

file: media/v4l/capture.c

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/*
 * V4L2 video capture example
 *
 * This program can be used and distributed without restrictions.
 *
 * This program is provided with the V4L2 API
 * see https://linuxtv.org/docs.php for more information
 */

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <assert.h>

#include <getopt.h>          /* getopt_long() */

#include <fcntl.h>           /* low-level i/o */
#include <unistd.h>
#include <errno.h>
#include <sys/stat.h>
#include <sys/types.h>
#include <sys/time.h>
#include <sys/mman.h>
#include <sys/ioctl.h>

#include <linux/videodev2.h>

#define CLEAR(x) memset(&(x), 0, sizeof(x))

enum io_method {
    IO_METHOD_READ,
    IO_METHOD_MMAP,
    IO_METHOD_USERPTR,
};

struct buffer {
    void *start;
    size_t length;
};

static char *dev_name;
static enum io_method io = IO_METHOD_MMAP;
static int fd = -1;
static struct buffer *buffers;
static unsigned int n_buffers;
static int out_buf;
static int force_format;
static int frame_count = 70;

static void errno_exit(const char *s)
{
    fprintf(stderr, "%s error %d, %s\n", s, errno, strerror(errno));
    exit(EXIT_FAILURE);
}

static int xioctl(int fh, int request, void *arg)
{
    int r;

    do {
        r = ioctl(fh, request, arg);
    } while (-1 == r && EINTR == errno);

    return r;
}

static void process_image(const void *p, int size)
{
    if (out_buf)
        fwrite(p, size, 1, stdout);

    fflush(stderr);
    fprintf(stderr, ".");
    fflush(stdout);
}
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static int read_frame(void)
{
    struct v4l2_buffer buf;
    unsigned int i;

    switch (io) {
    case IO_METHOD_READ:
        if (-1 == read(fd, buffers[0].start, buffers[0].length)) {
            switch (errno) {
            case EAGAIN:
                return 0;

            case EIO:
                /* Could ignore EIO, see spec. */

                /* fall through */

            default:
                errno_exit("read");
            }
        }

        process_image(buffers[0].start, buffers[0].length);
        break;

    case IO_METHOD_MMAP:
        CLEAR(buf);

        buf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
        buf.memory = V4L2_MEMORY_MMAP;

        if (-1 == xioctl(fd, VIDIOC_DQBUF, &buf)) {
            switch (errno) {
            case EAGAIN:
                return 0;

            case EIO:
                /* Could ignore EIO, see spec. */

                /* fall through */

            default:
                errno_exit("VIDIOC_DQBUF");
            }
        }

        assert(buf.index < n_buffers);

        process_image(buffers[buf.index].start, buf.bytesused);

        if (-1 == xioctl(fd, VIDIOC_QBUF, &buf))
            errno_exit("VIDIOC_QBUF");
        break;

    case IO_METHOD_USERPTR:
        CLEAR(buf);

        buf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
        buf.memory = V4L2_MEMORY_USERPTR;

        if (-1 == xioctl(fd, VIDIOC_DQBUF, &buf)) {
            switch (errno) {
            case EAGAIN:
                return 0;

            case EIO:
                /* Could ignore EIO, see spec. */

                /* fall through */

            default:
                errno_exit("VIDIOC_DQBUF");
            }
        }

        for (i = 0; i < n_buffers; ++i)
            if (buf.m.userptr == (unsigned long)buffers[i].start
                && buf.length == buffers[i].length)
                break;

        assert(i < n_buffers);
    }
}

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        process_image((void *)buf.m.userptr, buf.bytesused);

        if (-1 == xioctl(fd, VIDIOC_QBUF, &buf))
            errno_exit("VIDIOC_QBUF");
        break;
    }

    return 1;
}

static void mainloop(void)
{
    unsigned int count;

    count = frame_count;

    while (count-- > 0) {
        for (;;) {
            fd_set fds;
            struct timeval tv;
            int r;

            FD_ZERO(&fds);
            FD_SET(fd, &fds);

            /* Timeout. */
            tv.tv_sec = 2;
            tv.tv_usec = 0;

            r = select(fd + 1, &fds, NULL, NULL, &tv);

            if (-1 == r) {
                if (EINTR == errno)
                    continue;
                errno_exit("select");
            }

            if (0 == r) {
                fprintf(stderr, "select timeout\n");
                exit(EXIT_FAILURE);
            }

            if (read_frame())
                break;
            /* EAGAIN - continue select loop. */
        }
    }
}

static void stop_capturing(void)
{
    enum v4l2_buf_type type;

    switch (io) {
        case IO_METHOD_READ:
            /* Nothing to do. */
            break;

        case IO_METHOD_MMAP:
        case IO_METHOD_USERPTR:
            type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
            if (-1 == xioctl(fd, VIDIOC_STREAMOFF, &type))
                errno_exit("VIDIOC_STREAMOFF");
            break;
    }
}

static void start_capturing(void)
{
    unsigned int i;
    enum v4l2_buf_type type;

    switch (io) {
        case IO_METHOD_READ:
            /* Nothing to do. */
            break;

        case IO_METHOD_MMAP:
            for (i = 0; i < n_buffers; ++i) {
                struct v4l2_buffer buf;

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        CLEAR(buf);
        buf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
        buf.memory = V4L2_MEMORY_MMAP;
        buf.index = i;

        if (-1 == xioctl(fd, VIDIOC_QBUF, &buf))
            errno_exit("VIDIOC_QBUF");
    }
    type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
    if (-1 == xioctl(fd, VIDIOC_STREAMON, &type))
        errno_exit("VIDIOC_STREAMON");
    break;

case IO_METHOD_USERPTR:
    for (i = 0; i < n_buffers; ++i) {
        struct v4l2_buffer buf;

        CLEAR(buf);
        buf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
        buf.memory = V4L2_MEMORY_USERPTR;
        buf.index = i;
        buf.m.userptr = (unsigned long)buffers[i].start;
        buf.length = buffers[i].length;

        if (-1 == xioctl(fd, VIDIOC_QBUF, &buf))
            errno_exit("VIDIOC_QBUF");
    }
    type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
    if (-1 == xioctl(fd, VIDIOC_STREAMON, &type))
        errno_exit("VIDIOC_STREAMON");
    break;
}

}

static void uninit_device(void)
{
    unsigned int i;

    switch (io) {
case IO_METHOD_READ:
        free(buffers[0].start);
        break;

case IO_METHOD_MMAP:
        for (i = 0; i < n_buffers; ++i)
            if (-1 == munmap(buffers[i].start, buffers[i].length))
                errno_exit("munmap");
        break;

case IO_METHOD_USERPTR:
        for (i = 0; i < n_buffers; ++i)
            free(buffers[i].start);
        break;
    }

    free(buffers);
}

static void init_read(unsigned int buffer_size)
{
    buffers = calloc(1, sizeof(*buffers));

    if (!buffers) {
        fprintf(stderr, "Out of memory\n");
        exit(EXIT_FAILURE);
    }

    buffers[0].length = buffer_size;
    buffers[0].start = malloc(buffer_size);

    if (!buffers[0].start) {
        fprintf(stderr, "Out of memory\n");
        exit(EXIT_FAILURE);
    }
}

static void init_mmap(void)
{
    struct v4l2_requestbuffers req;

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CLEAR(req);

req.count = 4;
req.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
req.memory = V4L2_MEMORY_MMAP;

if (-1 == xioctl(fd, VIDIOC_REQBUFS, &req)) {
    if (EINVAL == errno) {
        fprintf(stderr, "%s does not support "
            "memory mapping", dev_name);
        exit(EXIT_FAILURE);
    } else {
        errno_exit("VIDIOC_REQBUFS");
    }
}

if (req.count < 2) {
    fprintf(stderr, "Insufficient buffer memory on %s\n",
        dev_name);
    exit(EXIT_FAILURE);
}

buffers = calloc(req.count, sizeof(*buffers));

if (!buffers) {
    fprintf(stderr, "Out of memory\n");
    exit(EXIT_FAILURE);
}

for (n_buffers = 0; n_buffers < req.count; ++n_buffers) {
    struct v4l2_buffer buf;

    CLEAR(buf);

    buf.type      = V4L2_BUF_TYPE_VIDEO_CAPTURE;
    buf.memory    = V4L2_MEMORY_MMAP;
    buf.index     = n_buffers;

    if (-1 == xioctl(fd, VIDIOC_QUERYBUF, &buf))
        errno_exit("VIDIOC_QUERYBUF");

    buffers[n_buffers].length = buf.length;
    buffers[n_buffers].start =
        mmap(NULL /* start anywhere */,
            buf.length,
            PROT_READ | PROT_WRITE /* required */,
            MAP_SHARED /* recommended */,
            fd, buf.m.offset);

    if (MAP_FAILED == buffers[n_buffers].start)
        errno_exit("mmap");
}
}

static void init_userp(unsigned int buffer_size)
{
    struct v4l2_requestbuffers req;

    CLEAR(req);

    req.count = 4;
    req.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
    req.memory = V4L2_MEMORY_USERPTR;

    if (-1 == xioctl(fd, VIDIOC_REQBUFS, &req)) {
        if (EINVAL == errno) {
            fprintf(stderr, "%s does not support "
                "user pointer i/on", dev_name);
            exit(EXIT_FAILURE);
        } else {
            errno_exit("VIDIOC_REQBUFS");
        }
    }

    buffers = calloc(4, sizeof(*buffers));

    if (!buffers) {
        fprintf(stderr, "Out of memory\n");
        exit(EXIT_FAILURE);
    }
}

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    for (n_buffers = 0; n_buffers < 4; ++n_buffers) {
        buffers[n_buffers].length = buffer_size;
        buffers[n_buffers].start = malloc(buffer_size);

        if (!buffers[n_buffers].start) {
            fprintf(stderr, "Out of memory\n");
            exit(EXIT_FAILURE);
        }
    }
}

static void init_device(void)
{
    struct v4l2_capability cap;
    struct v4l2_cropcap cropcap;
    struct v4l2_crop crop;
    struct v4l2_format fmt;
    unsigned int min;

    if (-1 == xiocctl(fd, VIDIOC_QUERYCAP, &cap)) {
        if (EINVAL == errno) {
            fprintf(stderr, "%s is no V4L2 device\n",
                    dev_name);
            exit(EXIT_FAILURE);
        } else {
            errno_exit("VIDIOC_QUERYCAP");
        }
    }

    if (!(cap.capabilities & V4L2_CAP_VIDEO_CAPTURE)) {
        fprintf(stderr, "%s is no video capture device\n",
                dev_name);
        exit(EXIT_FAILURE);
    }

    switch (io) {
    case IO_METHOD_READ:
        if (!(cap.capabilities & V4L2_CAP_READWRITE)) {
            fprintf(stderr, "%s does not support read i/o\n",
                    dev_name);
            exit(EXIT_FAILURE);
        }
        break;

    case IO_METHOD_MMAP:
    case IO_METHOD_USERPTR:
        if (!(cap.capabilities & V4L2_CAP_STREAMING)) {
            fprintf(stderr, "%s does not support streaming i/o\n",
                    dev_name);
            exit(EXIT_FAILURE);
        }
        break;
    }

    /* Select video input, video standard and tune here. */

    CLEAR(cropcap);

    cropcap.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;

    if (0 == xiocctl(fd, VIDIOC_CROPCAP, &cropcap)) {
        crop.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
        crop.c = cropcap.defrect; /* reset to default */

        if (-1 == xiocctl(fd, VIDIOC_S_CROP, &crop)) {
            switch (errno) {
            case EINVAL:
                /* Cropping not supported. */
                break;
            default:
                /* Errors ignored. */
                break;
            }
        }
    } else {
        /* Errors ignored. */
    }
}

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CLEAR(fmt);

fmt.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
if (force_format) {
    fmt.fmt.pix.width      = 640;
    fmt.fmt.pix.height     = 480;
    fmt.fmt.pix.pixelformat = V4L2_PIX_FMT_YUYV;
    fmt.fmt.pix.field      = V4L2_FIELD_INTERLACED;

    if (-1 == xioctl(fd, VIDIOC_S_FMT, &fmt))
        errno_exit("VIDIOC_S_FMT");

    /* Note VIDIOC_S_FMT may change width and height. */
} else {
    /* Preserve original settings as set by v4l2-ctl for example */
    if (-1 == xioctl(fd, VIDIOC_G_FMT, &fmt))
        errno_exit("VIDIOC_G_FMT");
}

/* Buggy driver paranoia. */
min = fmt.fmt.pix.width * 2;
if (fmt.fmt.pix.bytesperline < min)
    fmt.fmt.pix.bytesperline = min;
min = fmt.fmt.pix.bytesperline * fmt.fmt.pix.height;
if (fmt.fmt.pix.sizeimage < min)
    fmt.fmt.pix.sizeimage = min;

switch (io) {
case IO_METHOD_READ:
    init_read(fmt.fmt.pix.sizeimage);
    break;

case IO_METHOD_MMAP:
    init_mmap();
    break;

case IO_METHOD_USERPTR:
    init_userp(fmt.fmt.pix.sizeimage);
    break;
}
}

static void close_device(void)
{
    if (-1 == close(fd))
        errno_exit("close");

    fd = -1;
}

static void open_device(void)
{
    struct stat st;

    if (-1 == stat(dev_name, &st)) {
        fprintf(stderr, "Cannot identify '%s': %d, %s\n",
            dev_name, errno, strerror(errno));
        exit(EXIT_FAILURE);
    }

    if (!S_ISCHR(st.st_mode)) {
        fprintf(stderr, "%s is no devicen", dev_name);
        exit(EXIT_FAILURE);
    }

    fd = open(dev_name, O_RDWR /* required */ | O_NONBLOCK, 0);

    if (-1 == fd) {
        fprintf(stderr, "Cannot open '%s': %d, %s\n",
            dev_name, errno, strerror(errno));
        exit(EXIT_FAILURE);
    }
}

static void usage(FILE *fp, int argc, char **argv)
{
    fprintf(fp,
        "Usage: %s [options]\n\n"
        "Version 1.3\n"
        "Options:\n"
        "-d | --device name    Video device name [%s]\n\n"

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        "-h | --help          Print this message\n"
        "-m | --mmap          Use memory mapped buffers [default]\n"
        "-r | --read           Use read() calls\n"
        "-u | --userp          Use application allocated buffers\n"
        "-o | --output          Outputs stream to stdout\n"
        "-f | --format          Force format to 640x480 YUYV\n"
        "-c | --count          Number of frames to grab [%i]\n"
        "",
        argv[0], dev_name, frame_count);
}

static const char short_options[] = "d:hmrufc:";

static const struct option
long_options[] = {
    { "device", required_argument, NULL, 'd' },
    { "help",   no_argument,       NULL, 'h' },
    { "mmap",   no_argument,       NULL, 'm' },
    { "read",   no_argument,       NULL, 'r' },
    { "userp",  no_argument,       NULL, 'u' },
    { "output", no_argument,       NULL, 'o' },
    { "format", no_argument,       NULL, 'f' },
    { "count",  required_argument, NULL, 'c' },
    { 0, 0, 0, 0 }
};

int main(int argc, char **argv)
{
    dev_name = "/dev/video0";

    for (;;) {
        int idx;
        int c;

        c = getopt_long(argc, argv,
                        short_options, long_options, &idx);

        if (-1 == c)
            break;

        switch (c) {
            case 0: /* getopt_long() flag */
                break;

            case 'd':
                dev_name = optarg;
                break;

            case 'h':
                usage(stdout, argc, argv);
                exit(EXIT_SUCCESS);

            case 'm':
                io = IO_METHOD_MMAP;
                break;

            case 'r':
                io = IO_METHOD_READ;
                break;

            case 'u':
                io = IO_METHOD_USERPTR;
                break;

            case 'o':
                out_buf++;
                break;

            case 'f':
                force_format++;
                break;

            case 'c':
                errno = 0;
                frame_count = strtol(optarg, NULL, 0);
                if (errno)
                    errno_exit(optarg);
                break;

            default:
                usage(stderr, argc, argv);

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        exit(EXIT_FAILURE);
    }

    open_device();
    init_device();
    start_capturing();
    mainloop();
    stop_capturing();
    uninit_device();
    close_device();
    fprintf(stderr, "\n");
    return 0;
}
```