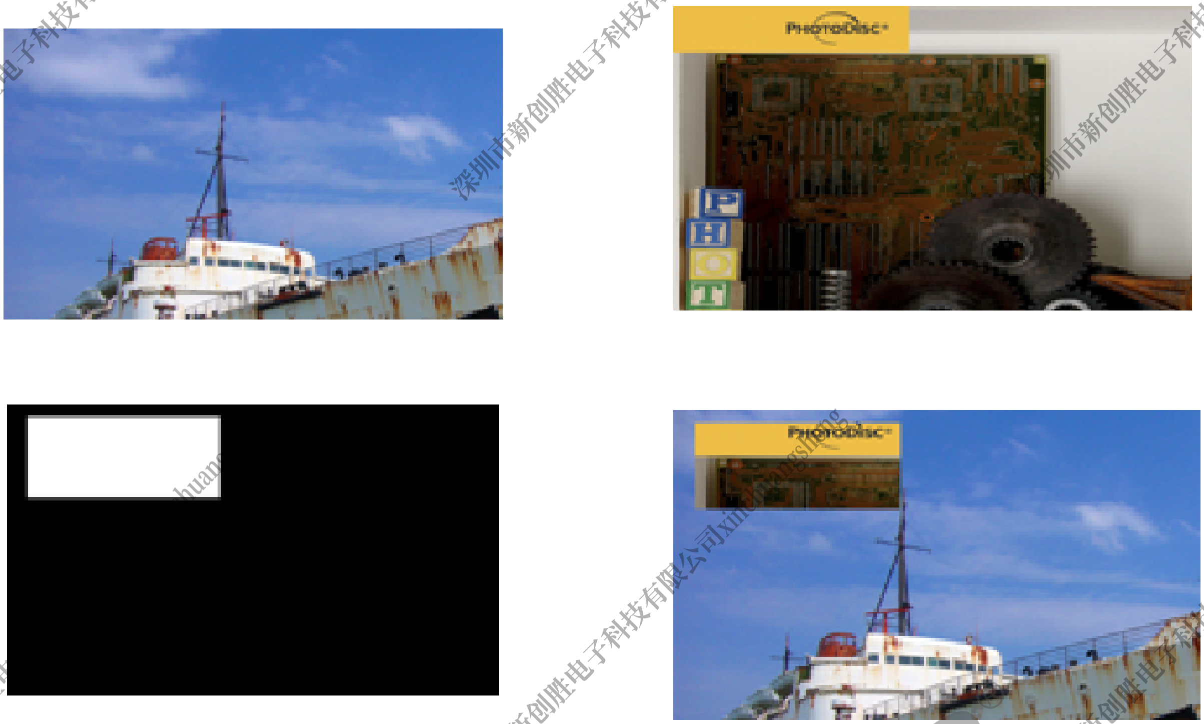


图 2-7: maskblt rop3

2.2 限制条件

2.2.1 颜色填充、图像旋转

- 对于 32bpp 的格式如 ARGB8888，填充或旋转的图像数据设置的输出宽度要求大于 2。
- 对于 24bpp 的格式如 RGB888，填充或旋转的图像数据设置的输出宽度要求大于 3。
- 对于 16bpp 的格式如 RGB565，填充或旋转的图像数据设置的输出宽度要求大于 4。

2.3 相关术语介绍

2.3.1 硬件术语

表 2-1: 硬件术语列表

术语	说明
G2D	2D 图形加速器。

2.3.2 软件术语

表 2-2: 软件术语列表

术语	说明
Fill Rectangle	对某块区域进行预定的颜色值填充。
Rotate And mirror	对图像进行旋转或镜像操作。
Alpha Blending	对两个图像按照预定的比例进行颜色混合。
Colorkey	在两个图像叠加混合的时候，对特殊色做特殊过滤。

2.4 模块配置介绍

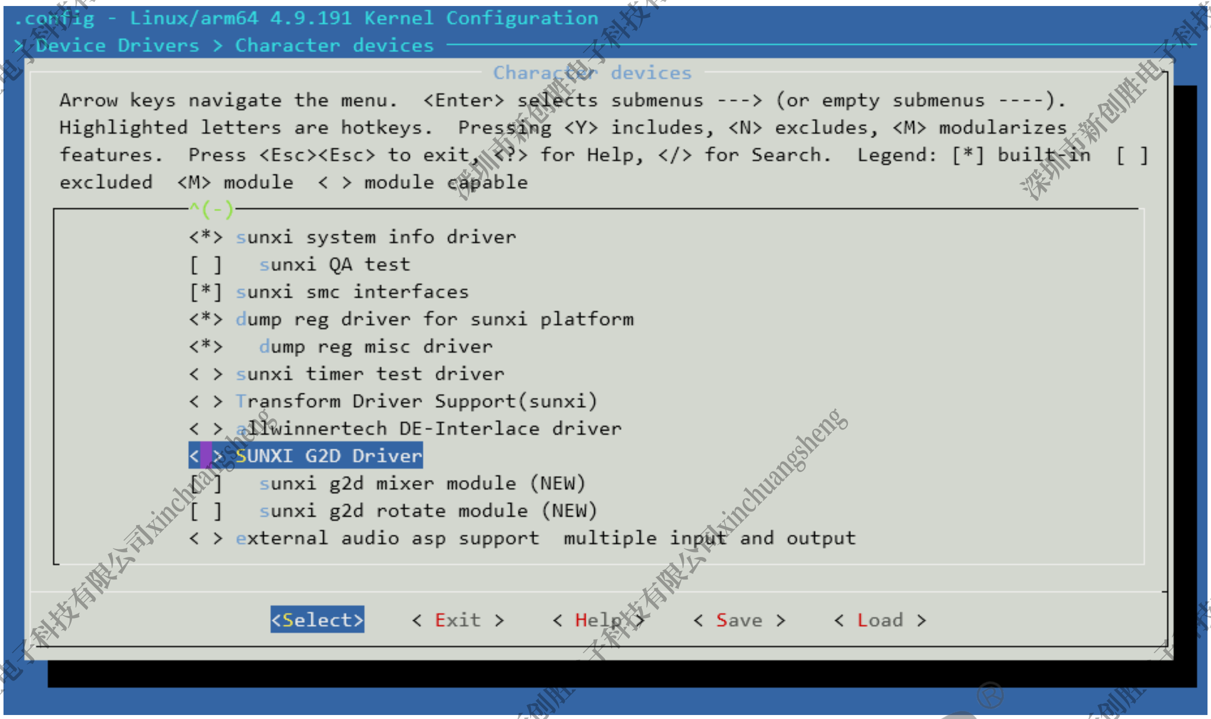
2.4.1 Device Tree 配置说明

```
g2d:g2d@01480000{
    compatible = "allwinner,sunxi-g2d";
    reg = <0x0 0x01480000 0x0 0xbffff>;
    interrupts = <GIC_SPI 21 0x0104>;
    clocks = <&clk_g2d>;
    iommus = <&mmu_aw 5 1>;
    status = "okay";
  };
```

2.4.2 kernel menuconfig 配置说明

在命令行中进入 longan 根目录，执行./build.sh menuconfig 进入配置主界面，对于 linux4.9，具体配置路径为：

```
Device Drivers->Character devices->sunxi g2d driver
```

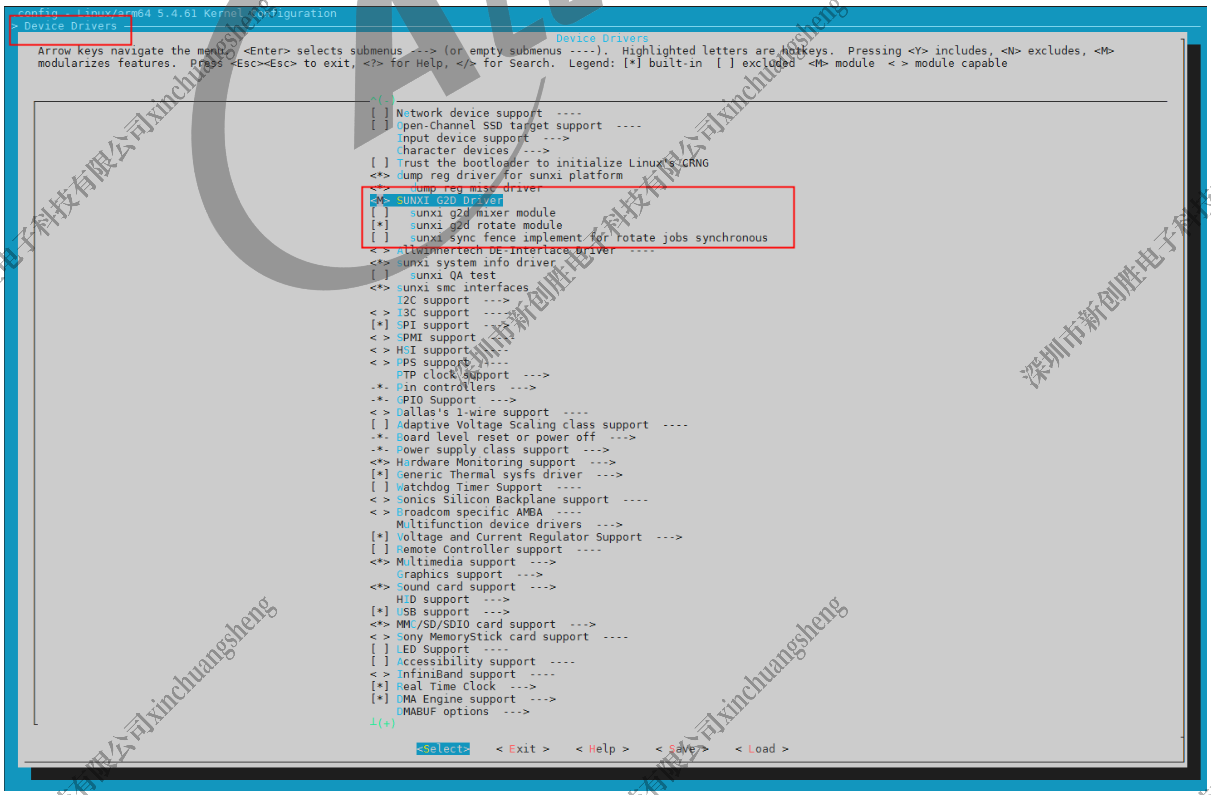


```
.config - Linux/arm64 4.9.191 Kernel Configuration
> Device Drivers > Character devices ──────────────────────────────────────
                      Character devices
  Arrow keys navigate the menu.  <Enter> selects submenus ---> (or empty submenus ----).
  Highlighted letters are hotkeys.  Pressing <Y> includes, <N> excludes, <M> modularizes
  features.  Press <Esc><Esc> to exit, <?> for Help, </> for Search.  Legend: [*] built-in  [ ]
  excluded  <M> module  < > module capable
              ^(-)
              <*> sunxi system info driver
              [ ]   sunxi QA test
              [*] sunxi smc interfaces
              <*> dump reg driver for sunxi platform
              <*>   dump reg misc driver
              < > sunxi timer test driver
              < > Transform Driver Support(sunxi)
              < > allwinnertech DE-Interlace driver
              < > SUNXI G2D Driver
              [ ]   sunxi g2d mixer module (NEW)
              [ ]   sunxi g2d rotate module (NEW)
              < > external audio asp support  multiple input and output

        <Select>    < Exit >    < Help >    < Save >    < Load >
```

图 2-8: menuconfig 4.9

对于 linux5.4，具体配置路径为：

```
Device Drivers->sunxi g2d driver
```

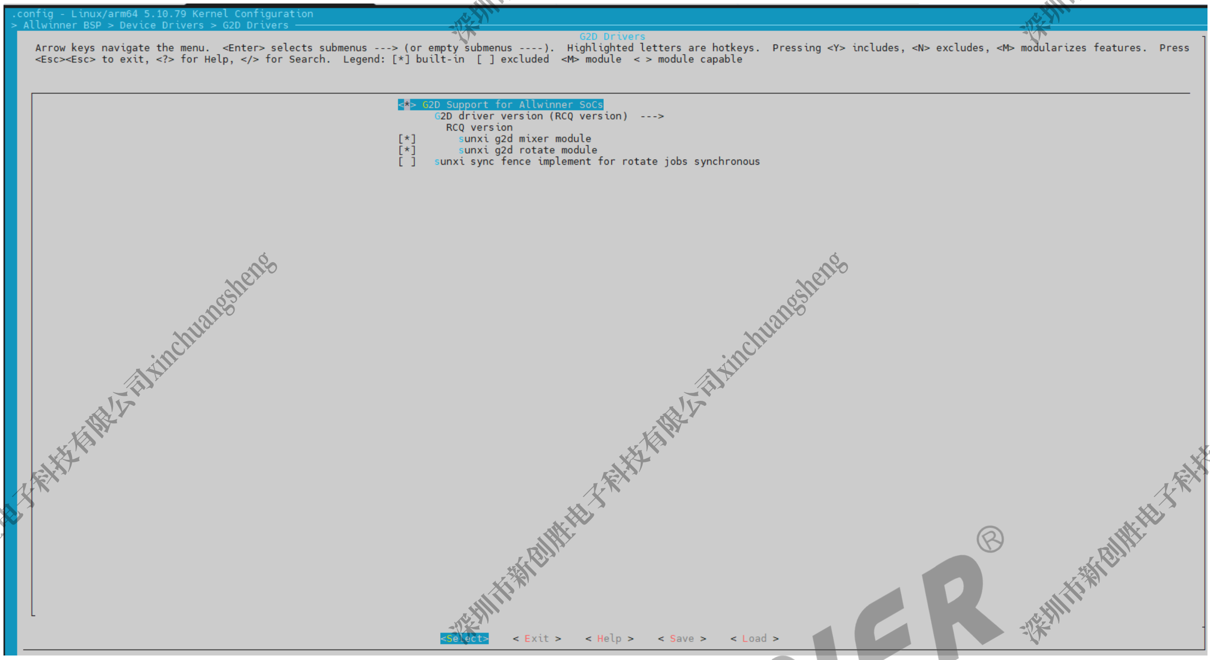


```
.config - Linux/arm64 5.4.61 Kernel Configuration
> Device Drivers ─────────────────────────────────────────────────────────────
                                        Device Drivers
  Arrow keys navigate the menu.  <Enter> selects submenus ---> (or empty submenus ----).  Highlighted letters are hotkeys.  Pressing <Y> includes, <N> excludes, <M>
  modularizes features.  Press <Esc><Esc> to exit, <?> for Help, </> for Search.  Legend: [*] built-in  [ ] excluded  <M> module  < > module capable

                          ^(-)
                          [ ] Network device support  ----
                          [ ] Open-Channel SSD target support  ----
                              Input device support  --->
                              Character devices  --->
                          [ ] Trust the bootloader to initialize Linux's CRNG
                          <*> dump reg driver for sunxi platform
                          <*>   dump reg misc driver
                          <M> SUNXI G2D Driver
                          [ ]   sunxi g2d mixer module
                          [*]   sunxi g2d rotate module
                          [ ]   sunxi sync fence implement for rotate jobs synchronous
                          < > Allwinnertech DE-Interlace Driver  ----
                          <*> sunxi system info driver
                          [ ]   sunxi QA test
                          <*> sunxi smc interfaces
                              I2C support  --->
                          < > I3C support  ----
                          [*] SPI support  --->
                          < > SPMI support  ----
                          < > HSI support  ----
                          < > PPS support  ----
                              PTP clock support  --->
                          -*- Pin controllers  --->
                          -*- GPIO Support  --->
                          < > Dallas's 1-wire support  ----
                          [ ] Adaptive Voltage Scaling class support  ----
                          -*- Board level reset or power off  --->
                          -*- Power supply class support  --->
                          <*> Hardware Monitoring support  --->
                          [*] Generic Thermal sysfs driver  --->
                          [ ] Watchdog Timer Support  ----
                          < > Sonics Silicon Backplane support  ----
                          < > Broadcom specific AMBA  ----
                              Multifunction device drivers  --->
                          [*] Voltage and Current Regulator Support  --->
                          [ ] Remote Controller support  ----
                          <*> Multimedia support  --->
                              Graphics support  --->
                          <*> Sound card support  --->
                              HID support  --->
                          [*] USB support  --->
                          <*> MMC/SD/SDIO card support  --->
                          < > Sony MemoryStick card support  ----
                          [ ] LED Support  ----
                          [ ] Accessibility support  ----
                          < > InfiniBand support  ----
                          [*] Real Time Clock  --->
                          [*] DMA Engine support  --->
                              DMABUF options  --->
                          ⊥(+)

                 <Select>    < Exit >    < Help >    < Save >    < Load >
```

图 2-9: menuconfig 5.4

对于 linux5.10，具体配置路径为：

```
Allwinner BSP->Device Drivers->G2D Drivers
```



```
.config - Linux/arm64 5.10.79 Kernel Configuration
> Allwinner BSP > Device Drivers > G2D Drivers
                                         G2D Drivers
 Arrow keys navigate the menu.  <Enter> selects submenus ---> (or empty submenus ----).  Highlighted letters are hotkeys.  Pressing <Y> includes, <N> excludes, <M> modularizes features.  Press
 <Esc><Esc> to exit, <?> for Help, </> for Search.  Legend: [*] built-in  [ ] excluded  <M> module  < > module capable

                                   <*> G2D Support for Allwinner SoCs
                                          G2D driver version (RCQ version)  --->
                                            RCQ version
                                   [*]        sunxi g2d mixer module
                                   [*]        sunxi g2d rotate module
                                   [ ]    sunxi sync fence implement for rotate jobs synchronous
```

图 2-10: image-20220712094714080

2.5 源码结构介绍

Linux-5.10 以下版本 G2d 驱动的源代码位于内核在 `drivers/char/sunxi_g2d` 目录下：

```
drivers/char/sunxi_g2d/g2d_rcq
├── g2d_bld.c
├── g2d_bld.h
├── g2d_bsp.h
├── g2d.c
├── g2d_driver_i.h
├── g2d_mixer.c
├── g2d_mixer.h
├── g2d_mixer_type.h
├── g2d_ovl_u.c
├── g2d_ovl_u.h
├── g2d_ovl_v.c
├── g2d_ovl_v.h
├── g2d_rcq.c
├── g2d_rcq.h
├── g2d_rotate.c
├── g2d_rotate.h
├── g2d_rotate_type.h
├── g2d_scal.c
├── g2d_scal.h
├── g2d_top.c
├── g2d_top.h
├── g2d_top_type.h
├── g2d_wb.c
├── g2d_wb.h
└── Makefile
```

- g2d.c：为 G2D 驱动顶层文件。
- g2d_xxxx.c：封装了相关功能的实现处理。

Linux-5.10 版本 G2d 驱动的源代码位于`bsp/drivers/g2d`目录下：

```
bsp/drivers/g2d/g2d_rcq
├── g2d_bld.c
├── g2d_bld.h
├── g2d_bsp.h
├── g2d.c
├── g2d_driver_i.h
├── g2d_mixer.c
├── g2d_mixer.h
├── g2d_mixer_type.h
├── g2d_ovl_u.c
├── g2d_ovl_u.h
├── g2d_ovl_v.c
├── g2d_ovl_v.h
├── g2d_rcq.c
├── g2d_rcq.h
├── g2d_rotate.c
├── g2d_rotate.h
├── g2d_rotate_type.h
├── g2d_scal.c
├── g2d_scal.h
├── g2d_top.c
├── g2d_top.h
├── g2d_top_type.h
├── g2d_wb.c
├── g2d_wb.h
└── Makefile
```

2.6 驱动框架介绍

其代码框架如下图所示：

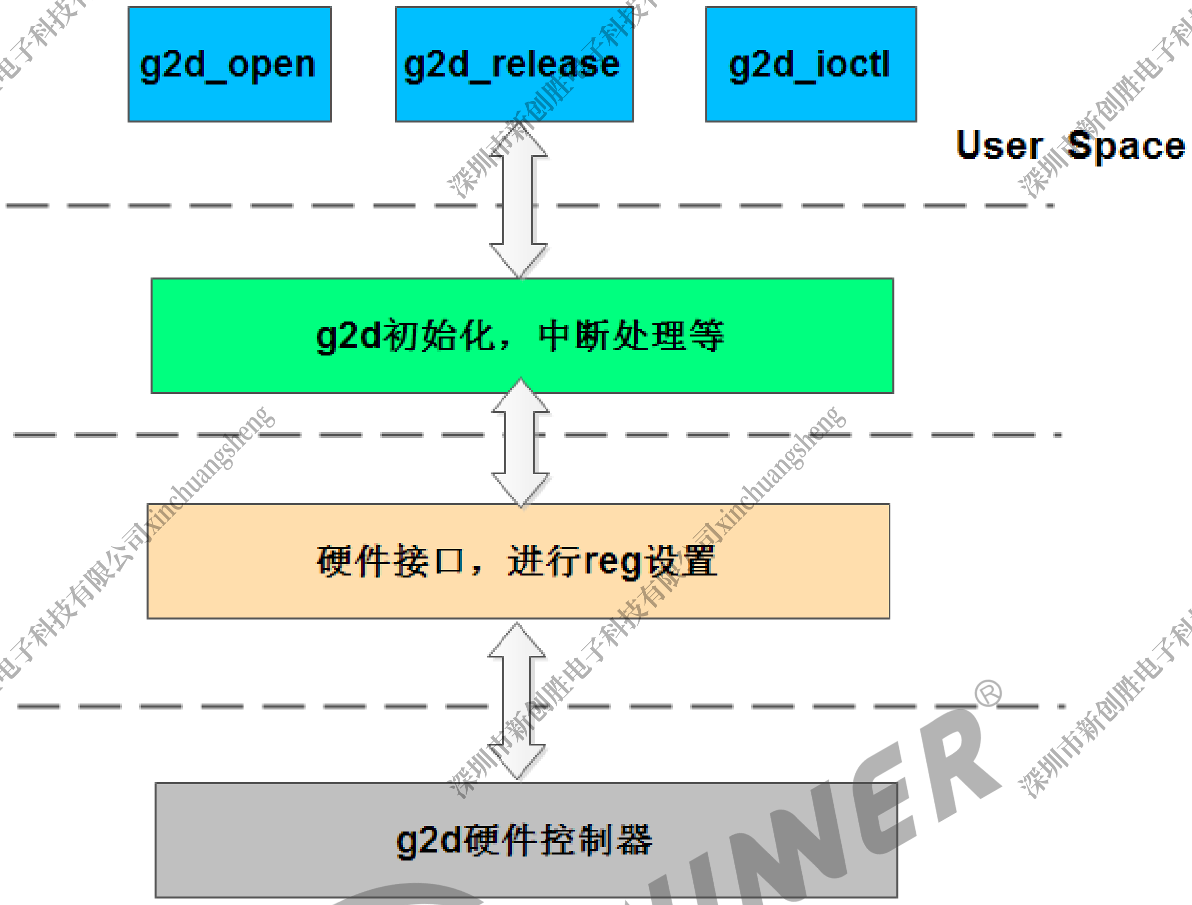


图 2-11: G2D 代码框架图

3 模块接口说明

3.1 关键数据结构

3.1.1 g2d_blt_flags

- 作用

g2d_blt_flags 用于描述一个 bitblt 和 stretchblt 的 flag 属性信息。

- 定义

```
typedef enum {
    G2D_BLT_NONE            = 0x00000000,
    G2D_BLT_PIXEL_ALPHA     = 0x00000001,
    G2D_BLT_PLANE_ALPHA     = 0x00000002,
    G2D_BLT_MULTI_ALPHA     = 0x00000004,
    G2D_BLT_SRC_COLORKEY    = 0x00000008,
    G2D_BLT_DST_COLORKEY    = 0x00000010,
    G2D_BLT_FLIP_HORIZONTAL = 0x00000020,
    G2D_BLT_FLIP_VERTICAL   = 0x00000040,
    G2D_BLT_ROTATE90        = 0x00000080,
    G2D_BLT_ROTATE180       = 0x00000100,
    G2D_BLT_ROTATE270       = 0x00000200,
    G2D_BLT_MIRROR45        = 0x00000400,
    G2D_BLT_MIRROR135       = 0x00000800,
}g2d_blt_flags;
```

- 成员说明

```
G2D_BLT_NONE            - 纯拷贝
G2D_BLT_PIXEL_ALPHA     - 点alpha标志
G2D_BLT_PLANE_ALPHA     - 面alpha标志
G2D_BLT_MULTI_ALPHA     - 混合alpha标志
G2D_BLT_SRC_COLORKEY    - 源colorkey标志
G2D_BLT_DST_COLORKEY    - 目标colorkey标志
G2D_BLT_FLIP_HORIZONTAL - 水平翻转
G2D_BLT_FLIP_VERTICAL   - 垂直翻转
G2D_BLT_ROTATE90        - 逆时针旋转90度
G2D_BLT_ROTATE180       - 逆时针旋转180度
G2D_BLT_ROTATE270       - 逆时针旋转270度
G2D_BLT_MIRROR45        - 镜像45度
```

```
G2D_BLT_MIRROR135       - 镜像135度
```

3.1.2 g2d_fillrect_flags

- 作用

g2d_fillrect_flags 用于描述一个 fillrect 属性信息。

- 定义

```
typedef enum {
    G2D_FIL_NONE            = 0x00000000,
    G2D_FIL_PIXEL_ALPHA     = 0x00000001,
    G2D_FIL_PLANE_ALPHA     = 0x00000002,
    G2D_FIL_MULTI_ALPHA     = 0x00000004,
}g2d_fillrect_flags;
```

- 成员说明

```
G2D_FIL_NONE        - 纯填充
G2D_FIL_PIXEL_ALPHA - 填充区域和目标做点alpha
G2D_FIL_PLANE_ALPHA - 填充区域和目标做面alpha
G2D_FIL_MULTI_ALPHA - 填充区域的alpha值*面alpha值后再和目标做alpha
```

3.1.3 g2d_data_fmt(version 1.0)

- 作用

g2d_data_fmt 用于描述像素格式。

- 定义

1.0 版本支持的图像格式：

```
typedef enum {
  G2D_FMT_ARGB_AYUV8888   = (0x0),
  G2D_FMT_BGRA_VUYA8888   = (0x1),
  G2D_FMT_ABGR_AVUY8888   = (0x2),
  G2D_FMT_RGBA_YUVA8888   = (0x3),
  G2D_FMT_XRGB8888        = (0x4),
  G2D_FMT_BGRX8888        = (0x5),
  G2D_FMT_XBGR8888        = (0x6),
  G2D_FMT_RGBX8888        = (0x7),
  G2D_FMT_ARGB4444        = (0x8),
  G2D_FMT_ABGR4444        = (0x9),
  G2D_FMT_RGBA4444        = (0xA),
  G2D_FMT_BGRA4444        = (0xB),
  G2D_FMT_ARGB1555        = (0xC),
  G2D_FMT_ABGR1555        = (0xD),
  G2D_FMT_RGBA5551        = (0xE),
  G2D_FMT_BGRA5551        = (0xF),
  G2D_FMT_RGB565          = (0x10),
  G2D_FMT_BGR565          = (0x11),
  G2D_FMT_IYUV422         = (0x12),
  G2D_FMT_8BPP_MONO       = (0x13),
  G2D_FMT_4BPP_MONO       = (0x14),
  G2D_FMT_2BPP_MONO       = (0x15),
  G2D_FMT_1BPP_MONO       = (0x16),
  G2D_FMT_PYUV422UVC      = (0x17),
  G2D_FMT_PYUV420UVC      = (0x18),
  G2D_FMT_PYUV411UVC      = (0x19),

//只有输出才有的格式:
    G2D_FMT_PYUV422       = (0x1A),
    G2D_FMT_PYUV420       = (0x1B),
    G2D_FMT_PYUV411       = (0x1C),

//只有输入才支持的格式:
    G2D_FMT_8BPP_PALETTE    = (0x1D),
    G2D_FMT_4BPP_PALETTE    = (0x1E),
    G2D_FMT_2BPP_PALETTE    = (0x1F),
    G2D_FMT_1BPP_PALETTE    = (0x20),
    G2D_FMT_PYUV422UVC_MB16 = (0x21),
    G2D_FMT_PYUV420UVC_MB16 = (0x22),
    G2D_FMT_PYUV411UVC_MB16 = (0x23),
    G2D_FMT_PYUV422UVC_MB32 = (0x24),
    G2D_FMT_PYUV420UVC_MB32 = (0x25),
    G2D_FMT_PYUV411UVC_MB32 = (0x26),
    G2D_FMT_PYUV422UVC_MB64 = (0x27),
    G2D_FMT_PYUV420UVC_MB64 = (0x28),
    G2D_FMT_PYUV411UVC_MB64 = (0x29),
    G2D_FMT_PYUV422UVC_MB128= (0x2A),
    G2D_FMT_PYUV420UVC_MB128= (0x2B),
    G2D_FMT_PYUV411UVC_MB128= (0x2C),
}g2d_data_fmt;
```

- 成员说明

```
G2D_FMT_ARGB8888        : alpha(8bit)R(8bit)G(8bit)B(8bit)
G2D_FMT_BGRA8888        : B(8bit)G(8bit)R(8bit)alpha(8bit)
G2D_FMT_ABGR8888        : alpha(8bit)B(8bit)G(8bit)R(8bit)
G2D_FMT_RGBA8888        : R(8bit)G(8bit)B(8bit)alpha(8bit)

G2D_FMT_XRGB8888        : 24bit,RGB各8bit,alpha为高位自动填充为0xFF
G2D_FMT_BGRX8888        : 24bit,BGR各8bit,alpha为低位自动填充为0xFF
G2D_FMT_XBGR8888        : 24bit,BGR各8bit,alpha为高位自动填充为0xFF
G2D_FMT_RGBX8888        : 24bit,RGB各8bit,alpha为低位自动填充为0xFF

G2D_FMT_ARGB4444        : alpha(4bit)R(4bit)G(4bit)B(4bit)
G2D_FMT_BGRA4444        : B(4bit)G(4bit)R(4bit)alpha(4bit)
```

```
G2D_FMT_ABGR4444        : alpha(4bit)B(4bit)G(4bit)R(4bit)
G2D_FMT_RGBA4444        : R(4bit)G(4bit)B(4bit)alpha(4bit)
G2D_FMT_ARGB1555        : alpha(1bit)R(5bit)G(5bit)B(5bit)
G2D_FMT_BGRA1555        : B(5bit)G(5bit)R(5bit)alpha(1bit)
G2D_FMT_ABGR1555        : alpha(1bit)B(5bit)G(5bit)R(5bit)
G2D_FMT_RGBA1555        : R(5bit)G(5bit)B(5bit)alpha(1bit)

G2D_FMT_RGB565      : R(5bit)G(6bit)B(5bit)
G2D_FMT_BGR565      : B(5bit)G(6bit)R(5bit)

G2D_FMT_IYUV422     : Interleaved YUV422

G2D_FMT_8BPP_MONO   : 8bit per pixel mono
G2D_FMT_4BPP_MONO   : 4bit per pixel mono
G2D_FMT_2BPP_MONO   : 2bit per pixel mono
G2D_FMT_1BPP_MONO   : 1bit per pixel mono

G2D_FMT_PYUV422UVC  : Planar UV combined only
G2D_FMT_PYUV420UVC  : Planar UV combined only
G2D_FMT_PYUV411UVC  : Planar UV combined only

G2D_FMT_PYUV422     : Planar YUV422
G2D_FMT_PYUV420     : Planar YUV420
G2D_FMT_PYUV411     : Planar YUV411

G2D_FMT_8BPP_PALETTE: 8bit per pixel palette only for input
G2D_FMT_4BPP_PALETTE: 4bit per pixel palette only for input
G2D_FMT_2BPP_PALETTE: 2bit per pixel palette only for input
G2D_FMT_1BPP_PALETTE: 1bit per pixel palette only for input

G2D_FMT_PYUV422UVC_MB16: 16x16 tile base planar uv combined only for input
G2D_FMT_PYUV420UVC_MB16: 16x16 tile base planar uv combined only for input
G2D_FMT_PYUV411UVC_MB16: 16x16 tile base planar uv combined only for input
G2D_FMT_PYUV422UVC_MB32: 16x16 tile base planar uv combined only for input
G2D_FMT_PYUV420UVC_MB32: 16x16 tile base planar uv combined only for input
G2D_FMT_PYUV411UVC_MB32: 16x16 tile base planar uv combined only for input
G2D_FMT_PYUV422UVC_MB64: 16x16 tile base planar uv combined only for input
G2D_FMT_PYUV420UVC_MB64: 16x16 tile base planar uv combined only for input
G2D_FMT_PYUV411UVC_MB64: 16x16 tile base planar uv combined only for input
G2D_FMT_PYUV422UVC_MB128: 16x16 tile base planar uv combined only for input
G2D_FMT_PYUV420UVC_MB128: 16x16 tile base planar uv combined only for input
G2D_FMT_PYUV411UVC_MB128: 16x16 tile base planar uv combined only for input
```

3.1.4 g2d_pixel_seq(version 1.0)

- 作用

g2d_pixel_seq 用于描述像素序列。

- 定义

```
typedef enum {
    G2D_SEQ_NORMAL              = 0x0,
    G2D_SEQ_VYUY                = 0x1,
    G2D_SEQ_YVYU                = 0x2,
    G2D_SEQ_VUVU                = 0x3,
    G2D_SEQ_P10                 = 0x4,
    G2D_SEQ_P01                 = 0x5,
    G2D_SEQ_P3210               = 0x6,
    G2D_SEQ_P0123               = 0x7,
    G2D_SEQ_P76543210           = 0x8,
    G2D_SEQ_P67452301           = 0x9,
    G2D_SEQ_P10325476           = 0xA,
    G2D_SEQ_P01234567           = 0xB,
    G2D_SEQ_2BPP_BIG_BIG        = 0xC,
    G2D_SEQ_2BPP_BIG_LITTER     = 0xD,
    G2D_SEQ_2BPP_LITTER_BIG     = 0xE,
    G2D_SEQ_2BPP_LITTER_LITTER  = 0xF,
    G2D_SEQ_1BPP_BIG_BIG        = 0x10,
    G2D_SEQ_1BPP_BIG_LITTER     = 0x11,
    G2D_SEQ_1BPP_LITTER_BIG     = 0x12,
    G2D_SEQ_1BPP_LITTER_LITTER  = 0x13,

  }g2d_pixel_seq;
```

- 成员说明

```
G2D_SEQ_NORMAL          : Normal sequence

//for interleaved yuv422
G2D_SEQ_VYUY            : pixel 0在低16位
G2D_SEQ_YVYU            : pixel 1在低16位

// for uv_combined yuv420
G2D_SEQ_VUVU            : Planar VU combined only

// for 16bpp rgb
G2D_SEQ_P10             : pixel 0在低16位
G2D_SEQ_P01             : pixel 1在低16位

// planar format or 8bpp rgb
G2D_SEQ_P3210           : pixel 0在低8位
G2D_SEQ_P0123           : pixel 3在低8位

// for 4bpp rgb
G2D_SEQ_P76543210       :   7,6,5,4,3,2,1,0
G2D_SEQ_P67452301       :   6,7,4,5,2,3,0,1
G2D_SEQ_P10325476       :   1,0,3,2,5,4,7,6
G2D_SEQ_P01234567       :   0,1,2,3,4,5,6,7

// for 2bpp rgb
G2D_SEQ_2BPP_BIG_BIG    :
15,14,13,12,11,10,9,8,7,6,5,4,3,2,1,0

G2D_SEQ_2BPP_BIG_LITTER :
12,13,14,15,8,9,10,11,4,5,6,7,0,1,2,3

G2D_SEQ_2BPP_LITTER_BIG :
3,2,1,0,7,6,5,4,11,10,9,8,15,14,13,12

G2D_SEQ_2BPP_LITTER_LITTER  :
0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
```

```
// for 1bpp rgb
G2D_SEQ_1BPP_BIG_BIG        :
31,30,29,28,27,26,25,24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1,0

G2D_SEQ_1BPP_BIG_LITTER     :
24,25,26,27,28,29,30,31,16,17,18,19,20,21,22,23,8,9,10,11,12,13,14,15,0,1,2,3,4,5,6,7

G2D_SEQ_1BPP_LITTER_BIG     :
7,6,5,4,3,2,1,0,15,14,13,12,11,10,9,8,23,22,21,20,19,18,17,16,31,30,29,28,27,26,25,24

G2D_SEQ_1BPP_LITTER_LITTER      :
0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31
```

3.1.5 g2d_blt_flags_h

- 作用

g2d_blt_flags_h 定义二元光栅操作码。

- 定义

```
typedef enum {
    G2D_BLT_NONE_0 = 0x0,
    G2D_BLT_BLACKNESS,
    G2D_BLT_NOTMERGEPEN,
    G2D_BLT_MASKNOTPEN,
    G2D_BLT_NOTCOPYPEN,
    G2D_BLT_MASKPENNOT,
    G2D_BLT_NOT,
    G2D_BLT_XORPEN,
    G2D_BLT_NOTMASKPEN,
    G2D_BLT_MASKPEN,
    G2D_BLT_NOTXORPEN,
    G2D_BLT_NOP,
    G2D_BLT_MERGENOTPEN,
    G2D_BLT_COPYPEN,
    G2D_BLT_MERGEPENNOT,
    G2D_BLT_MERGEPEN,
    G2D_BLT_WHITENESS = 0x000000ff,

    G2D_ROT_90   =    0x00000100,
    G2D_ROT_180  =    0x00000200,
    G2D_ROT_270  =    0x00000300,
    G2D_ROT_0    =    0x00000400,
    G2D_ROT_H    =    0x00001000,
    G2D_ROT_V    =    0x00002000,

    G2D_SM_DTLR_1  =  0x10000000,
} g2d_blt_flags_h;
```

- 成员说明

```
G2D_BLT_NONE     单个源操作

//使用与物理调色板的索引0相关的色彩来填充目标矩形区域,(对缺省的物理调色板,该颜色为黑色)
G2D_BLT_BLACK    BLACKNESS

G2D_BLT_NOTMERGEPEN dst = ~(dst+src)  :
G2D_BLT_MASKNOTPEN  dst =~src&dst
G2D_BLT_NOTCOPYPEN  dst =~src
G2D_BLT_MASKPENNOT  dst =src&~dst

//使目标矩形区域颜色取反
G2D_BLT_NOT dst =~dst
G2D_BLT_XORPEN  dst =src^dst
G2D_BLT_NOTMASKPEN  dst =~(src&dst)
G2D_BLT_MASKPEN dst =src&dst
G2D_BLT_NOTXORPEN   dst =~(src^dst)
G2D_BLT_NOP dst =dst
G2D_BLT_MERGENOTPEN dst =~src+dst
G2D_BLT_COPEPEN dst =src
G2D_BLT_MERGEPENNOT dst =src+~dst
G2D_BLT_MERGEPEN    dst =src+dst
//使用与物理调色板中索引1有关的颜色填充目标矩形区域(对于缺省物理调色板来说,这个颜色为白色)
G2D_BLT_WHITE    WHITENESS
```

3.1.6 g2d_image (version 1.0)

- 作用

g2d_image 用于描述 image 属性信息。

- 定义

```
typedef struct {
  __u32           addr[3];
  __u32           w;
  __u32           h;
  g2d_data_fmt    format;
  g2d_pixel_seq   pixel_seq;
}g2d_image;
```

- 成员说明

```
addr[3]:    图像帧的基地址，对于UV combined，addr[0,1]有效，planar类型addr[0,1, 2]有效，其他addr[0]
    有效。在linux5.10版本及以后的版本中，            addr[0]形式参数接收的实际参数是上层应用程序通过
    dma_buf_heap相关接口中请到的内存句柄fd，addr[1]和addr[2]废弃
w:          图像帧的宽
h:          图像帧的高
format:     图像帧buffer的像素格式，详见g2d_data_fmt
pixel_seq:  图像帧buffer的像素序列，详见g2d_pixel_seq
```

3.1.7 g2d_image_enh

- 作用

g2d_image_enh 主要描述图片的宽高、存放地址、是否做 Clip 处理，是否为预乘等。

- 定义

```
typedef struct {
  int           bbuff;
    __u32       color;
    g2d_fmt_enh format;
    __u32       laddr[3];
    __u32       haddr[3];
    __u32       width;
    __u32       height;
    __u32       align[3];
    g2d_rect    clip_rect;
    __u32       gamut;
    int         bpremul;
    __u8        alpha;
    g2d_alpha_mode_enh mode;
} g2d_image_enh;
```

- 成员说明

```
成员       作用
format      : 图格式
laddr       : 起始低位地址
haddr       : 起始高位地址
width       : 图宽度 (in pixel)
height      : 图高度 (in pixel)
pitch       : Buffer的pitch
clip_rect   : ROI矩形
gamut       : 图的色域
bpremul     : 是否为预乘
alpha       : 面alpha值
mode        : alpha模式设置
```

3.1.8 g2d_fmt_enh

- 作用

g2d_fmt_enh 用于描述 G2D 模块支持的格式。

- 定义

```
typedef enum{
    G2D_FORMAT_ARGB8888,
    G2D_FORMAT_ABGR8888,
    G2D_FORMAT_RGBA8888,
    G2D_FORMAT_BGRA8888,
    G2D_FORMAT_XRGB8888,
    G2D_FORMAT_XBGR8888,
    G2D_FORMAT_RGBX8888,
    G2D_FORMAT_BGRX8888,
    G2D_FORMAT_RGB888,
    G2D_FORMAT_BGR888,
    G2D_FORMAT_RGB565,
    G2D_FORMAT_BGR565,
    G2D_FORMAT_ARGB4444,
    G2D_FORMAT_ABGR4444,
    G2D_FORMAT_RGBA4444,
    G2D_FORMAT_BGRA4444,
    G2D_FORMAT_ARGB1555,
    G2D_FORMAT_ABGR1555,
    G2D_FORMAT_RGBA5551,
    G2D_FORMAT_BGRA5551,
    G2D_FORMAT_ARGB2101010,
    G2D_FORMAT_ABGR2101010,
    G2D_FORMAT_RGBA1010102,
    G2D_FORMAT_BGRA1010102,

    /* invailed for UI channel */
    G2D_FORMAT_IYUV422_V0Y1U0Y0 = 0x20,
    G2D_FORMAT_IYUV422_Y1V0Y0U0,
    G2D_FORMAT_IYUV422_U0Y1V0Y0,
    G2D_FORMAT_IYUV422_Y1U0Y0V0,

    G2D_FORMAT_YUV422UVC_V1U1V0U0,
    G2D_FORMAT_YUV422UVC_U1V1U0V0,
    G2D_FORMAT_YUV422_PLANAR,

    G2D_FORMAT_YUV420UVC_V1U1V0U0 = 0x28,
    G2D_FORMAT_YUV420UVC_U1V1U0V0,
    G2D_FORMAT_YUV420_PLANAR,

    G2D_FORMAT_YUV411UVC_V1U1V0U0 = 0x2c,
    G2D_FORMAT_YUV411UVC_U1V1U0V0,
    G2D_FORMAT_YUV411_PLANAR,

    G2D_FORMAT_Y8 = 0x30,

    /* YUV 10bit format */
    G2D_FORMAT_YVU10_P010 = 0x34,

    G2D_FORMAT_YVU10_P210 = 0x36,

    G2D_FORMAT_YVU10_444 = 0x38,
    G2D_FORMAT_YUV10_444 = 0x39,
}g2d_fmt_enh;
```

3.1.9 g2d_rop3_cmd_flag

- 作用

g2d_rop3_cmd_flag 用于定义三元光栅操作码。

- 定义

```
typedef enum {
    G2D_ROP3_BLACKNESS    = 0x00,
    G2D_ROP3_NOTSRCERASE = 0x11,
    G2D_ROP3_NOTSRCCOPY  = 0x33,
    G2D_ROP3_SRCERASE    = 0x44,
    G2D_ROP3_DSTINVERT   = 0x55,
    G2D_ROP3_PATINVERT   = 0x5A,
    G2D_ROP3_SRCINVERT   = 0x66,
    G2D_ROP3_SRCAND      = 0x88,
    G2D_ROP3_MERGEPAINT  = 0xBB,
    G2D_ROP3_MERGECOPY   = 0xC0,
    G2D_ROP3_SRCCOPY     = 0xCC,
    G2D_ROP3_SRCPAINT    = 0xEE,
    G2D_ROP3_PATCOPY     = 0xF0,
    G2D_ROP3_PATPAINT    = 0xFB,
    G2D_ROP3_WHITENESS   = 0xFF,
}g2d_rop3_cmd_flag;
```

- 成员说明

```
G2D_ROP3_BLACKNESS    dst = BLACK
G2D_ROP3_NOTSRCERASE  dst = (NOT src) AND (NOT dst)
G2D_ROP3_NOTSRCCOPY   dst = (NOT src)        :将源矩形区域颜色取反，拷贝到目标矩形区域
G2D_ROP3_SRCERASE     dst = src AND (NOT dst )
G2D_ROP3_DSTINVERT    dst = (NOT dst)
G2D_ROP3_PATINVERT    dst = pattern XOR dst    :通过使用布尔型的异或(XOR)操作符将特定模式和目标矩形
    区域颜色合并
G2D_ROP3_SRCINVERT    dst = src XOR dst        :通过使用布尔型的异或(XOR)操作符将源和目标矩形区域颜
    色合并
G2D_ROP3_SRCAND       dst = srcAND dst         :通过使用与操作符将源和目标矩形区域颜色值合并
G2D_ROP3_MERGEPAINT   dst = (NOT src) OR dst   :通过使用布尔型的或(OR)操作符将反向的源矩形区域的颜
    色与目标矩形区域颜色合并
G2D_ROP3_MERGECOPY    dst = (src AND pattern)
G2D_ROP3_SRCCOPY      dst = src                :将源矩形区域直接拷贝到目标矩形区域
G2D_ROP3_SRCPAINT     dst = src OR dst         :通过使用布尔型的或(OR)操作符将源和目标矩形区域颜色
    合并
G2D_ROP3_PATCOPY      dst = pattern
G2D_ROP3_PATPAINT     dst = DPSnoo             :通过使用布尔型的或(OR)操作符将源矩形区域取反后的颜
    色值与特定模式的颜色合并，然后使用OR操作符与该操作的结果与目标矩形区域内的颜色合并
G2D_ROP3_WHITENESS    dst = WHITE
```

3.1.10 g2d_bld_cmd_flag

- 作用

g2d_bld_cmd_flag 定义 BLD 操作命令。

- 定义

```
typedef enum {
    G2D_BLD_CLEAR     = 0x00000001,
    G2D_BLD_COPY      = 0x00000002,
    G2D_BLD_DST       = 0x00000003,
    G2D_BLD_SRCOVER   = 0x00000004,
    G2D_BLD_DSTOVER   = 0x00000005,
    G2D_BLD_SRCIN     = 0x00000006,
    G2D_BLD_DSTIN     = 0x00000007,
    G2D_BLD_SRCOUT    = 0x00000008,
    G2D_BLD_DSTOUT    = 0x00000009,
    G2D_BLD_SRCATOP   = 0x0000000a,
    G2D_BLD_DSTATOP   = 0x0000000b,
    G2D_BLD_XOR       = 0x0000000c,
    G2D_CK_SRC        = 0x00010000,
    G2D_CK_DST        = 0x00020000,
}g2d_bld_cmd_flag;
```

- 成员说明

```
G2D_BLD_CLEAR     清除source和destination图像,也即result图像为空
G2D_BLD_COPY      result = source                                    :result图像为source图像
G2D_BLD_DST       result = destination                              :result图像为destination
    图像
G2D_BLD_SRCOVER   result = (1 - As) * destination + source            :As为Alpha source参数
G2D_BLD_DSTOVER   result = (1 - Ad) * source + destination            : Ad为Alpha
    destination参数
G2D_BLD_SRCIN     result = Ad * source
G2D_BLD_DSTIN     result = As * destination
G2D_BLD_SRCOUT    result = (1 - Ad) * source
G2D_BLD_DSTOUT    result = (1 - As) * destination
G2D_BLD_SRCATOP   result = (1 - As) * destination + Ad * source
G2D_BLD_DSTATOP   result = As * destination + (1 - Ad) * source
G2D_BLD_XOR       result = (1 - As) * destination + (1 - Ad) * source
G2D_CK_SRC        when the pixel value matches destination images, it displays the pixel
    from source image
G2D_CK_DST        when the pixel value matches source images, it displays the pixel from
    destination image
```

3.1.11 g2d_ck

- 作用

g2d_ck 定义了 colorkey 操作的参数。

- 定义

```
typedef struct {
    int match_rule;
    __u32 max_color;
    __u32 min_color;
}g2d_ck;
```

- 成员说明

```
match_rule  当match_rule为假时，Color Min=<Color<=Color Max表示满足匹配条件
当match_rule为真时，Color>Color Max or Color <Color Min表示满足匹配条件
ck_max_color    Color Max
ck_min_color    Color Min
```

3.1.12 g2d_alpha_mode_enh

- 作用

g2d_alpha_mode_enh 定义进行 alpha blend 操作时，选择的 alpha mode。

- 定义

```
typedef enum{
    G2D_PIXEL_ALPHA,
    G2D_GLOBAL_ALPHA,
    G2D_MIXER_ALPHA,
}g2d_alpha_mode_enh;
```

- 成员说明

```
成员              作用
G2D_PIXEL_ALPHA   点alpha
G2D_GLOBAL_ALPHA 面alpha
G2D_MIXER_ALPHA  混合alpha
```

3.1.13 g2d_color_gmt

- 作用

g2d_color_gmt 定义进行位操作时，选择的颜色空间。

- 定义

```
typedef enum{
    G2D_BT601,
    G2D_BT709,
    G2D_BT2020,
}g2d_color_gmt;
```

3.1.14 g2d_scan_order(version 1.0)

- 作用

g2d_scan_order 定义进行 alpha blend 操作时，选择的图像扫行模式。

- 定义

```
enum g2d_scan_order {
    G2D_SM_TDLR = 0x00000000,
    G2D_SM_TDRL = 0x00000001,
    G2D_SM_DTLR = 0x00000002,
    G2D_SM_DTRL = 0x00000003,
};
```

- 成员说明

```
G2D_SM_TDLR Top to down, Left to right
G2D_SM_DTLR Down to top, Left to right
G2D_SM_TDRL Top to down, Right to left
G2D_SM_DTRL Down to top, Left to right
```

3.1.15 g2d_blt(version 1.0)

- 作用

g2d_blt 用于一个源和目标做 blt 的信息。

- 定义

```
typedef struct {
    g2d_blt_flags        flag;
    g2d_image            src_image;
    g2d_rect             src_rect;
    g2d_image            dst_image;
    __s32                dst_x;
    __s32                dst_y;
    __u32                color;
    __u32                alpha;
}g2d_blt;
```

- 成员说明

```
flag         : block transfer标志，详见g2d_blt_flags
src_image    : 源图像信息，详见g2d_image
dst_image    : 目标图像信息，详见g2d_image
dst_x        : 目标矩形左上角x
dst_y        : 目标矩形左上角y
color        : colorkey颜色
alpha        : 面alpha值
```

3.1.16 g2d_fillrect(version 1.0)

- 作用

g2d_fillrect 用于描述一个 fill rectangle 参数信息。

- 定义

```
typedef struct {
    g2d_fillrect_flags   flag;
    g2d_image            dst_image;
    g2d_rect             dst_rect;
    __u32                color;
    __u32                alpha;
}g2d_fillrect;
```

- 成员说明

```
flag         : 填充矩形标志，详见g2d_fillrect_flags
dst_image    : 目标图像信息，详见g2d_image
dst_rect     : 目标矩形信息，x/y/w/h-左上角x/左上角y/宽/高
color        : 填充颜色
alpha        : 面alpha值
```

3.1.17 g2d_stretchblt(version 1.0)

- 作用

g2d_stretchblt 用于描述一个 stretchblt 参数信息。

- 定义

```
typedef struct {
    g2d_blt_flags        flag;
    g2d_image            src_image;
    g2d_rect             src_rect;
    g2d_image            dst_image;
    g2d_rect             dst_rect;
    __u32                color;
    __u32                alpha;
} g2d_stretchblt;
```

- 成员说明

```
flag         : block transfer标志，详见g2d_blt_flags
src_image    : 源图像信息，详见g2d_image
src_rect     : 源矩形信息，x/y/w/h-左上角x/左上角y/宽/高
dst_image    : 目标图像信息，详见g2d_image
dst_rect     : 目标矩形信息，x/y/w/h-左上角x/左上角y/宽/高
color        : colorkey颜色
alpha        : 面alpha值
```

3.1.18 g2d_blt_h

- 作用

g2d_blt_h 实现对 foreground 带缩放的 ROP2 处理。

- 定义

```
typedef struct {
    g2d_blt_flags_h      flag_h;
    g2d_image_enh        src_image_h;
    g2d_image_enh        dst_image_h;
    __u32                color;
    __u32                alpha;
}g2d_blt_h;
```

- 成员说明

```
flag_h          : blt操作flag标志，增强版标志
src_image_h   : 源图像信息,增强版的图像参数,详见g2d_image_enh
dst_image_h   : 目标图像信息，增强版的图像参数
color             : colorkey颜色
alpha             : 面alpha值
```

3.1.19 g2d_bld(version 1.0)

- 作用

g2d_bld 实现两幅图的 BLD 和 colorkey 操作。

- 定义

```
typedef struct {
    g2d_bld_cmd_flag     bld_cmd;
    g2d_image_enh        dst_image_h;
    g2d_image_enh        src_image_h;
    g2d_ck               ck_para;
}g2d_bld;/* blending enhance */
```

- 成员说明

```
bld_cmd      : blending的操作flag标志，增强版标志
src_image_h : 源图像信息,增强版的图像参数
dst_image_h : 目标图像信息，增强版的图像参数
ck_para      : colorkey参数
```

3.1.20 g2d_fillrect_h

- 作用

实现带透明度的颜色填充。

- 定义

```
typedef struct {
    g2d_image_enh dst_image_h;
} g2d_fillrect_h;

typedef struct {
    int         bbuff;
    __u32         color;
    g2d_fmt_enh     format;
    __u32         laddr[3];
    __u32         haddr[3];
    __u32         width;
    __u32         height;
    __u32         align[3];

    g2d_rect     clip_rect;
    g2d_coor     coor;

    g2d_color_gmt     gamut;
    int         bpremul;
    __u8         alpha;
    g2d_alpha_mode_enh mode;
    int         fd;
    __u32 use_phy_addr;
    enum color_range color_range;
} g2d_image_enh;
```

- 成员说明

```
其中color成员用于传递填充的颜色参数，各个分量：A[31:24] R[23:16] G[15:8] B[7:0]
```

3.2 函数接口

用户层通过 ioctl() 函数与内核驱动进行交互。

1.0 版本接口与 2.0 版本接口在功能上几乎无差别，1.0 版本旋转和缩放可以一起用，但是 2.0 版本以后，缩放和旋转不可以同时操作；此外 1.0 版本与 2.0 版本函数所使用的结构体也存在差别。

3.2.1 1.0 版本接口

3.2.1.1 G2D_CMD_BITBLT

- 作用：BITBLT 函数实现的是两个图层的运算，比如源拷贝到目标；源旋转放入目标；源和目标做 alpha blending/colorkey 后拷贝到目标。
- 原型:

```
int ioctl(int *fd, int cmd, unsigned long arg);
```

- 参数:

- fd：G2D 设备文件标识符。
- cmd：G2D_CMD_BITBLT。
- arg：arg 为 g2d_blt 结构体指针。
- 返回:
- 0：成功。
- 其他：失败。
- 举例:

```
/* 输入/输出image buffer */
g2d_image image_front,scn;
g2d_rect src_rect;
g2d_blt blit;
__s32 dst_x, dst_y;

image_front.addr[0]     = mem_in;
image_front.w           = 800;
image_front.h           = 480;
image_front.format      = G2D_FMT_ARGB8888;
image_front.pixel_seq   = G2D_SEQ_NORMAL;

scn.addr[0]             = mem_out;
scn.w                   = 800;
scn.h                   = 480;
scn.format              = G2D_FMT_RGBA8888;
scn.pixel_seq           = G2D_SEQ_NORMAL;
src_rect.x              = 0;
src_rect.y              = 0;
src_rect.w              = 480;
src_rect.h              = 272;

dst_x                   = 0;
dst_y                   = 0;

/* 设置BITBLT flag标志：做点alpha和水平翻转 */
blit.flag = G2D_BLT_PIXEL_ALPHA| G2D_BLT_FLIP_HORIZONTAL;
blit.color = 0xee8899;
blit.alpha = 0x73;

/* 设置源imgae和源rect */
blit.src_image.addr[0]  = image_front.addr[0];
blit.src_image.w        = image_front.w;
blit.src_image.h        = image_front.h;
blit.src_image.format   = image_front.format;
blit.src_image.pixel_seq= image_front.pixel_seq;
blit.src_rect.x         = src_rect.x;
blit.src_rect.y         = src_rect.y;
blit.src_rect.w         = src_rect.w;
blit.src_rect.h         = src_rect.h;

/* 设置目标imgae和目标rect */
blit.dst_image.addr[0]  = scn.addr[0];
blit.dst_image.w        = scn.w;
blit.dst_image.h        = scn.h;
blit.dst_image.format   = scn.format;
blit.dst_image.pixel_seq= scn.pixel_seq;
blit.dst_x              = dst_x;
blit.dst_y              = dst_y;

if(ioctl(g2d_fd, G2D_CMD_BITBLT, &blit)<0)
{
    printf("G2D_CMD_BITBLT failed!\n");
}
```

3.2.1.2 G2D_CMD_FILLRECT

- 作用：用一种颜色的画点画直线及矩形填充，同时也能实现填充颜色和目标做 alpha blending。
- 原型：

```
int ioctl(int *fd, int cmd, unsigned long arg);
```

- 参数：
- fd：G2D 设备文件标识符。
- cmd：G2D_CMD_FILLRECT。
- arg：arg 为 g2d_fillrect 结构体指针。
- 返回：
- 0：成功。
- 其他：失败。
- 举例：

```
/* 输出image buffer */
g2d_image scn;
g2d_rect dst_rect;
g2d_fillrect fillrect;

/* 设置FILLRECT标志：做面alpha */
fillrect.flag               = G2D_FIL_PLANE_ALPHA;
fillrect.color              = 0xFF345678;
fillrect.alpha              = 0x40;

/* 设置目标image和目标rect */
fillrect.dst_image.addr[0]  = scn.addr[0];
fillrect.dst_image.w        = scn.w;
fillrect.dst_image.h        = scn.h;
fillrect.dst_image.format   = scn.format;
fillrect.dst_image.pixel_seq= scn.pixel_seq;
fillrect.dst_rect.x         = dst_rect.x;
fillrect.dst_rect.y         = dst_rect.y;
fillrect.dst_rect.w         = dst_rect.w;
fillrect.dst_rect.h         = dst_rect.h;
```

```
if (ioctl(g2d_fd, G2D_CMD_FILLRECT, &fillrect) < 0) {
    printf("G2D_CMD_FILLRECT failed!\n");
}
```

3.2.1.3 G2D_CMD_STRETCHBLT

- 作用：STRETCHBLT 函数实现的是两个图层的运算。

```
比如源缩放到目标大小后拷贝到目标；源缩放到目标大小旋转放入目标；
源缩放到目标大小后和目标做alpha blending/colorkey拷贝到目标
```

- 原型：

```
int ioctl(int *fd, int cmd, unsigned long arg);
```

- 参数：
- fd：G2D 设备文件标识符。
- cmd：G2D_CMD_STRETCHBLT。
- arg：arg 为 g2d_stretchblt 结构体指针。
- 返回：
- 0：成功。
- 其他：失败。
- 举例：

```
/* 输出image buffer */
g2d_image image_front,scn;
g2d_rect src_rect,dst_rect;
g2d_stretchblt str;

image_front.addr[0]     = mem_in;
image_front.w           = 800;
image_front.h           = 480;
image_front.format      = G2D_FMT_PYUV420UVC;
image_front.pixel_seq   = G2D_SEQ_NORMAL;
image_front.addr[1]     = mem_in+ image_front.w*image_front.h;

scn.addr[0]             = mem_out;
scn.w                   = 800;
scn.h                   = 480;
scn.format              = G2D_FMT_ARGB8888;
scn.pixel_seq           = G2D_SEQ_NORMAL;
src_rect.x              = 0;
src_rect.y              = 0;
src_rect.w              = 480;
src_rect.h              = 272;
dst_rect.x              = 17;
dst_rect.y              = 100;
dst_rect.w              = 480;
dst_rect.h              = 272;

/* 设置STRETCHBLT标志:做点alpha和旋转90度 */
str.flag = G2D_BLT_PIXEL_ALPHA|G2D_BLT_ROTATE90;
str.color               = 0xee8899;
str.alpha               = 0x73;

/* 设置源image和源rect */
str.src_image.addr[0]   = image_front.addr[0];
str.src_image.addr[1]   = image_front.addr[1];
str.src_image.w         = image_front.w;
str.src_image.h         = image_front.h;
str.src_image.format    = image_front.format;
str.src_image.pixel_seq = image_front.pixel_seq;
str.src_rect.x          = src_rect.x;
str.src_rect.y          = src_rect.y;
str.src_rect.w          = src_rect.w;
str.src_rect.h          = src_rect.h;

/* 设置目标image和目标rect */
str.dst_image.addr[0]   = scn.addr[0];
str.dst_image.w         = scn.w;
str.dst_image.h         = scn.h;
str.dst_image.format    = scn.format;
str.dst_image.pixel_seq = scn.pixel_seq;
str.dst_rect.x          = dst_rect.x;
str.dst_rect.y          = dst_rect.y;
str.dst_rect.w          = dst_rect.w;
str.dst_rect.h          = dst_rect.h;

if(ioctl(g2d_fd, G2D_CMD_STRETCHBLT, &str) < 0)
{
    printf("G2D_CMD_STRETCHBLT failed!\n");
}
```

3.2.1.4 G2D_CMD_PALETTE_TBL

- 作用：PALETTE_TAL 函数实现的是把查找表写入硬件 SDRAM，也只有在前面接口的源数据 format 设置为 palette 模式时才需要先使用这条命令。
- 原型：

```
int ioctl(int *fd, int cmd, unsigned long arg);
```

- 参数：
- fd：G2D 设备文件标识符。
- cmd：G2D_CMD_PALETTE_TBL。
- arg：arg 为 g2d_palette 结构体指针。
- 返回：

- 0：成功。
- 其他：失败。
- 举例：

```
unsigned long length;
/* 查找表数组 */
unsigned long palette[0x100];
g2d_palette pal;

pal->pbuffer = &palette;
pal.size = length;

if(ioctl(g2d_fd, G2D_CMD_PALETTE_TBL, &pal)<0)
{
    printf("G2D_CMD_PALETTE_TBL failed!\n");
}
```

3.2.2 2.0 版本接口

3.2.3 G2D_CMD_BITBLT_H

- PROTOTYPE

```
int ioctl(int fd, int cmd, void *arg)
```

- ARGUMENTS

```
cmd             G2D_CMD_BITBLT_H
arg             arg为g2d_blt_h结构体指针
```

- RETURNS

  成功：0，失败：失败号。

- DESCRIPTION

  实现单幅图的缩放、格式转换等。实现对 foreground 带缩放的 ROP2 处理。

- DEMO

（适用于 Linux5.10 及以上版本）

```
/*
 * g2d_hal/g2d_hal.c
 *
 * Copyright (c) 2007-2022 Allwinnertech Co., Ltd.
 * Author: libairong <libairong@allwinnertech.com>
 *
 * g2d hal
 *
 * This software is licensed under the terms of the GNU General Public
 * License version 2, as published by the Free Software Foundation, and
 * may be copied, distributed, and modified under those terms.
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
 * GNU General Public License for more details.
 *
 */

#include <sys/ioctl.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <unistd.h>

#include "g2d_hal.h"

enum device_status {
    ABNORMAL = 0,  // ABNORMAL Must be 0.
    NORMAL,
};

struct g2d_device_info {
    int g2d_fd;
    enum device_status status;
};

static struct g2d_device_info device_info;

int g2d_device_open() {
    if (device_info.g2d_fd == 0) {
        device_info.g2d_fd = open(G2D_DEVICE_PATH, O_RDWR);

        if (device_info.g2d_fd < 0) {
            device_info.g2d_fd = 0;
            device_info.status = ABNORMAL;
            G2D_HAL_ERR("Open G2D device failed!");
            return -1;
        }
    }

    device_info.status = NORMAL;
    return OK;
}

void g2d_device_close() {
    if (device_info.g2d_fd != 0) {
        close(device_info.g2d_fd);
        device_info.status = ABNORMAL;
    }
}

/* 旋转功能 */
g2d_status g2d_do_rotate(struct g2d_rotate *p_rotate) {
    g2d_blt_h blt;
    int ret;

    // check device.
    if (device_info.status != NORMAL)
        return G2D_DEV_ERR;

    memset(&blt, 0, sizeof(g2d_blt_h));

    if (p_rotate->rot_ch.input.bcolor) {
        G2D_HAL_ERR("rot_ch can input a layer with color_mode.");
        return PARAM_INVALID;
    }
    /* 支持0度， 90度， 180度， 270度旋转，具体见sunxi-g2d.h的struct g2d_blt_flags_h结构体 */
    blt.flag_h = p_rotate->rot_ch.flag;
    /* configure src image */
    blt.src_image_h.bbuff            = 1;
    blt.src_image_h.format       = p_rotate->rot_ch.input.format;
    blt.src_image_h.laddr[0]     = p_rotate->rot_ch.input.laddr[0];
    blt.src_image_h.laddr[1]     = p_rotate->rot_ch.input.laddr[1];
    blt.src_image_h.laddr[2]     = p_rotate->rot_ch.input.laddr[2];
    blt.src_image_h.haddr[0]     = p_rotate->rot_ch.input.haddr[0];
    blt.src_image_h.haddr[1]     = p_rotate->rot_ch.input.haddr[1];
    blt.src_image_h.haddr[2]     = p_rotate->rot_ch.input.haddr[2];
    blt.src_image_h.width        = p_rotate->rot_ch.input.width;
    blt.src_image_h.height       = p_rotate->rot_ch.input.height;
    blt.src_image_h.align[0]     = p_rotate->rot_ch.input.align[0];
    blt.src_image_h.align[1]     = p_rotate->rot_ch.input.align[1];
    blt.src_image_h.align[2]     = p_rotate->rot_ch.input.align[2];
    blt.src_image_h.clip_rect.x  = p_rotate->rot_ch.input.clip_rect.x;
    blt.src_image_h.clip_rect.y  = p_rotate->rot_ch.input.clip_rect.y;
    blt.src_image_h.clip_rect.w  = p_rotate->rot_ch.input.clip_rect.w;
    blt.src_image_h.clip_rect.h  = p_rotate->rot_ch.input.clip_rect.h;
    blt.src_image_h.coor.x       = p_rotate->rot_ch.input.coor.x;
    blt.src_image_h.coor.y       = p_rotate->rot_ch.input.coor.y;
    blt.src_image_h.gamut        = p_rotate->rot_ch.input.gamut;

    if (p_rotate->rot_ch.input.fd != 0) {
        blt.src_image_h.fd           = p_rotate->rot_ch.input.fd;
        blt.src_image_h.use_phy_addr = 0;
    } else
        blt.src_image_h.use_phy_addr = 1;

    blt.src_image_h.color_range  = p_rotate->rot_ch.input.color_range;

    /* configure dst image */
    blt.dst_image_h.bbuff            = 1;
    blt.dst_image_h.format       = p_rotate->output.format;
    blt.dst_image_h.laddr[0]     = p_rotate->output.laddr[0];
    blt.dst_image_h.laddr[1]     = p_rotate->output.laddr[1];
    blt.dst_image_h.laddr[2]     = p_rotate->output.laddr[2];
    blt.dst_image_h.haddr[0]     = p_rotate->output.haddr[0];
    blt.dst_image_h.haddr[1]     = p_rotate->output.haddr[1];
    blt.dst_image_h.haddr[2]     = p_rotate->output.haddr[2];
    blt.dst_image_h.width        = p_rotate->output.width;
    blt.dst_image_h.height       = p_rotate->output.height;
    blt.dst_image_h.align[0]     = p_rotate->output.align[0];
    blt.dst_image_h.align[1]     = p_rotate->output.align[1];
    blt.dst_image_h.align[2]     = p_rotate->output.align[2];
    blt.dst_image_h.clip_rect.x  = p_rotate->output.clip_rect.x;
    blt.dst_image_h.clip_rect.y  = p_rotate->output.clip_rect.y;
    blt.dst_image_h.clip_rect.w  = p_rotate->output.clip_rect.w;
    blt.dst_image_h.clip_rect.h  = p_rotate->output.clip_rect.h;
    blt.dst_image_h.gamut        = p_rotate->output.gamut;

    if (p_rotate->output.fd != 0) {
        blt.dst_image_h.fd          = p_rotate->output.fd;
        blt.dst_image_h.use_phy_addr = 0;
    } else
        blt.dst_image_h.use_phy_addr = 1;

    blt.dst_image_h.color_range  = p_rotate->output.color_range;

#if defined(G2D_LBC_SUPPORT)
    g2d_lbc_rot lbc_rot;

    memcpy(&lbc_rot.blt, &blt, sizeof(g2d_blt_h));
    lbc_rot.lbc_cmp_ratio = p_rotate->rot_ch.lbc_cmp_ratio;
    lbc_rot.enc_is_lossy = p_rotate->rot_ch.enc_is_lossy;
    lbc_rot.dec_is_lossy = p_rotate->rot_ch.dec_is_lossy;

    if (p_rotate->enable) {
        ret = g2d_ioctl(device_info.g2d_fd, G2D_CMD_LBC_ROT, (void *)(&lbc_rot));
    } else {
        ret = g2d_ioctl(device_info.g2d_fd, G2D_CMD_BITBLT_H, (void *)(&blt));
    }
#else
    ret = g2d_ioctl(device_info.g2d_fd, G2D_CMD_BITBLT_H, (void *)(&blt));
#endif

    return ret;
}

/* 缩放功能 */
g2d_status g2d_do_scale(struct g2d_scale *p_scale) {
    g2d_blt_h blt;
    int ret;

    if (device_info.status != NORMAL)
        return G2D_DEV_ERR;

    bzero(&blt, sizeof(g2d_blt_h));

    blt.flag_h = G2D_BLT_NONE_H;
    /* configure src image */
    blt.src_image_h.bbuff           = 1;
    /* 如果要实现格式转换功能，只需要指定input_fmt和output_fmt即可，具体支持的格式见sunxi_g2d.h的
    struct g2d_fmt_enh结构体 */
    blt.src_image_h.format       = p_scale->vi_ch.input.format;
    blt.src_image_h.laddr[0]     = p_scale->vi_ch.input.laddr[0];
    blt.src_image_h.laddr[1]     = p_scale->vi_ch.input.laddr[1];
    blt.src_image_h.laddr[2]     = p_scale->vi_ch.input.laddr[2];
    blt.src_image_h.haddr[0]     = p_scale->vi_ch.input.haddr[0];
    blt.src_image_h.haddr[1]     = p_scale->vi_ch.input.haddr[1];
    blt.src_image_h.haddr[2]     = p_scale->vi_ch.input.haddr[2];
    blt.src_image_h.width        = p_scale->vi_ch.input.width;
    blt.src_image_h.height       = p_scale->vi_ch.input.height;
    blt.src_image_h.align[0]     = p_scale->vi_ch.input.align[0];
    blt.src_image_h.align[1]     = p_scale->vi_ch.input.align[1];
    blt.src_image_h.align[2]     = p_scale->vi_ch.input.align[2];
    blt.src_image_h.clip_rect.x  = p_scale->vi_ch.input.clip_rect.x;
    blt.src_image_h.clip_rect.y  = p_scale->vi_ch.input.clip_rect.y;
    blt.src_image_h.clip_rect.w  = p_scale->vi_ch.input.clip_rect.w;
    blt.src_image_h.clip_rect.h  = p_scale->vi_ch.input.clip_rect.h;
    blt.src_image_h.coor.x       = p_scale->vi_ch.input.coor.x;
    blt.src_image_h.coor.y       = p_scale->vi_ch.input.coor.y;
    blt.src_image_h.gamut        = p_scale->vi_ch.input.gamut;

    if (p_scale->vi_ch.input.fd != 0) {
        blt.src_image_h.fd           = p_scale->vi_ch.input.fd;
        blt.src_image_h.use_phy_addr = 0;
    } else
        blt.src_image_h.use_phy_addr = 1;

    blt.src_image_h.color_range  = p_scale->vi_ch.input.color_range;

    /* configure dst image */
    blt.dst_image_h.bbuff            = 1;
    blt.dst_image_h.format       = p_scale->output.format;
    blt.dst_image_h.laddr[0]     = p_scale->output.laddr[0];
    blt.dst_image_h.laddr[1]     = p_scale->output.laddr[1];
    blt.dst_image_h.laddr[2]     = p_scale->output.laddr[2];
    blt.dst_image_h.haddr[0]     = p_scale->output.haddr[0];
    blt.dst_image_h.haddr[1]     = p_scale->output.haddr[1];
    blt.dst_image_h.haddr[2]     = p_scale->output.haddr[2];
    /* 修改output的width，height即可，注意缩放限制为1/16x~4x */
    blt.dst_image_h.width        = p_scale->output.width;
    blt.dst_image_h.height       = p_scale->output.height;
    blt.dst_image_h.align[0]     = p_scale->output.align[0];
    blt.dst_image_h.align[1]     = p_scale->output.align[1];
    blt.dst_image_h.align[2]     = p_scale->output.align[2];
    blt.dst_image_h.clip_rect.x  = p_scale->output.clip_rect.x;
    blt.dst_image_h.clip_rect.y  = p_scale->output.clip_rect.y;
    blt.dst_image_h.clip_rect.w  = p_scale->output.clip_rect.w;
    blt.dst_image_h.clip_rect.h  = p_scale->output.clip_rect.h;
    blt.dst_image_h.gamut        = p_scale->output.gamut;

    if (p_scale->output.fd != 0) {
        blt.dst_image_h.fd           = p_scale->output.fd;
        blt.dst_image_h.use_phy_addr = 0;
    } else
        blt.dst_image_h.use_phy_addr = 1;

    blt.dst_image_h.color_range  = p_scale->output.color_range;

    ret = g2d_ioctl(device_info.g2d_fd, G2D_CMD_BITBLT_H, (void *)(&blt));

    return ret;
}
```

```
/*
 * g2d_hal/g2d_hal.h
 *
 * Copyright (c) 2007-2022 Allwinnertech Co., Ltd.
 * Author: libairong <libairong@allwinnertech.com>
 *
 * g2d hal
 *
 * This software is licensed under the terms of the GNU General Public
 * License version 2, as published by the Free Software Foundation, and
 * may be copied, distributed, and modified under those terms.
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
 * GNU General Public License for more details.
 *
 */

#ifdef __cplusplus
extern "C" {
#endif

#ifndef __G2D_HAL_H__
#define __G2D_HAL_H__

#include <stdbool.h>
#include <stddef.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include "sunxi_g2d.h"

#define G2D_DEVICE_PATH "/dev/g2d"

/* some debug method. */
#define G2D_HAL_INFO(fmt, args...) \
    do {\
        printf("[G2D INFO] (%s) line:%d: " fmt "\n", __func__, __LINE__, ##args);\
    } while (0)

#define G2D_HAL_ERR(fmt, args...) \
    do {\
        printf("[G2D ERR] (%s) line:%d: " fmt "\n", __func__, __LINE__, ##args);\
    } while (0)

typedef enum {
    OK,
    PARAM_INVALID = -1,
    G2D_DEV_ERR,

} g2d_status;

/*
 * When g2d_layer as output, the coor is not used.
 */
struct g2d_layer {
    // 0:buffer_mode, 1:color_mode.
    // Rotation channel does not support color mode.
    int                 bcolor;

    /* color mode */
    unsigned int        color;

    /* buffer mode */
    sunxi_g2d_fmt_enh           format;
    __u32               width;
    __u32               height;
    sunxi_g2d_color_gmt     gamut;
    enum sunxi_color_range  color_range;
    // select data.
    sunxi_g2d_rect          clip_rect;

    // for output.
    sunxi_g2d_coor          coor;
    __u32             laddr[3];
    __u32             haddr[3];
    __u32             align[3];
    int               fd;             // dma-buf fd
};

/**
 * version: 2.0
 *
 * G2D IP desc:
 *    mixer:
 *
 *    vi_channel(scaler inside)------\
 *                                     blender --> output
 *    ui_channel ---\               /
 *    ui_channel ---->  rop  -------/
 *    ui_channel ---/
 *
 *    rotator:
 *    rot_channel ----> output
 *
 *    usage:
 *        You can config all of modules in IP by using module's struct.
 *        Something worth talking about that the output module is just a layer.
 */

/*
 * channel and blender can do premultiply. They are usually opened together.
 * Therefore, this structure is defined uniformly and placed in the channel by
 * default.
 */
struct alpha_premul {
    int                  bpremul;
    __u8                  alpha;
    sunxi_g2d_alpha_mode_enh    mode;
};

struct g2d_scaler {
    unsigned int width;
    unsigned int height;
};

struct vi_channel {
    struct g2d_layer input;
    struct alpha_premul premul;
    struct g2d_scaler resize;
};

struct ui_channel {
    struct g2d_layer input;
    struct alpha_premul premul;
};

struct rot_channel {
    struct g2d_layer input;
    sunxi_g2d_blt_flags_h flag;
#ifdef G2D_LBC_SUPPORT
    bool        enable;
    __u32    lbc_cmp_ratio;
    bool    enc_is_lossy;
    bool    dec_is_lossy;
#endif
};

// We only use ui_channel[2] to handle pic,
// so the rop module does not need to be configured
struct rop {
    unsigned int dwval;
};

struct g2d_blender {
    sunxi_g2d_bld_cmd_flag  bld_cmd;
    sunxi_g2d_ck            ck_para;
    unsigned int      bg_color;

};

/*
 * The following are the functions currently provided by G2D, which are composed
 * of modules.
 */

struct g2d_rotate {
    struct rot_channel rot_ch; // coor is invalid.
    struct g2d_layer output;
};

struct g2d_scale {
    struct vi_channel vi_ch;
    struct g2d_layer output;
};

struct g2d_fmt_convert {
    struct vi_channel vi_ch;
    struct g2d_layer output;
}
// This implament can do scale, fillcolor, blend in one time.
struct g2d_mixer {
    struct vi_channel vi_ch;
    struct ui_channel ui_ch;
    struct g2d_blender bld;
    struct g2d_layer  output;
};

int g2d_device_open();
void g2d_device_close();

g2d_status g2d_do_rotate(struct g2d_rotate *p_rotate);
g2d_status g2d_do_scale(struct g2d_scale *p_scale);
g2d_status g2d_do_mixer(struct g2d_mixer *p_mixer);

/* +++++++++++++++++++++++++++++++++ */

#endif  // __G2D_HAL_H__
#ifdef __cplusplus
```

```
}
#endif
```

3.2.4 G2D_CMD_BLD_H

- PROTOTYPE

```
int ioctl(int fd, int cmd, void *arg)
```

- ARGUMENTS

```
cmd            G2D_CMD_BLD_H
arg            arg为g2d_bld结构体指针
```

- RETURNS
  成功：0，失败：失败号。
- DESCRIPTION
  实现两幅图的 BLD(porter-duff) 操作。
- DEMO

```
/* 相关结构体和头文件见G2D_CMD_BITBLT_H接口 */
g2d_status g2d_do_mixer(struct g2d_mixer *p_mixer) {
    if (device_info.status != NORMAL)
        return G2D_DEV_ERR;
    g2d_bld bld;
    int ret;

    if (device_info.status != NORMAL)
        return G2D_DEV_ERR;

    bzero(&bld, sizeof(g2d_bld));

    printf("mixer start ......................\n");
    sleep(1);
    bld.bld_cmd = G2D_BLD_SRCOVER;
    /* configure src image */
    bld.src_image[0].bbuff            = p_mixer->vi_ch.input.bcolor == 0 ? 1 : 0;
    bld.src_image[0].format       = p_mixer->vi_ch.input.format;
    // laddr and haddr is not set.
    bld.src_image[0].laddr[0]     = p_mixer->vi_ch.input.laddr[0];
    bld.src_image[0].laddr[1]     = p_mixer->vi_ch.input.laddr[1];
    bld.src_image[0].laddr[2]     = p_mixer->vi_ch.input.laddr[2];
    bld.src_image[0].haddr[0]     = p_mixer->vi_ch.input.haddr[0];
    bld.src_image[0].haddr[1]     = p_mixer->vi_ch.input.haddr[1];
    bld.src_image[0].haddr[2]     = p_mixer->vi_ch.input.haddr[2];
    bld.src_image[0].width        = p_mixer->vi_ch.input.width;
    bld.src_image[0].height       = p_mixer->vi_ch.input.height;
    bld.src_image[0].align[0]     = p_mixer->vi_ch.input.align[0];
    bld.src_image[0].align[1]     = p_mixer->vi_ch.input.align[1];
    bld.src_image[0].align[2]     = p_mixer->vi_ch.input.align[2];
    bld.src_image[0].clip_rect.x  = p_mixer->vi_ch.input.clip_rect.x;
    bld.src_image[0].clip_rect.y  = p_mixer->vi_ch.input.clip_rect.y;
    bld.src_image[0].clip_rect.w  = p_mixer->vi_ch.input.clip_rect.w;
    bld.src_image[0].clip_rect.h  = p_mixer->vi_ch.input.clip_rect.h;
    bld.src_image[0].coor.x       = p_mixer->vi_ch.input.coor.x;
    bld.src_image[0].coor.y       = p_mixer->vi_ch.input.coor.y;
    bld.src_image[0].gamut        = p_mixer->vi_ch.input.gamut;

    // resize will be set to input.w/h by defaultly.
    bld.src_image[0].resize.w     = p_mixer->vi_ch.resize.width != 0
                    ? p_mixer->vi_ch.resize.width : p_mixer->vi_ch.input.width;
    bld.src_image[0].resize.h     = p_mixer->vi_ch.resize.height != 0
                    ? p_mixer->vi_ch.resize.height : p_mixer->vi_ch.input.height;

    bld.src_image[0].alpha        = 0xff;  // p_mixer->vi_ch.input.alpha;
    bld.src_image[0].mode         = G2D_GLOBAL_ALPHA;
    bld.src_image[0].color        = p_mixer->vi_ch.input.color;

    bld.src_image[1].bbuff        = p_mixer->ui_ch.input.bcolor == 0 ? 1 : 0;
    bld.src_image[1].format       = p_mixer->ui_ch.input.format;
    // laddr and haddr is not set.
    bld.src_image[1].laddr[0]     = p_mixer->ui_ch.input.laddr[0];
    bld.src_image[1].laddr[1]     = p_mixer->ui_ch.input.laddr[1];
    bld.src_image[1].laddr[2]     = p_mixer->ui_ch.input.laddr[2];
    bld.src_image[1].haddr[0]     = p_mixer->ui_ch.input.haddr[0];
    bld.src_image[1].haddr[1]     = p_mixer->ui_ch.input.haddr[1];
    bld.src_image[1].haddr[2]     = p_mixer->ui_ch.input.haddr[2];
    bld.src_image[1].width        = p_mixer->ui_ch.input.width;
    bld.src_image[1].height       = p_mixer->ui_ch.input.height;
    bld.src_image[1].align[0]     = p_mixer->ui_ch.input.align[0];
    bld.src_image[1].align[1]     = p_mixer->ui_ch.input.align[1];
    bld.src_image[1].align[2]     = p_mixer->ui_ch.input.align[2];
    bld.src_image[1].clip_rect.x  = p_mixer->ui_ch.input.clip_rect.x;
    bld.src_image[1].clip_rect.y  = p_mixer->ui_ch.input.clip_rect.y;
    bld.src_image[1].clip_rect.w  = p_mixer->ui_ch.input.clip_rect.w;
    bld.src_image[1].clip_rect.h  = p_mixer->ui_ch.input.clip_rect.h;
    bld.src_image[1].coor.x       = p_mixer->ui_ch.input.coor.x;
    bld.src_image[1].coor.y       = p_mixer->ui_ch.input.coor.y;
    bld.src_image[1].gamut        = p_mixer->ui_ch.input.gamut;
    bld.src_image[1].alpha        = 0xff;
    bld.src_image[1].mode         = G2D_GLOBAL_ALPHA;
    bld.src_image[1].color        = p_mixer->ui_ch.input.color;

    if (p_mixer->vi_ch.input.fd != 0) {
        bld.src_image[0].fd           = p_mixer->vi_ch.input.fd;
        bld.src_image[1].fd           = p_mixer->ui_ch.input.fd;
        bld.src_image[0].use_phy_addr = 0;
        bld.src_image[1].use_phy_addr = 0;
    } else
        bld.src_image[0].use_phy_addr = 1;


    bld.src_image[0].color_range  = p_mixer->vi_ch.input.color_range;
    bld.src_image[1].color_range  = p_mixer->vi_ch.input.color_range;
    /* configure dst image */
    bld.dst_image.bbuff            = 1;
    bld.dst_image.format       = p_mixer->output.format;
```

```
    bld.dst_image.laddr[0]     = p_mixer->output.laddr[0];
    bld.dst_image.laddr[1]     = p_mixer->output.laddr[1];
    bld.dst_image.laddr[2]     = p_mixer->output.laddr[2];
    bld.dst_image.haddr[0]     = p_mixer->output.haddr[0];
    bld.dst_image.haddr[1]     = p_mixer->output.haddr[1];
    bld.dst_image.haddr[2]     = p_mixer->output.haddr[2];
    bld.dst_image.width        = p_mixer->output.width;
    bld.dst_image.height       = p_mixer->output.height;
    bld.dst_image.align[0]     = p_mixer->output.align[0];
    bld.dst_image.align[1]     = p_mixer->output.align[1];
    bld.dst_image.align[2]     = p_mixer->output.align[2];
    bld.dst_image.clip_rect.x  = p_mixer->output.clip_rect.x;
    bld.dst_image.clip_rect.y  = p_mixer->output.clip_rect.y;
    bld.dst_image.clip_rect.w  = p_mixer->output.clip_rect.w;
    bld.dst_image.clip_rect.h  = p_mixer->output.clip_rect.h;
    bld.dst_image.gamut        = p_mixer->output.gamut;
    bld.dst_image.alpha        = 0xff;
    bld.dst_image.mode         = G2D_GLOBAL_ALPHA;
    bld.dst_image.color        = 0x00000000;
    bld.dst_image.color_range  = p_mixer->output.color_range;
    if (p_mixer->output.fd != 0) {
        bld.dst_image.fd           = p_mixer->output.fd;
        bld.dst_image.use_phy_addr = 0;
    } else
        bld.dst_image.use_phy_addr = 1;


    ret = g2d_ioctl(device_info.g2d_fd, G2D_CMD_BLD_H, (void *)(&bld));

    return 0;
}
```

3.2.5 G2D_CMD_FILLRECT_H

- PROTOTYPE

```
int ioctl(int fd, int cmd, void *arg)
```

- ARGUMENTS

cmd	G2D_CMD_FILLRECT_H
arg	arg为g2d_fillrect_h结构体指针

- RETURNS

  成功：0，失败：失败号。

- DESCRIPTION

  向目标图像填充颜色矩形。

- DEMO

```
fillrect.dst_image_h.format = 0;
fillrect.info.dst_image_h.color = 0x90000090;
fillrect.info.dst_image_h.width = 800;
fillrect.info.dst_image_h.height = 480;
fillrect.info.dst_image_h.clip_rect.x = 0;
fillrect.info.dst_image_h.clip_rect.y = 0;
fillrect.info.dst_image_h.clip_rect.w = 800;
fillrect.info.dst_image_h.clip_rect.h = 480;
fillrect.info.dst_image_h.align[0] = phy_addr;

/* fill color */
if(ioctl(fd , G2D_CMD_FILLRECT_H ,(unsigned long)(&fillrect)) < 0)
{
    printf("[%d][%s][%s]G2D_CMD_FILLRECT_H failure!\n",__LINE__,__FILE__,__FUNCTION__);
    close(fd);

    return -1;
}
```

3.2.6 G2D_CMD_MASK_H

- PROTOTYPE

```
int ioctl(int fd, int cmd, void *arg)
```

- ARGUMENTS

cmd	G2D_CMD_MASK_H
arg	arg为g2d_maskblt结构体指针

- RETURNS
  成功：0；失败：失败号。
- DESCRIPTION
  根据掩膜图和光栅操作码对 src、pattern 和 dst 进行操作，并将结果保存到 dst 中。
- DEMO

```
mask.back_flag = G2D_ROP3_NOTSRCCOPY;
mask.fore_flag = G2D_ROP3_SRCINVERT;
mask.src_image_h.clip_rect.x = 0;
mask.src_image_h.clip_rect.y = 0;
mask.src_image_h.clip_rect.w = 1280;
mask.src_image_h.clip_rect.h = 800;
mask.src_image_h.width = 1280;
mask.src_image_h.height = 800;
mask.src_image_h.mode = G2D_GLOBAL_ALPHA;
mask.dst_image_h.clip_rect.x = 0;
mask.dst_image_h.clip_rect.y = 0;
mask.dst_image_h.clip_rect.w = 1280;
mask.dst_image_h.clip_rect.h = 800;
mask.dst_image_h.width = 1280;
mask.dst_image_h.height = 800;
mask.dst_image_h.mode = G2D_GLOBAL_ALPHA;
mask.mask_image_h.clip_rect.x = 0;
mask.mask_image_h.clip_rect.y = 0;
mask.mask_image_h.clip_rect.w = 1280;
mask.mask_image_h.clip_rect.h = 800;
mask.mask_image_h.width = 1280;
mask.mask_image_h.height = 800;
mask.mask_image_h.mode = G2D_GLOBAL_ALPHA;
mask.ptn_image_h.clip_rect.x = 0;
mask.ptn_image_h.clip_rect.y = 0;
mask.ptn_image_h.clip_rect.w = 1280;
mask.ptn_image_h.clip_rect.h = 800;
mask.ptn_image_h.width = 1280;
mask.ptn_image_h.height = 800;
mask.ptn_image_h.mode = G2D_GLOBAL_ALPHA;
mask.src_image_h.alpha = 0xff;
mask.mask_image_h.alpha = 0xff;
mask.ptn_image_h.alpha = 0xff;
mask.dst_image_h.alpha = 0xff;
mask.src_image_h.format = G2D_FORMAT_ARGB8888;
mask.mask_image_h.format = G2D_FORMAT_ARGB8888;
mask.ptn_image_h.format = G2D_FORMAT_ARGB8888;
mask.dst_image_h.format = G2D_FORMAT_ARGB8888;

if(ioctl(int fd, G2D_CMD_MASK_H ,(unsigned long)(&mask)) < 0)
{
printf("[%d][%s][%s]G2D_CMD_MASK_H failure!\n",__LINE__, __FILE__,__FUNCTION__);
            return -1;
}
```

3.3 批处理接口

```
struct mixer_para {
    g2d_operation_flag op_flag;
    g2d_blt_flags_h flag_h;
    g2d_rop3_cmd_flag back_flag;
    g2d_rop3_cmd_flag fore_flag;
    g2d_bld_cmd_flag     bld_cmd;
    g2d_image_enh src_image_h;
    g2d_image_enh dst_image_h;
    g2d_image_enh ptn_image_h;
    g2d_image_enh mask_image_h;
    g2d_ck ck_para;
};

typedef enum {
    OP_FILLRECT = 0x1,
    OP_BITBLT = 0x2,
    OP_BLEND = 0x4,
    OP_MASK = 0x8,
    OP_SPLIT_MEM = 0x10,
} g2d_operation_flag;
```

struct mixer_para 是 RCQ 批处理的核心结构体。可以看到除了第一个成员，其它成员的类型都是旧驱动里面有的。struct mixer_para 是之前驱动接口结构体的一个合集，如图 3-1 所示：

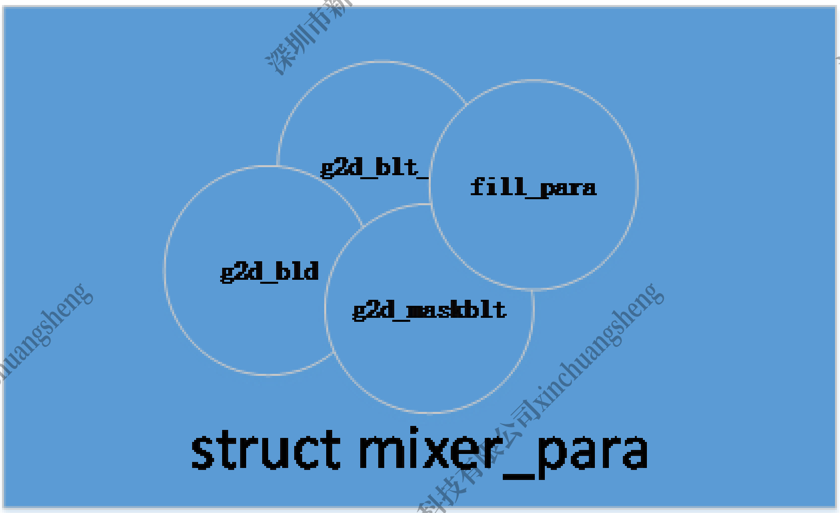


图 3-1: mixerpara

所以你可以用批处理接口完成上面其它接口的功能，只要你设置好对应的成员和 g2d_operation_flag 即可。

3.3.1 G2D_CMD_MIXER_TASK

- PROTOTYPE

```
int ioctl(int fd, int cmd, void *arg)
```

- ARGUMENTS

```
cmd:            G2D_CMD_MIXER_TASK

arg[0]:         设备文件标识符arg指向mixer_para指针，批处理的话就是数组指针。

arg[1]:         指针需要处理的帧的数量，大于等于1
```

- RETURN

```
成功: 0, 失败: 失败号
```

用户要做的事情，就是填充好 mixer_para 数组，申请好输入输出内存，将要处理的图像写入到输入内存里面，将处理好的图像在输出内存里面取出来。

下面是批处理缩放 16 帧示例，其中 4 帧是 rgb 格式的缩放，6 帧是 Y8 的是缩放，6 帧是 nv12 的缩放。

```
#define RGB_IMAGE_NAME "../../pic/c1080_good.rgb"
 #define Y8_IMAGE_NAME "../../pic/en_dmabuf_bike_1280x720_220_Y8.bin"
 #define NV12_IMAGE_NAME "../../pic/bike_1280x720_220.bin"

 #define FRAME_TO_BE_PROCESS 16
 /*4 rgb convert  6 Y8 convert  6 yuv420 convert*/
 unsigned int out_width[FRAME_TO_BE_PROCESS] = {
     192,  154,  108,  321,  447,  960, 241, 320,
     1920, 1439, 1280, 1920, 2048, 720, 800, 480};
 unsigned int out_height[FRAME_TO_BE_PROCESS] = {108,  87,  70,   217, 213, 640,
                                                 840,  240, 1080, 777, 800, 1080,
                                                 2048, 480, 480,  240};

struct test_info_t
{
         struct mixer_para info[FRAME_TO_BE_PROCESS];
          .....
};

Int main()
{
....
  test_info.info[0].flag_h = G2D_BLT_NONE_H;
         test_info.info[0].op_flag = OP_BITBLT;
         test_info.info[0].src_image_h.format = G2D_FORMAT_RGB888;
         test_info.info[0].src_image_h.width = 1920;
         test_info.info[0].src_image_h.height = 1080;
         test_info.info[0].src_image_h.clip_rect.x = 0;
         test_info.info[0].src_image_h.clip_rect.y = 0;
         test_info.info[0].src_image_h.clip_rect.w = 1920;
         test_info.info[0].src_image_h.clip_rect.h = 1080;
         test_info.info[0].src_image_h.color = 0xee8899;
         test_info.info[0].src_image_h.mode = G2D_PIXEL_ALPHA;
         test_info.info[0].src_image_h.alpha = 0xaa;
         test_info.info[0].src_image_h.align[0] = 0;
         test_info.info[0].src_image_h.align[1] = 0;
         test_info.info[0].src_image_h.align[2] = 0;

         test_info.info[0].dst_image_h.format = G2D_FORMAT_RGB888;
         test_info.info[0].dst_image_h.width = 800;
         test_info.info[0].dst_image_h.height = 480;
         test_info.info[0].dst_image_h.clip_rect.x = 0;
         test_info.info[0].dst_image_h.clip_rect.y = 0;
         test_info.info[0].dst_image_h.clip_rect.w = 1920;
         test_info.info[0].dst_image_h.clip_rect.h = 1080;
         test_info.info[0].dst_image_h.color = 0xee8899;
         test_info.info[0].dst_image_h.mode = G2D_PIXEL_ALPHA;
         test_info.info[0].dst_image_h.alpha = 255;
         test_info.info[0].dst_image_h.align[0] = 0;
         test_info.info[0].dst_image_h.align[1] = 0;
         test_info.info[0].dst_image_h.align[2] = 0;
for (i = 0; i < FRAME_TO_BE_PROCESS; ++i) {
                 memcpy(&test_info.info[i], &test_info.info[0],
                        sizeof(struct mixer_para));
                 test_info.info[i].dst_image_h.width = out_width[i];
                 test_info.info[i].dst_image_h.height = out_height[i];
                 test_info.info[i].dst_image_h.clip_rect.w = out_width[i];
```

```
                test_info.info[i].dst_image_h.clip_rect.h = out_height[i];
                if (i < 4) {
                        test_info.out_size[i] = test_info.info[i].dst_image_h.width *
   test_info.info[i].dst_image_h.height * 3;
                        test_info.info[i].src_image_h.format = G2D_FORMAT_BGR888;
                        test_info.info[i].src_image_h.width = 1920;
                        test_info.info[i].src_image_h.height = 1080;
                        test_info.info[i].src_image_h.clip_rect.w = 1920;
                        test_info.info[i].src_image_h.clip_rect.h = 1080;
                        test_info.in_size[i] = 1920*1080*3;
                        snprintf(test_info.src_image_name[i], 100,"%s",RGB_IMAGE_NAME);
                } else if (i < 10) {
                        test_info.out_size[i] = test_info.info[i].dst_image_h.width *
   test_info.info[i].dst_image_h.height;
                        test_info.info[i].src_image_h.format = G2D_FORMAT_Y8;
                        test_info.info[i].src_image_h.width = 1280;
                        test_info.info[i].src_image_h.height = 720;
                        test_info.info[i].src_image_h.clip_rect.w = 1280;
                        test_info.info[i].src_image_h.clip_rect.h = 720;
                        test_info.in_size[i] = 1280*720;
                        snprintf(test_info.src_image_name[i], 100,"%s",Y8_IMAGE_NAME);
                } else {
                        test_info.out_size[i] = test_info.info[i].dst_image_h.width *
   test_info.info[i].dst_image_h.height * 2;
                        test_info.info[i].src_image_h.format =
   G2D_FORMAT_YUV420UVC_U1V1U0V0;
                        test_info.info[i].src_image_h.width = 1280;
                        test_info.info[i].src_image_h.height = 720;
                        test_info.info[i].src_image_h.clip_rect.w = 1280;
                        test_info.info[i].src_image_h.clip_rect.h = 720;
                        test_info.in_size[i] = 1280*720*2;
                        snprintf(test_info.src_image_name[i], 100,"%s",NV12_IMAGE_NAME);
                }
                ret = ion_memory_request(&test_info.dst_ion[i], 1, NULL, test_info.
   out_size[i]);
                test_info.info[i].dst_image_h.fd = test_info.dst_ion[i].fd_data.fd;//rtos-
   hal中的驱动不支持使用fd，这里请修改为物理地址，并设置好偏移

                test_info.info[i].dst_image_h.format = test_info.info[i].src_image_h.
   format;
                ret = ion_memory_request(&test_info.src_ion[i], 0, test_info.
   src_image_name[i], test_info.in_size[i]);
                test_info.info[i].src_image_h.fd = test_info.src_ion[i].fd_data.fd;//rtos-
   hal中的驱动不支持使用fd，这里请修改为物理地址，并设置好偏移
        }
arg[0] = (unsigned long)test_info.info;
        arg[1] = FRAME_TO_BE_PROCESS;
        if (ioctl(g2d_fd, G2D_CMD_MIXER_TASK, (arg)) < 0) {
                printf("[%d][%s][%s]G2D_CMD_MIXER_TASK failure!\n", __LINE__,
                       __FILE__, __FUNCTION__);
                goto FREE_SRC;
        }
        printf("[%d][%s][%s]G2D_CMD_MIXER_TASK SUCCESSFULL!\n", __LINE__,
               __FILE__, __FUNCTION__);


        printf("save result data to file\n");
        char sufix[40] = {0};
        for (i = 0; i < FRAME_TO_BE_PROCESS; ++i) {
                if (i < 4) {
```

```
                         snprintf(sufix, 40, "rgb888");
                 } else if (i < 10)
                         snprintf(sufix, 40, "y8");
                 else
                         snprintf(sufix, 40, "nv12");

                 snprintf(test_info.dst_image_name[i], 100,
                          "../../result/frame%d_%dx%d_to_%dx%d.%s",i,
                          test_info.info[i].src_image_h.width,
                          test_info.info[i].src_image_h.height,
                          test_info.info[i].dst_image_h.width,
                          test_info.info[i].dst_image_h.height, sufix);
                 if((test_info.dst_fp[i] = fopen(test_info.dst_image_name[i], "wb+")) ==
    NULL) {
                         printf("open file %s fail.\n", test_info.dst_image_name[i]);
                         break;
                 } else {
                         ret = fwrite(test_info.dst_ion[i].virt_addr,
                                      test_info.out_size[i], 1, test_info.dst_fp[i]);
                         fflush(test_info.src_fp);
                         printf("Frame %d saved\n", i);
                 }

         }
....
}
```

3.3.2 G2D_CMD_CREATE_TASK

- PROTOTYPE

```
int ioctl(int fd, int cmd, void *arg)
```

- ARGUMENTS

```
cmd             G2D_CMD_CREATE_TASK

arg[0]          arg指向mixer_para指针，批处理的话就是数组指针。

arg[1]          需要处理的帧的数量，大于等于1。
```

- RETURN

```
成功：task id，大于等于1，其它情况则为失败。

arg[0]对应的指针所指向的mixer_para内容会被更新。
```

该 ioctl 命令用于创建新的批处理实例，但不做硬件处理，只是准备好软件。

这个过程会构造对应帧数的 rcq 队列内存以及进行输入输出图像的 dma map 和 dma umap 操作，构造完毕之后会更新 mixer_para 回应用层。task_id 是唯一的，只要不销毁批处理实例，会一直占据这个 id。根据这个 id 用户可以进一步操作，比如设置，销毁，获取当前 mixer_para。

如下例子，会创建两个不同帧数和输入输出格式的批处理实例，最终得到两个不同的 task id，task0 和 task1。mixer_para 如何构造参考 G2D_CMD_MIXER_TASK 的例子。

```
arg[0] = (unsigned long)test_info.info;
    arg[1] = FRAME_TO_BE_PROCESS;
    task0 = ioctl(g2d_fd, G2D_CMD_CREATE_TASK, (arg));
    if (task0 < 1) {
        printf("[%d][%s][%s]G2D_CMD_CREATE_TASK failure!\n", __LINE__,
                 __FILE__, __FUNCTION__);
        goto FREE_SRC;
    }
    printf("[%d][%s][%s]G2D_CMD_CREATE_TASK SUCCESSFULL!\n", __LINE__,
           __FILE__, __FUNCTION__);


    arg[0] = (unsigned long)test_info2.info;
    arg[1] = FRAME_TO_BE_PROCESS2;
    task1 = ioctl(g2d_fd, G2D_CMD_CREATE_TASK, (arg));
    if (task1 < 1) {
        printf("[%d][%s][%s]G2D_CMD_CREATE_TASK failure!\n", __LINE__,
                 __FILE__, __FUNCTION__);
        goto FREE_SRC;
    }
    printf("[%d][%s][%s]G2D_CMD_CREATE_TASK SUCCESSFULL!\n", __LINE__,
           __FILE__, __FUNCTION__);
```

3.3.3 G2D_CMD_TASK_APPLY

- PROTOTYPE

```
int ioctl(int fd, int cmd, void *arg)
```

- ARGUMENTS

cmd	G2D_CMD_TASK_APPLY
arg[0]	task id(由G2D_CMD_CREATE_TASK命令获得)
arg[1]	arg指向mixer_para指针，批处理的话就是数组指针。

- RETURN

```
成功：0，失败：失败号
```

该 ioctl 命令的作用是执行批处理的硬件操作。

值得注意 arg[1] 中的 mixer_para，必须是 G2D_CMD_CREATE_TASK 之后返回的 mixer_para 或者是通过另外一个 ioctl 命令 G2D_CMD_TASK_GET_PARA 才行，这里不需要制定帧数的原因是前面的 G2D_CMD_CREATE_TASK 已经指定好帧数，而 G2D_CMD_TASK_APPLY 是基于 task id 来执行的。

```
arg[0] = task0;
    arg[1] = (unsigned long)test_info.info;
    if(ioctl(g2d_fd, G2D_CMD_TASK_APPLY, (arg)) < 0) {
        printf("[%d][%s][%s]G2D_CMD_TASK_APPLY failure!\n", __LINE__,
               __FILE__, __FUNCTION__);
        goto FREE_SRC;
    }
    printf("[%d][%s][%s]G2D_CMD_TASK_APPLY SUCCESSFULL!\n", __LINE__,
           __FILE__, __FUNCTION__);

    arg[0] = task1;
    arg[1] = (unsigned long)test_info2.info;
    if(ioctl(g2d_fd, G2D_CMD_TASK_APPLY, (arg)) < 0) {
        printf("[%d][%s][%s]G2D_CMD_TASK_APPLY failure!\n", __LINE__,
               __FILE__, __FUNCTION__);
        goto FREE_SRC;
    }
    printf("[%d][%s][%s]G2D_CMD_TASK_APPLY SUCCESSFULL!\n", __LINE__,
           __FILE__, __FUNCTION__);
```

3.3.4 G2D_CMD_TASK_DESTROY

- PROTOTYPE

```
int ioctl(int fd, int cmd, void *arg)
```

- ARGUMENTS

```
cmd             G2D_CMD_TASK_DESTROY

arg[0]          task id
```

- RETURN

```
成功：0，失败：失败号
```

该 ioctl 命令的作用是销毁指定 task id 的批处理实例。

```
 arg[0] = task0;;
    if(ioctl(g2d_fd, G2D_CMD_TASK_DESTROY, (arg)) < 0) {
        printf("[%d][%s][%s]G2D_CMD_TASK_DESTROY failure!\n", __LINE__,
               __FILE__, __FUNCTION__);
        goto FREE_SRC;
    }
    printf("[%d][%s][%s]G2D_CMD_TASK_DESTROY SUCCESSFULL!\n", __LINE__,
           __FILE__, __FUNCTION__);
    arg[0] = task1;;
    if(ioctl(g2d_fd, G2D_CMD_TASK_DESTROY, (arg)) < 0) {
        printf("[%d][%s][%s]G2D_CMD_TASK_DESTROY failure!\n", __LINE__,
               __FILE__, __FUNCTION__);
        goto FREE_SRC;
    }
    printf("[%d][%s][%s]G2D_CMD_TASK_DESTROY SUCCESSFULL!\n", __LINE__,
           __FILE__, __FUNCTION__);
```

3.3.5 G2D_CMD_TASK_GET_PARA

- PROTOTYPE

```
int ioctl(int fd, int cmd, void *arg)
```

- ARGUMENTS

cmd	G2D_CMD_TASK_DESTROY
arg[0]	task id
arg[1]	指向mixer_para指针，多帧的话就是数组指针。

- RETURN

```
成功：0，失败：失败号
```

该 ioctl 命令的作用是获取指定 task id 的 mixer para。

用户必须自行保证传入的指针所指向的内存足够存放这么多帧的参数。

4 FAQ

4.1 常见问题

4.1.1 对齐问题

- mixer 要 4byte 对齐。
- rotate 输出要 8byte 对齐，输入没有要求，底层关心的只是输入的宽和高，以及输出的 pitch 大小。

4.1.2 输出格式显示

yuv 格式，做旋转时，输出一律是 yuv420，旋转和缩放不能同时使用，要调用两次接口。

4.1.3 输出宽度

G2D 硬件模块不支持输出宽度等于 1 pixel。

著作权声明

商标声明

ALLWINNER、ALLWINNER 全志科技、全志科技、ALLWINNER®（不完全列举）均为珠海全志科技股份有限公司的商标或者注册商标。在本文档描述的产品中出现的其它商标，产品名称，和服务名称，均由其各自所有人拥有。

免责声明

您购买的产品、服务或特性应受您与珠海全志科技股份有限公司（“全志”）之间签署的商业合同和条款的约束。本文档中描述的全部或部分产品、服务或特性可能不在您所购买或使用的范围内。使用前请认真阅读合同条款和相关说明，并严格遵循本文档的使用说明。您将自行承担任何不当使用行为（包括但不限于如超压，超频，超温使用）造成的不利后果，全志概不负责。

本文档作为使用指导仅供参考。由于产品版本升级或其他原因，本文档内容有可能修改，如有变更，恕不另行通知。全志尽全力在本文档中提供准确的信息，但并不确保内容完全没有错误，因使用本文档而发生损害（包括但不限于间接的、偶然的、特殊的损失）或发生侵犯第三方权利事件，全志概不负责。本文档中的所有陈述、信息和建议并不构成任何明示或暗示的保证或承诺。

本文档未以明示或暗示或其他方式授予全志的任何专利或知识产权。在您实施方案或使用产品的过程中，可能需要获得第三方的权利许可。请您自行向第三方权利人获取相关的许可。全志不承担也不代为支付任何关于获取第三方许可的许可费或版税（专利税）。全志不对您所使用的第三方许可技术做出任何保证、赔偿或承担其他义务。