TX1 작업환경 조성(Autonomous car)

manual

ISL

안재원

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- LiDAR

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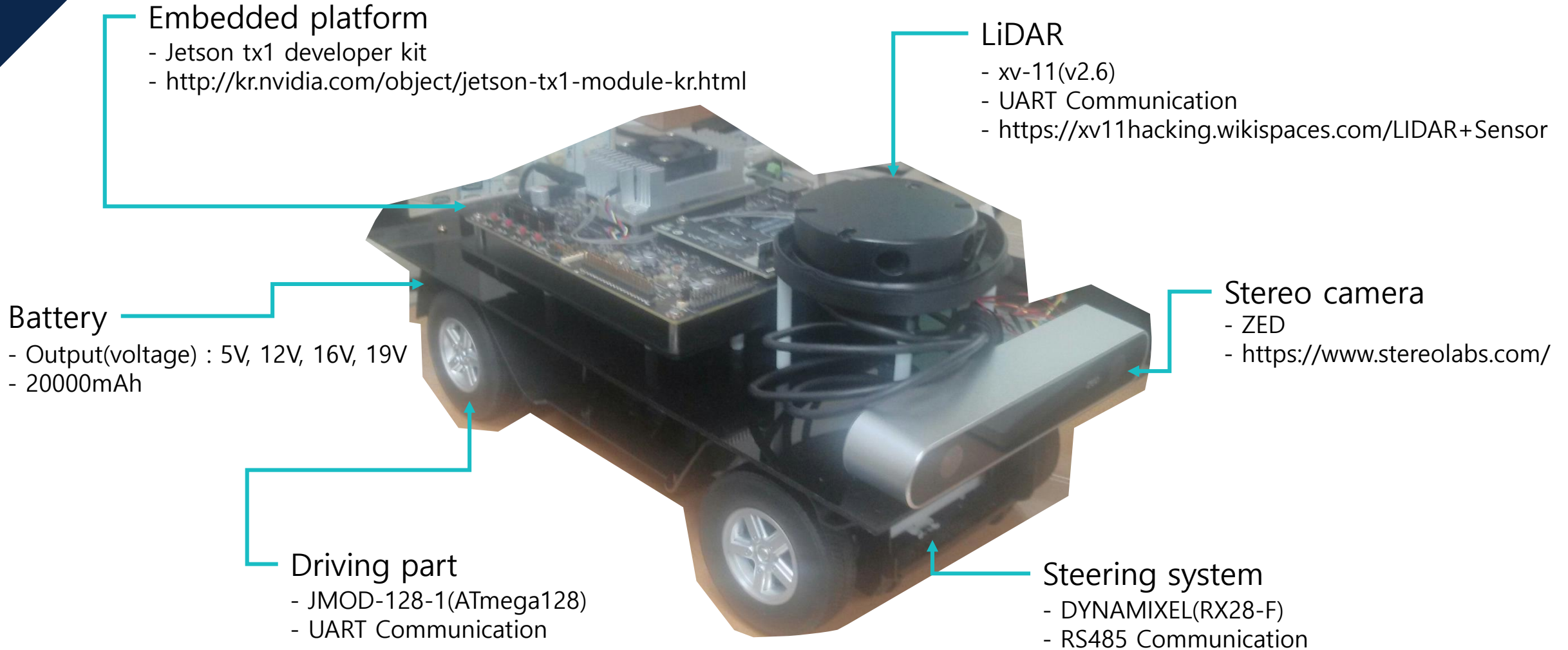ISL Image System Laboratory

Intro

Embedded platform

02

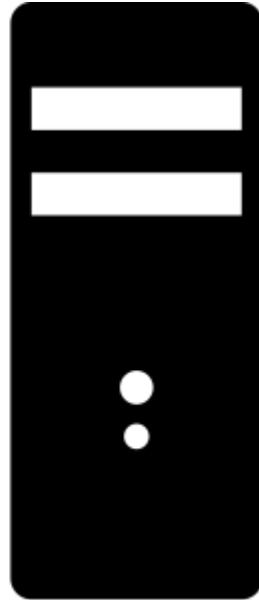*-Install JetPack for L4T (Force recovery)*
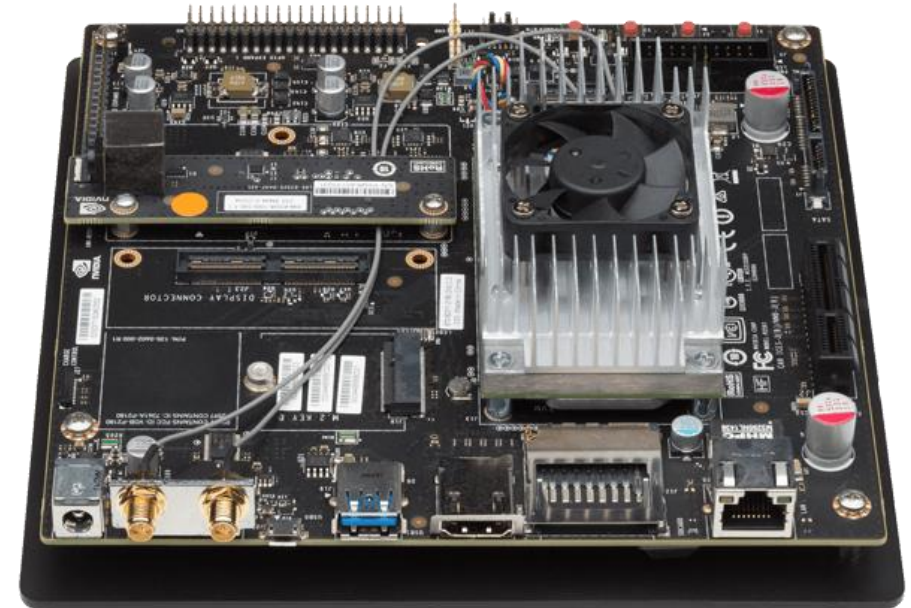
HOST

TX1

- Ubuntu Linux 64x(v14.04)
- Disk space requirements : 10GB
- Language : English
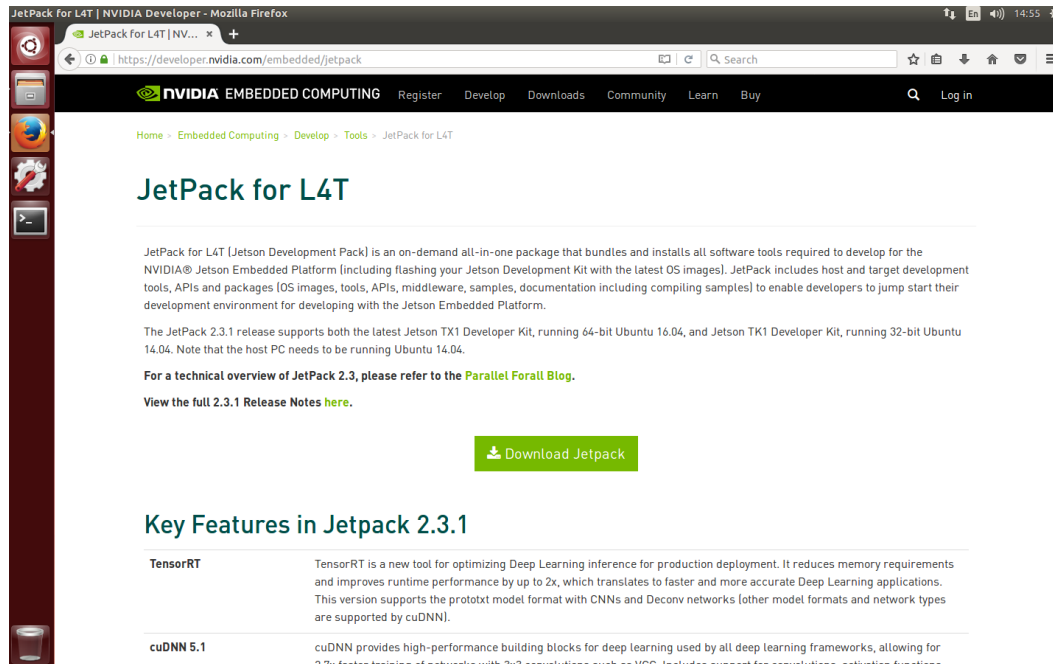- ETC : USB port and Router

- Jetson tx1 developer kit
- http://kr.nvidia.com/object/jetson-tx1-module-kr.html

Image System Laboratory

Embedded platform

02

-Install JetPack for L4T (Force recovery)

Download JetPack x.x

- https://developer.nvidia.com/embedded/jetpack

- Latest version : JetPack 3.0(2017.03.14)
- Include library
    openCV(2.4.13), CUDA(8.0), cuDNN(5.1),
    TensorRT(1.0), etc

Install JetPack

- JetPack 2.3.1

$ cd /home/<user name>/Downloads
$ sudo ./JetPack-L4T-<JetPack version>-linux-x64.run

Embedded platform

02

-Install JetPack for L4T (Force recovery)

Step 1.

- 특별한 선택사항이 없으므로 `Next >` 버튼 클릭
- Jetson TX1 Development Kit(64-bit) and Ubuntu Host 선택(Select Development Environment 페이지)

Embedded platform

-Install JetPack for L4T (Force recovery)

※ 참고 영상 : https://youtu.be/DyhRMjaUknQ

Step 2.

- 설치 항목 확인 후 [Next] 버튼 클릭하여 설치
- 전반적이 설치 과정
    1. HOST PC에 선행 설치 라이브러리를 설치
    2. 선행 설치 라이브러리와 OS를 TX1에 설치
    3. 추가 라이브러리 설치

※ 참고 자료 : http://docs.nvidia.com/jetpack-l4t/index.html#developertools/mobile/jetpack/l4t/3.0/jetpack_l4t_install.htm

Embedded platform

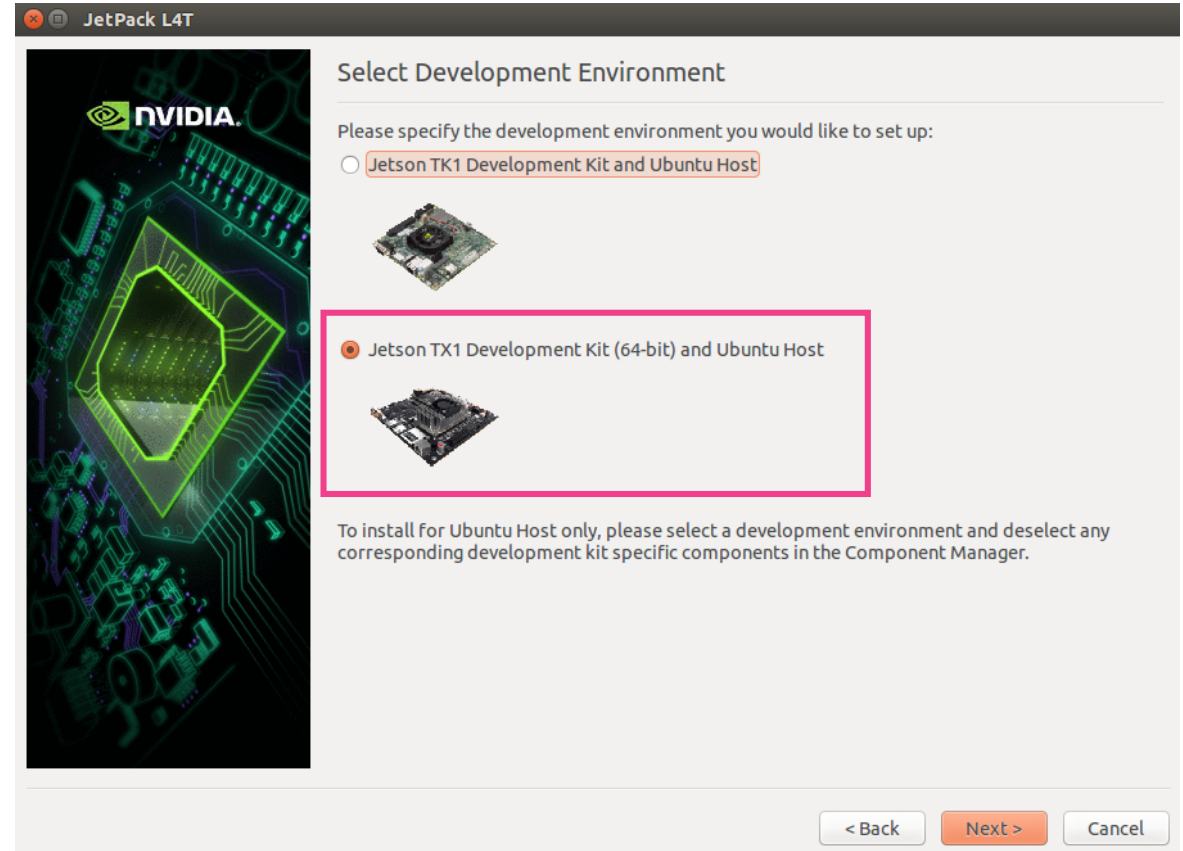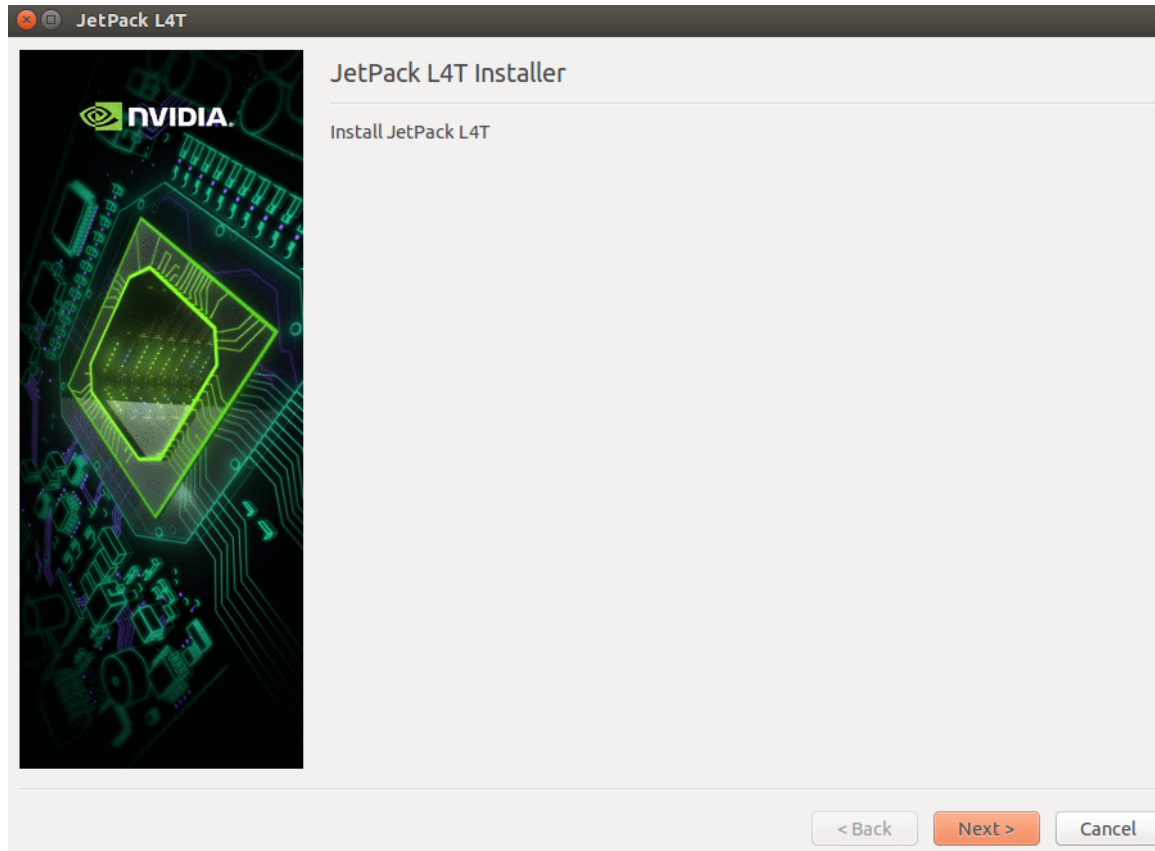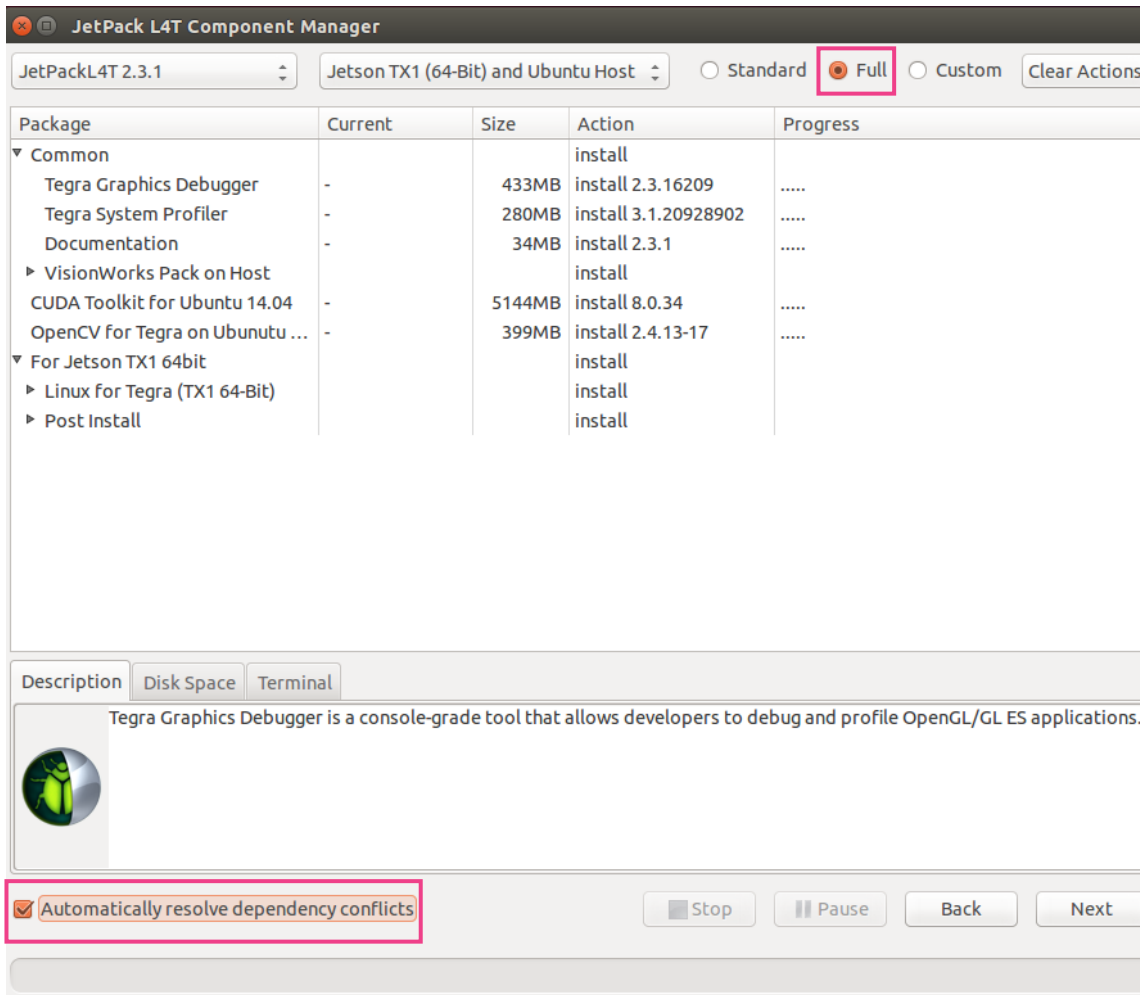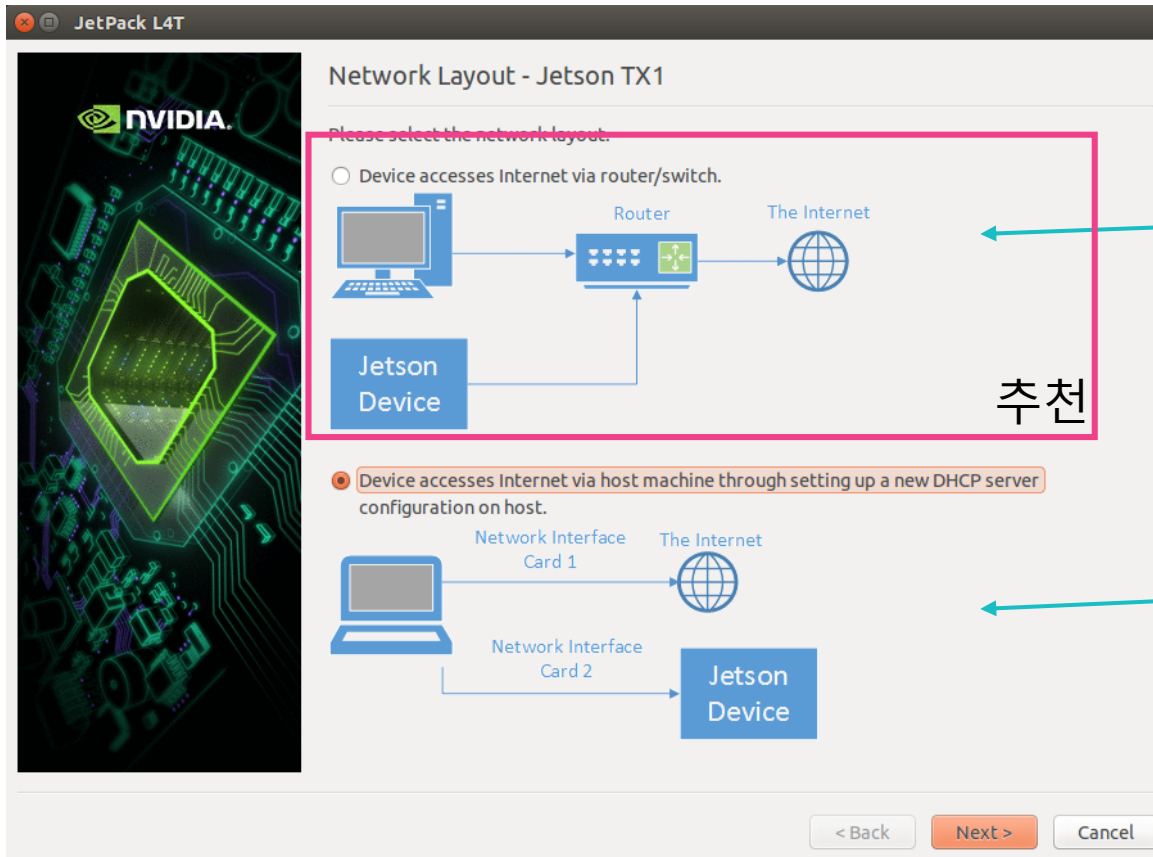*-Install JetPack for L4T (Force recovery)*

Step 3.

- 추가라이브러리 설치 시 추가 라이브러리 다운로드 방법 선택.

- Router를 이용해 Host PC와 Jetson Device를 연결할 경우

- Router를 거치지 않고, Host PC와 Jetson Device를 연결할 경우

Embedded platform

-Install JetPack for L4T (Force recovery)

Step 4.

```
Post Installation
Please put your device to Force USB Recovery Mode, when your are ready, press En
ter key
To place system in Force USB Recovery Mode:
1. Power down the device. If connected, remove the AC adapter from the device. T
he device MUST be powered OFF, not in a suspend or sleep state.
2. Connect the Micro-B plug on the USB cable to the Recovery (USB Micro-B) Port
on the device and the other end to an available USB port on the host PC.
3. Connect the power adapter to the device.
4. Press and release the POWER button to power on device. Press and hold the FOR
CE RECOVERY button: while pressing the FORCE RECOVERY button, press and release
the RESET button; wait two seconds and release the FORCE RECOVERY button.;
5. When device is in recovery mode, lsusb command on host will list a line of "N
Vidia Corp"
```

- 전반적이 설치 과정
    1. HOST PC에 선행 설치 라이브러리를 설치
    2. 선행 설치 라이브러리와 OS를 TX1에 설치
    3. 추가 라이브러리 설치

1. TX1을 종료 한다.
2. Host pc와 TX1의 USB Port(micro B)를 연결한다.
3. TX1을 켠다.
4. Force recovery 버튼을 누르고, reset 버튼을 눌렀다가 땐 후에 2초 뒤에 Force recover버튼을 땐다.
5. Host pc상에서 Enter버튼을 누른다.
6. 설치가 완료 되면 TX1의 reset버튼을 누른다.

USB port
(micro B)

USB

Embedded platform

02

-Install JetPack for L4T (de-selected Flash OS)

HOST

TX1

- Ubuntu Linux 64x(v14.04)
- Disk space requirements : 10GB
- Language : English
- ETC : Router
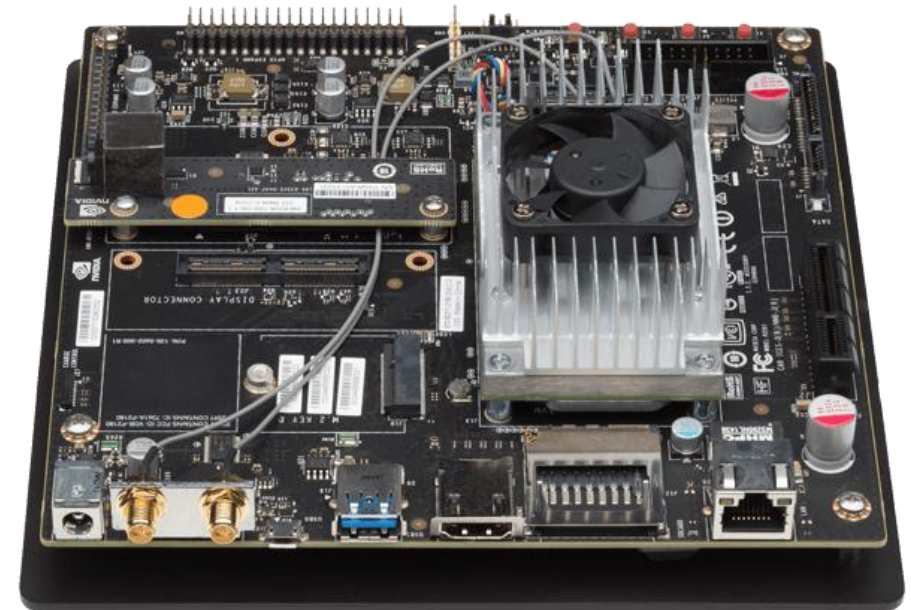
- Jetson tx1 developer kit
- http://kr.nvidia.com/object/jetson-tx1-module-kr.html

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Embedded platform

-Install JetPack for L4T (de-selected Flash OS)

Download JetPack x.x
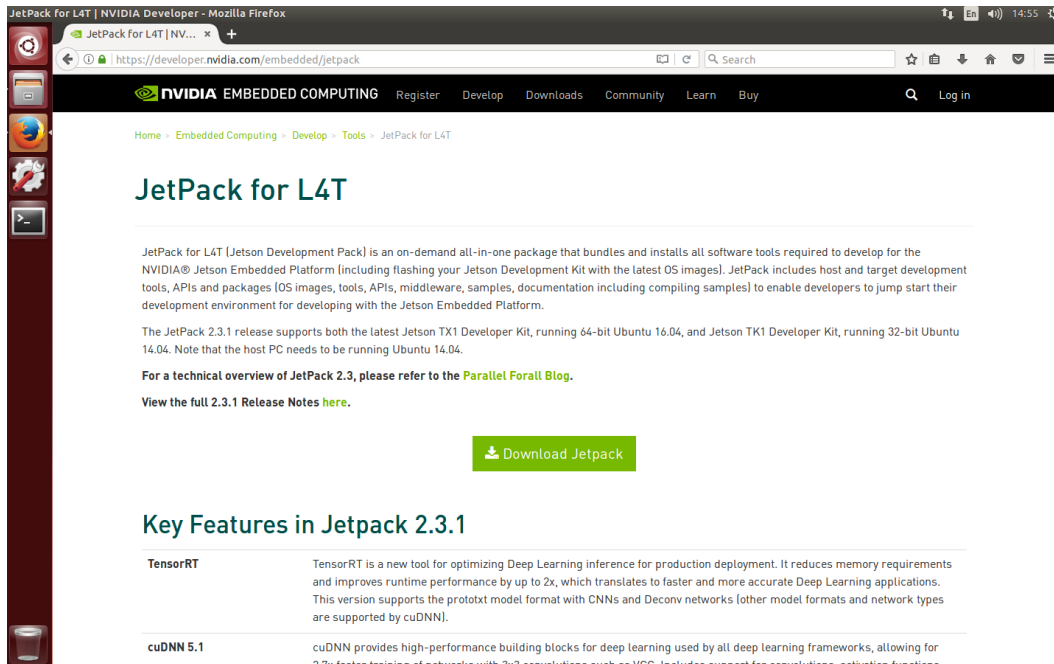
- https://developer.nvidia.com/embedded/jetpack

- Latest version : JetPack 3.0(2017.03.14)
- Include library
    openCV(2.4.13), CUDA(8.0), cuDNN(5.1),
    TensorRT(1.0), etc

Install JetPack

- JetPack 3.0

$ cd /home/<user name>/Downloads
$ sudo ./JetPack-L4T-<JetPack version>-linux-x64.run

Embedded platform

02

-Install JetPack for L4T (Force recovery)

Step 1.

- 선행 과정은 Force recovery와 같은 방식으로 진행한다.

- Target-Jetson TX1의 하위 항목에서 필요한 tool을 선택한다.
- [Next] 버튼을 클릭해 다음 과정으로 넘어간다.

Embedded platform

02

-Install JetPack for L4T (Force recovery)

Step 2.
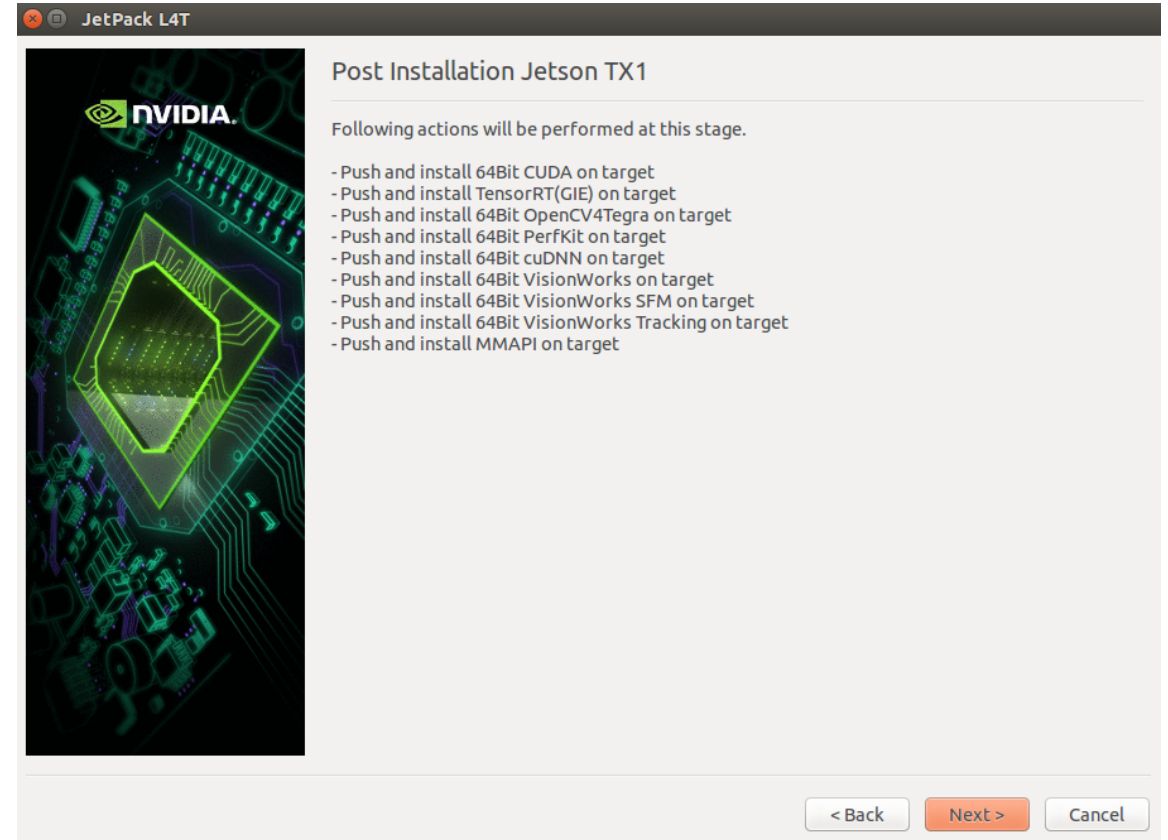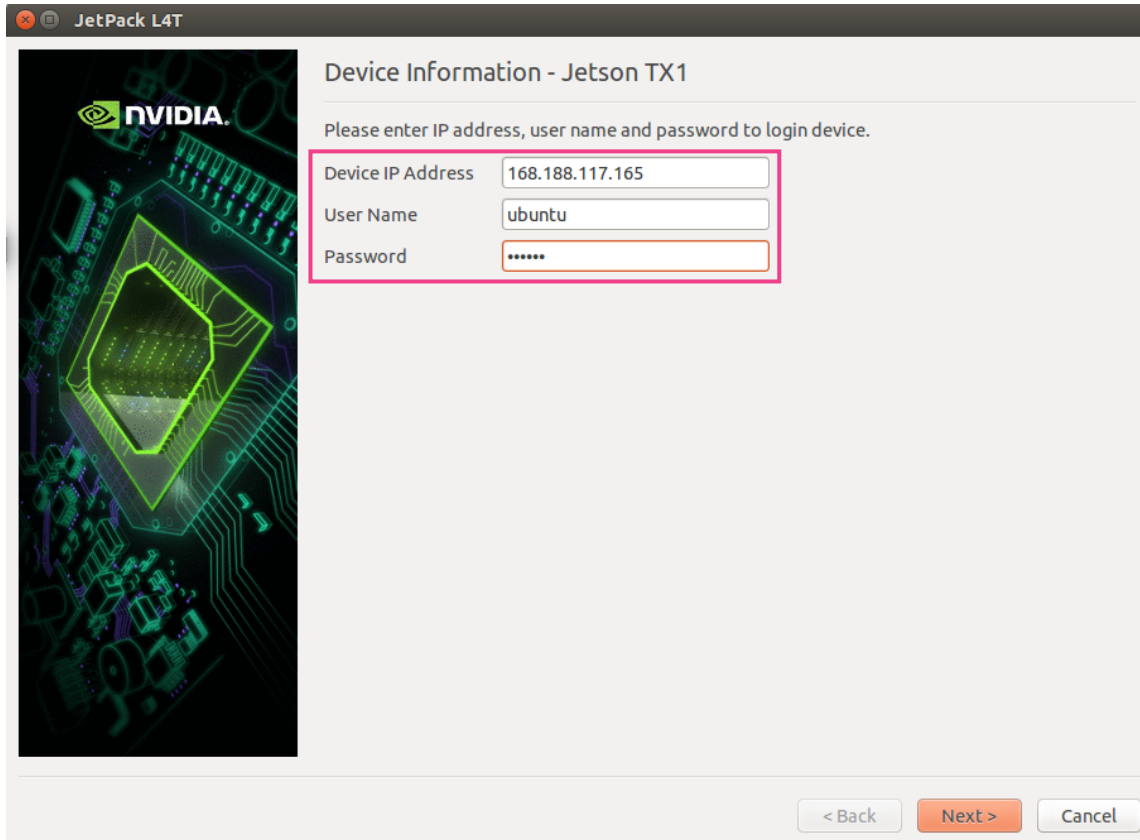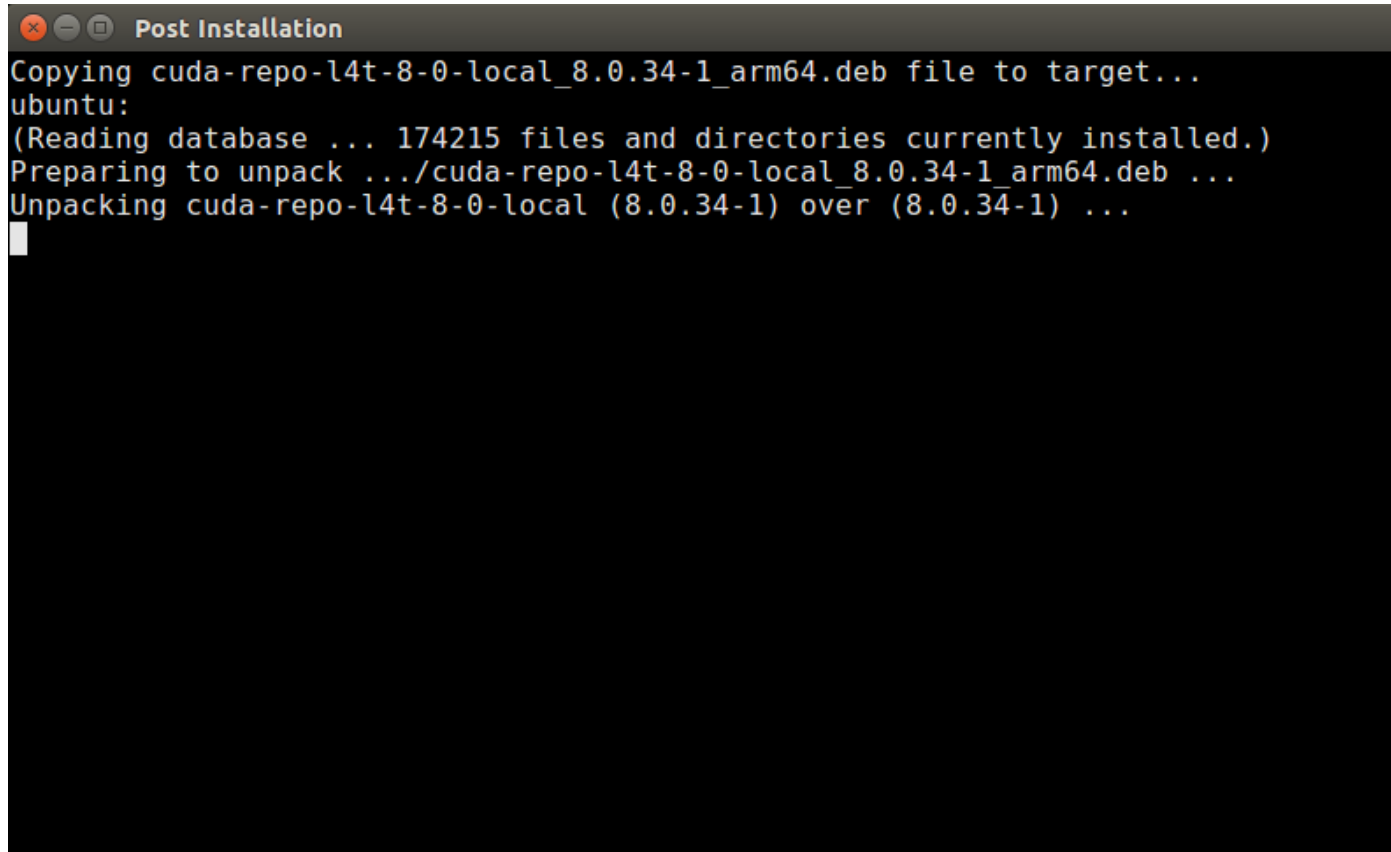
- Router를 이용해 TX1보드에 접속하여 선택한 항목 설치

Embedded platform

-Install JetPack for L4T (Force recovery)

Step 3.


```
Post Installation
Copying cuda-repo-l4t-8-0-local_8.0.34-1_arm64.deb file to target...
ubuntu:
(Reading database ... 174215 files and directories currently installed.)
Preparing to unpack .../cuda-repo-l4t-8-0-local_8.0.34-1_arm64.deb ...
Unpacking cuda-repo-l4t-8-0-local (8.0.34-1) over (8.0.34-1) ...
```

- 설치를 기다린다.

LiDAR

03

-XV-11 LiDAR

XV-11 LiDAR

- vacuum(진공청소기)
- XV-11, XV-21의 모델에 달려 있는 LiDAR.
- 측정 범위 : 15cm ~ 6m
- Firmware version : v2.6

- 1 channel
- 360° (1 per degree)
- UART Communication
- Pin out 1
    RED = +5V
    BROWN = RX
    ORANGE = TX
    BLACK = GND
- Pin out 2(motor)
    RED = PWR
    BLACK = GND

LiDAR
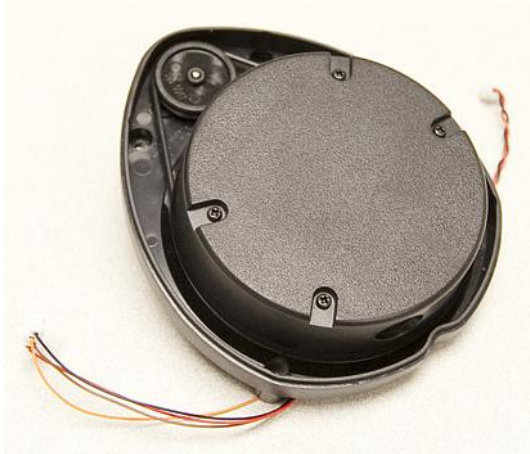
03

-XV-11 LiDAR

XV-11 LiDAR

- 1 channel
- 360° (1 per degree)
- UART Communication
- Pin out 1
    RED = +5V
    BROWN = RX
    ORANGE = TX
    BLACK = GND
- Pin out 2(motor)
    RED = PWR
    BLACK = GND

- 일정 (300rpm) 이상으로 회전할 때 계측 정보 출력.

- 8N1
- 3.3V의 신호를 출력
- Baud rate : 115200
- 1 packet size : 22 bytes
- Full data : 90 packets

- Packet information

Start 1 byte	Index 1 byte	Speed(L,H) 2 bytes	DATA[0:3] 16 bytes	Check sum(L,H) 2 Bytes

- 모터 드라이버를 이용한 제어를 추천
- 3.3v 입력으로 연속 회전(in Open loop control)

LiDAR

03

-XV-11 LiDAR

Packet information

0°
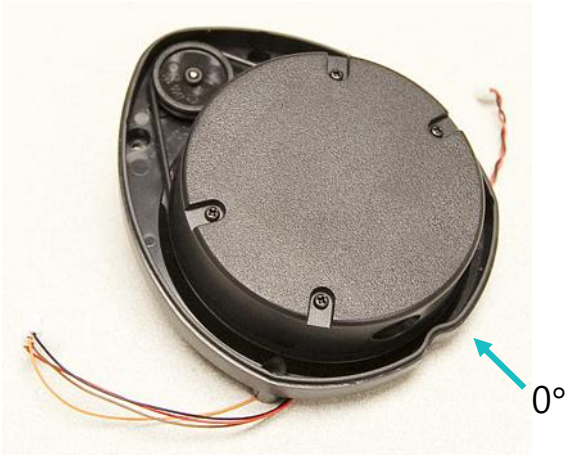
Packet[0]

Start 1 byte	Index 1 byte	Speed(L,H) 2 bytes	DATA[0:3] 16 bytes	Check sum(L,H) 2 Bytes

- Start : 0xFA
- Index : 0xA0(0°)~0xF9(360°)
- Speed : RPM.

- DATA[0:3] :
  - Byte 0 : <distance 7:0>
  - Byte 1 : <invalid data flag><strength warning flag><distance 13:8>
  - Byte 2 : <signal strength 7:0>
  - Byte 3 : <signal strength 15:8>

<특이사항>
1. 0xA0이 -10°일지도 모른다는 의견이 있음.
2. Distance의 단위는 mm

- Check sum

```
Data[10] = {0,}    →    Data[i] = Packet[2×i] + Packet[2×i+1]<<8    →    i < 10?    y (loop back)
i = 0                   i = i + 1                                         n →    CHK = 0
                                                                                  i = 0

CHK = (CHK<<1) + Data[i]    →    i < 10?    y (loop back)
i = i +1                         n →    Temp = (CHK & 0x7FFF) + (CHK >>15)    →    Check sum = temp & 0x7FFF
```

※ 참고 자료 : https://xv11hacking.wikispaces.com/LIDAR+Sensor

Driving part

04
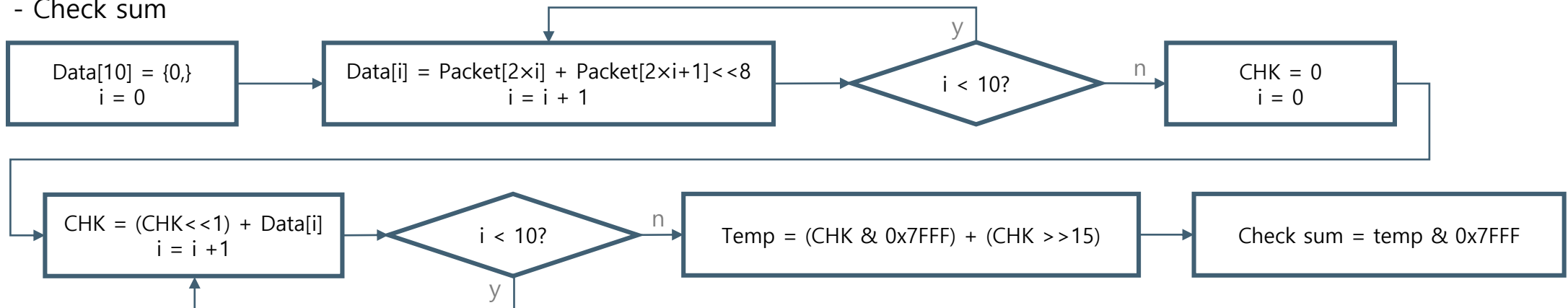
-JMOD-128-1(ATmega128)
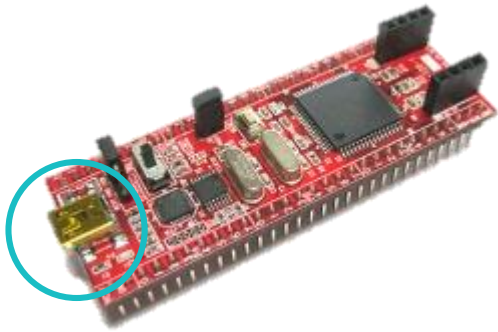
UART Communication

※ 속도 및 방향 정보 전달.

※ PWM

TX1

- JMOD-128-1(ATmega128)
- UART Communication(추가 부품 필요 없이 가능)
- TX1으로부터 받은 값을 이용해 PWM 생성하여 모터 동작.

- 단점 : 최신 버전의 컴파일러를 이용해 프로그램 업로드가 불가능.
    (tx1에서 프로그램 업로드가 불가능하여 pc에서 코딩 후 업로드 해야 함.)

Driving part

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Steering system

05

-DYNAMIXEL RX-28F

Reduction Gear + Controller + Driver + Network = Dynamixel
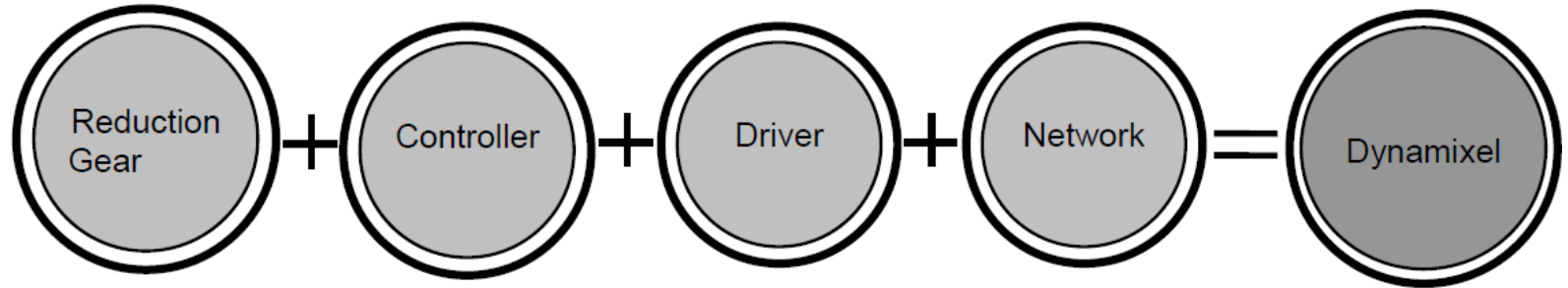
- DYNAMIXEL(RX28-F)
- RS485 Communication
- Packet information

T :

Header 1 byte	Header 1 byte	ID 1 byte	Length 1 byte	Instruction 1 byte	Parameter[n] n byte	Check sum 1 byte

R :

Header 1 byte	Header 1 byte	ID 1 byte	Length 1 byte	Error 1 byte	Parameter[n] n byte	Check sum 1 byte

- Voltage : 12V~16V
- Sensing
        Position, Temperature, Load, Input Voltage, etc..
- Running Degree : 300 °

- Pin in & out
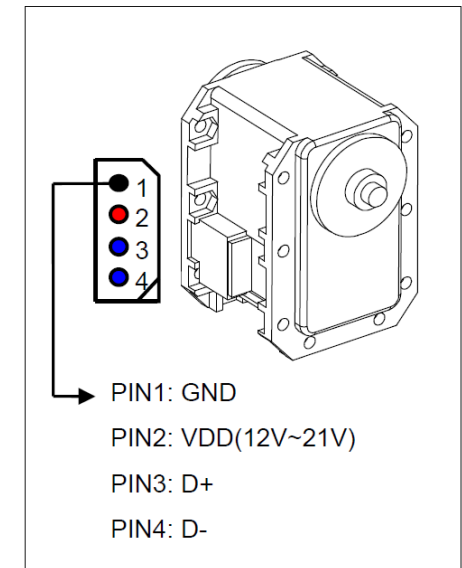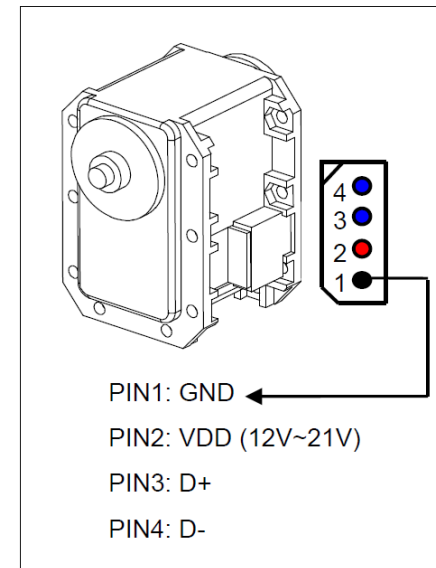
PIN1: GND
PIN2: VDD (12V~21V)
PIN3: D+
PIN4: D-

PIN1: GND
PIN2: VDD(12V~21V)
PIN3: D+
PIN4: D-

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※ 참고 자료 : https://www.robotis.com

Steering system

05

-DYNAMIXEL RX-28F

Packet information(Instruction Packet)

Header 1 byte	Header 1 byte	ID 1 byte	Length 1 byte	Instruction 1 byte	Parameter[n] n byte	Check sum 1 byte

- Header: 0xFF
- ID : Device ID(0x00~0xFD), Broadcasting ID(0xFE)
- Length : "The number of Parameters" + 2
- Instruction :
  - 0x02 : READ DATA
  - 0x03 : WRITE DATA
  - 0x04 : REG WRITE
  - 0x05 : ACTION

- Parameter : EEPROM or RAM Address & value

※ Example 1. : RX-28F의 설정된 Goal Position부터 Torque의 값을 알고 싶을 때
  Parameter[0] = 0x1E (GOAL Position(L)의 RAM Address)
  Parameter[1] = 0x06 (읽을 데이터의 길이)

※ Example 2. : RX-28F을 <SPEED>의 속도로 <GOAL>위치로 이동시킬 경우
  Parameter[0] = 0x1E (변경을 시작할 RAM Address, GOAL Position(L))
  Parameter[1] = (<GOAL> & 0x00FF)   (변경할 값 1 : GOAL Position(L))
  Parameter[2] = (<GOAL> & 0xFF00)>>8 (변경할 값 2 : GOAL Position(H))
  Parameter[3] = (<SPEED> & 0x00FF)   (변경할 값 3 : Moving Speed(L))
  Parameter[3] = (<SPEED> & 0xFF00)>>8 (변경할 값 4 : Moving Speed(H))

25 (0X19)	LED	LED On/Off
26 (0X1A)	CW Compliance Margin	CW Compliance margin
27 (0X1B)	CCW Compliance Margin	CCW Compliance margin
28 (0X1C)	CW Compliance Slope	CW Compliance slope
29 (0X1D)	CCW Compliance Slope	CCW Comliance slope
30 (0X1E)	Goal Position(L)	Lowest byte of Goal Position
31 (0X1F)	Goal Position(H)	Highest byte of Goal Position
32 (0X20)	Moving Speed(L)	Lowest byte of Moving Speed
33 (0X21)	Moving Speed(H)	Highest byte of Moving Speed
34 (0X22)	Torque Limit(L)	Lowest byte of Torque Limit
35 (0X23)	Torque Limit(H)	Highest byte of Torque Limit

※ 참고 자료 : https://www.robotis.com

Steering system

05

-DYNAMIXEL RX-28F

Packet information(Instruction Packet)

Header 1 byte	Header 1 byte	ID 1 byte	Length 1 byte	Instruction 1 byte	Parameter[n] n byte	Check sum 1 byte

- Check sum

Check sum = ~((ID + Length + Instruction + Parameter[0] + ⋯ + Parameter[N]) & 0xFF)

Packet information(Return Packet)

Header 1 byte	Header 1 byte	ID 1 byte	Length 1 byte	Error 1 byte	Parameter[n] n byte	Check sum 1 byte

- Error : error information
- Parameter : 요청한 정보.

Bit	Name	Contents
Bit 7	0	-
Bit 6	Instruction Error	In case of sending an undefined instruction or delivering the action command without the reg_write command, it is set as 1.
Bit 5	Overload Error	When the curren load cannot be controlled by the set Torque, it is set as 1.
Bit 4	Checksum Error	When the Checksum of the transmitted Instruction Packet is incorrect, it is set as 1.
Bit 3	Range Error	When a command is out of the range for use, it is set as 1
Bit 2	Overheating Error	When internal temperature of Dynamixel is out of the range of operating temperature set in the Control table, it is set as 1.
Bit 1	Angle Limit Error	When Goal Position is written out of the range from CW Angle Limit to CCW Angle Limit , it is set as 1.
Bit 0	Input Voltage Error	When the applied voltage is out of the range of operating voltage set in the Control table, it is as 1.

※ 참고 자료 : https://www.robotis.com

Stereo camera

06

-ZED

ZED

- Video

Video Mode	Frames per second	Output Resolution (side by side)
2.2K	15	4416x1242
1080p	30	3840x1080
720p	60	2560x720
WVGA	100	1344x376

- Depth Perception indoors and outdoors at up to 20m
- 6-DOF Positional Tracking
- Depth Range : 0.7m ~ 20m
- Connector : USB 3.0
- SDK system requirements
    Dual-core 2.3GHz or faster processor
    4GB RAM or more
    Nvidia GPU with compute capability >2.0

<특이사항>
1. Host PC의 Resource를 사용하기 때문에 일정 스펙 이상의 PC가 필요함.
2. tx1 보드를 위한 SDK 및 드라이버 설치 파일을 제공해줌.

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※ 참고 자료 : https://www.stereolabs.com/

Communication setting

-CP210x USB to UART Bridge

TX1

UART
Communication

Driving part

XV-11 LiDAR

- $ lsusb

```
ubuntu@tegra-ubuntu:/etc$ lsusb
Bus 002 Device 002: ID 0955:09ff NVidia Corp.
Bus 002 Device 001: ID 1d6b:0003 Linux Foundation 3.0 root hub
Bus 001 Device 003: ID 10c4:ea60 Cygnal Integrated Products, Inc. CP210x UART Bridge / myAVR mySmartUSB light
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
```

- $ ls /dev/ttyUSB*

```
ubuntu@tegra-ubuntu:/etc$ ls /dev/ttyUSB*
ls: cannot access '/dev/ttyUSB*': No such file or directory
ubuntu@tegra-ubuntu:/etc$
```

Communication setting

07

-CP210x USB to UART Bridge

Download Driver(Download for Linux _ Linux 3.x.x)
※ http://www.silabs.com/products/development-tools/software/usb-to-uart-bridge-vcp-drivers

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Silicon Labs » Products » Development Tools » Software » USB to UART Bridge VCP Drivers

CP210x USB to UART Bridge VCP Drivers

The CP210x USB to UART Bridge Virtual COM Port (VCP) drivers are required for device operation as a Virtual COM Port to facilitate host communication with CP210x products. These devices can also interface to a host using the direct access driver. These drivers are static examples detailed in application note 197: The Serial Communications Guide for the CP210x, download an example below:

AN197: The Serial Communications Guide for the CP210x

Download Software

The CP210x Manufacturing DLL and Runtime DLL have been updated and must be used with v6.0 and later of the CP210x Windows VCP Driver. Application Note Software downloads affected are AN144SW.zip, AN205SW.zip and AN223SW.zip. If you are using a 5.x driver and need support you can download archived Application Note Software.

Legacy OS software and driver package download links and support information ›

Download for Linux

Platform	Software	Release Notes	
Linux 3.x.x	Download VCP (10.0 KB)	Download Linux 3.x.x VCP Revision History	
Linux 2.6.x	Download VCP (10.2 KB)	Download Linux 2.6.x VCP Revision History	

ozilla so that we can improve your experience.

- Linux 버전은 Silicon labs 계정이 필요함.
- TX1의 SD card에 다운로드 받아져 있음.

- 설치 방법은 Release Notes에 나온다.

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Communication setting

-CP210x USB to UART Bridge

Make driver file(*.ko file)

1. $ cd /home/<user name>/Downloads   -> 다운 받은 위치로 이동
2. $ unzip <Driver source file>.zip
3. $ cd <Driver source file>
4. $ make   -> driver file(*.ko) 생성
5. $ sudo cp cp210x.ko /lib/modules/<kernel version>/kernel/drivers/usb/serial   -> driver file(*.ko) 이동
6. $ cd /lib/modules/<kernel version>/kernel/drivers/usb/serial
7. $ sudo insmod cp210.ko   -> driver file 등록

- $ ls /dev/ttyUSB*

```
ubuntu@tegra-ubuntu:~$ ls /dev/ttyUSB*
/dev/ttyUSB0
ubuntu@tegra-ubuntu:~$ 
```

Communication setting

07

-CH341SER

TX1

RS485

Steering system

Download Driver(Linux version)

※ http://www.wch.cn/download/CH341SER_LINUX_ZIP.html

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Communication setting

07

-CH341SER

Make driver file(*.ko file)

1. $ cd /home/<user name>/Downloads   -> 다운 받은 위치로 이동
2. $ unzip <Driver source file>.zip
3. $ cd <Driver source file>
4. $ make   -> driver file(*.ko) 생성
5. $ make load -> driver file 등록
              -> Makefile에 driver 등록 과정이 작성되어 있음.

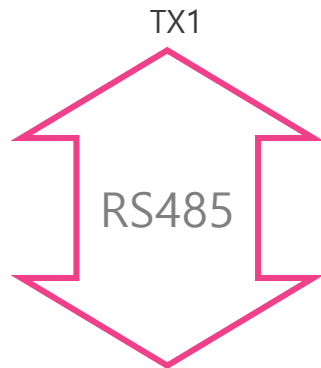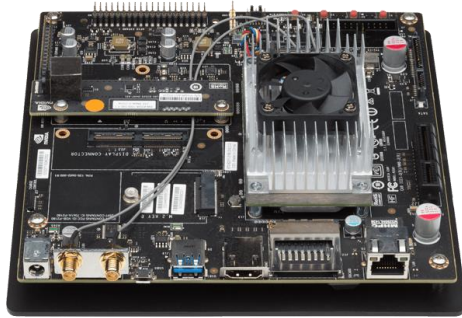- $ ls /dev/ttyUSB*

```
ubuntu@tegra-ubuntu:~$ ls /dev/ttyUSB*
/dev/ttyUSB0
ubuntu@tegra-ubuntu:~$ 
```

Communication setting

-*Driver 영구 등록*

　설명된 드라이버 등록과정(insmod만을 이용한 과정)을 통해 드라이버를 등록하면, 재부팅 또는 같은 드라이버를 사용하는 기기를 연결할 경우 인식하지 못하는 경우가 발생한다.
　재부팅 후 $ sudo insmod /lib/modules/<kernel version>/kernel/drivers/usb/serial/<ko파일명>을 통해 사용할 수 있지만, 인식을 못하는 경우가 발생할 수 있다.
　이를 해소하기 위해 다음 과정을 통해 드라이버를 영구 등록하는 과정이 필요로 하다.

1. $ cd /lib/modules/<kernel version>/kernel/drivers/usb/serial/
2. $ sudo depmod –a   -> /lib/modules/<kerner version>/kernel 하위 항목의 모든 드라이버 재 등록.

3. $ sudo insmod <ko 파일명>
4. $ sudo reboot

　　　　　　└──────▶ 3, 4번 입력은 필요 없을 수 도 있으나 확인 안됨.

Communication setting

-ttyUSB*과 통신하기 위한 기본 소스 코드

```cpp
bool CDCm::OpenPort(char * port,speed_t speed)
{
        /* Open File Descriptor */
        m_PORT= open(port, O_RDWR | O_NOCTTY);

        /* Error Handling */
        if (m_PORT< 0){
                std::cout << "Error " << errno << " opening " << port << ": " << strerror(errno) << std::endl;
                m_bPortState = false;
                return false;
        }

        /* *** Configure Port *** */
        memset(&m_tty, 0, sizeof m_tty);

        /* Error Handling */
        if (tcgetattr(m_PORT, &m_tty) != 0){
                std::cout << "Error " << errno << " from tcgetattr: " << strerror(errno) << std::endl;
                m_bPortState = false;
                return false;
        }

        /* Save old tty parameters */
        m_tty_old = m_tty;

        /* Set Baud Rate */
        cfsetospeed(&m_tty, (speed_t)speed);
        cfsetispeed(&m_tty, (speed_t)speed);
```

```cpp
        /* Setting other Port Stuff */
        m_tty.c_cflag &= ~PARENB;            // Make 8n1
        m_tty.c_cflag &= ~CSTOPB;
        m_tty.c_cflag &= ~CSIZE;
        m_tty.c_cflag |= CS8;

        m_tty.c_cflag &= ~CRTSCTS;           // no flow control
        m_tty.c_cc[VMIN] = 1;                // read doesn't block

        m_tty.c_cflag &= ~CRTSCTS;           // no flow control
        m_tty.c_cc[VMIN] = 1;                // read doesn't block
        m_tty.c_cc[VTIME] = 5;               // 0.5 seconds read timeout
        m_tty.c_cflag |= CREAD | CLOCAL;     // turn on READ & ignore ctrl lines
                                             /* Make raw */
        cfmakeraw(&m_tty);

        /* Flush Port, then applies attributes */
        tcflush(m_PORT, TCIFLUSH);
        if (tcsetattr(m_PORT, TCSANOW, &m_tty) != 0){
                std::cout << "Error " << errno << " from tcsetattr" << std::endl;
                m_bPortState = false;
                return false;
        }

        m_bPortState = true;
        return m_bPortState;
}
```

- Open 함수를 이용해 통신할 포트를 연다.
- Baud rate는 라이브러리에 지정된 속도만 가능하다. -> 확인할 필요가 있음.
- 통신 포트를 이용해 읽을 때는 read, 쓸 때는 write 함수를 이용한다.

Future work

08

- 센서 정보 획득 및 모터 동작은 가능한 상태 입니다.

- ROS를 사용해 동작시킬 계획이지만, 정해진 것은 없습니다.

- 기회가 된다면 바디 프레임을 업그레이드 하고 싶습니다.

- TX1보드가 ZED를 사용하기 얼마나 적합한 스펙인지 확인 할 필요가 있습니다.

Q & A