스마트시스템입문

2018년 1학기

Summary of previous lecture

- **Definition of "Smart systems"**
  - Smart systems are independent intelligent technical systems which collect information over sensors, make decisions based on this information, and act upon it accordingly.

- **Objective of the course**
  - This course introduces basic principles of smart systems and students learn how to design and implement smart systems for IoT services using Arduino as a platform.

What is *Smart Systems*?

- Smart systems are independent intelligent technical systems which collect information over sensors, make decisions based on this information, **and act upon it accordingly.**

- They can also be defined in different ways.

- We will focus on the smart systems based on IoT technology

  "Any device that is **connected** is smart. Any device that is not connected is dumb. In the future, everything's going to be smart."
  (*The Silent Intelligence*)

Smart Home

http://www.dt.co.kr/contents.html?article_no=2017101702109923811011

Smart home (home automation): the control and automation of lighting, heating, ventilation, air conditioning, and security (such as smart locks), as well as home appliances such as washer/dryers, ovens or refrigerators/freezers

사물 인터넷, Internet of Things (IoT)

- **IoT** is the **inter-networking of physical devices** or things embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data (Wikipedia).

- 인간과 사물, 서비스 세 가지 분산된 환경 요소에 대해 인간의 명시적 개입 없이 상호 협력적으로 센싱, 네트워킹, 정보 처리 등 지능적 관계를 형성하는 사물 공간 연결망 (민경식, NET Term, 한국인터넷진흥원)

http://www.datasitecolo.com/internet-of-things/high-density-power-requirements-can-data-center-support/

Examples of IoT technology

- Remote monitoring of industrial machinery

- Wearable electronics: emergency response, Alzheimer's

- Smart electric meters: thermostat

- RFID

- Connected cars: navigate traffic, insurance rate

- Small tracking devices for children, pets, cargos…

Has anyone used one of these examples?

D. Kellmereit and D. Obodovski, "The Silent Intelligence - The Internet of Things"

Examples of IoT technology

- **Real-life examples**

  Spend 10 min to find IoT products in the market.

  This can be the first article topic of the presentation.

  Which product would you want to buy?

Examples of IoT technology

- **Real-life examples**

Nest Learning Thermostat
Remote control
Thermostat learn from our preferences
Energy saving

- *It is cool but still expensive: ~ $250*
- *Do you still want to use it?*
- *What is the benefits of IoT?*
- *Are there any reasons that you don't want to use besides the price?*

Benefits and risks of the IoT

- **Benefits**
  - "Machine telepathy": utilize all the benefits of _digital & wireless_ communication in connecting the analog world around us (e.g., machines, people, environments, etc)
  - Fast speed, easy multiplication, easy integration
  - Eliminate guess work: data-driven service (e.g., insurance)
- **Risks**
  - Privacy
  - Cybersecurity
  - Liability

D. Kellmereit and D. Obodovski, "The Silent Intelligence - The Internet of Things"

Ethical issues
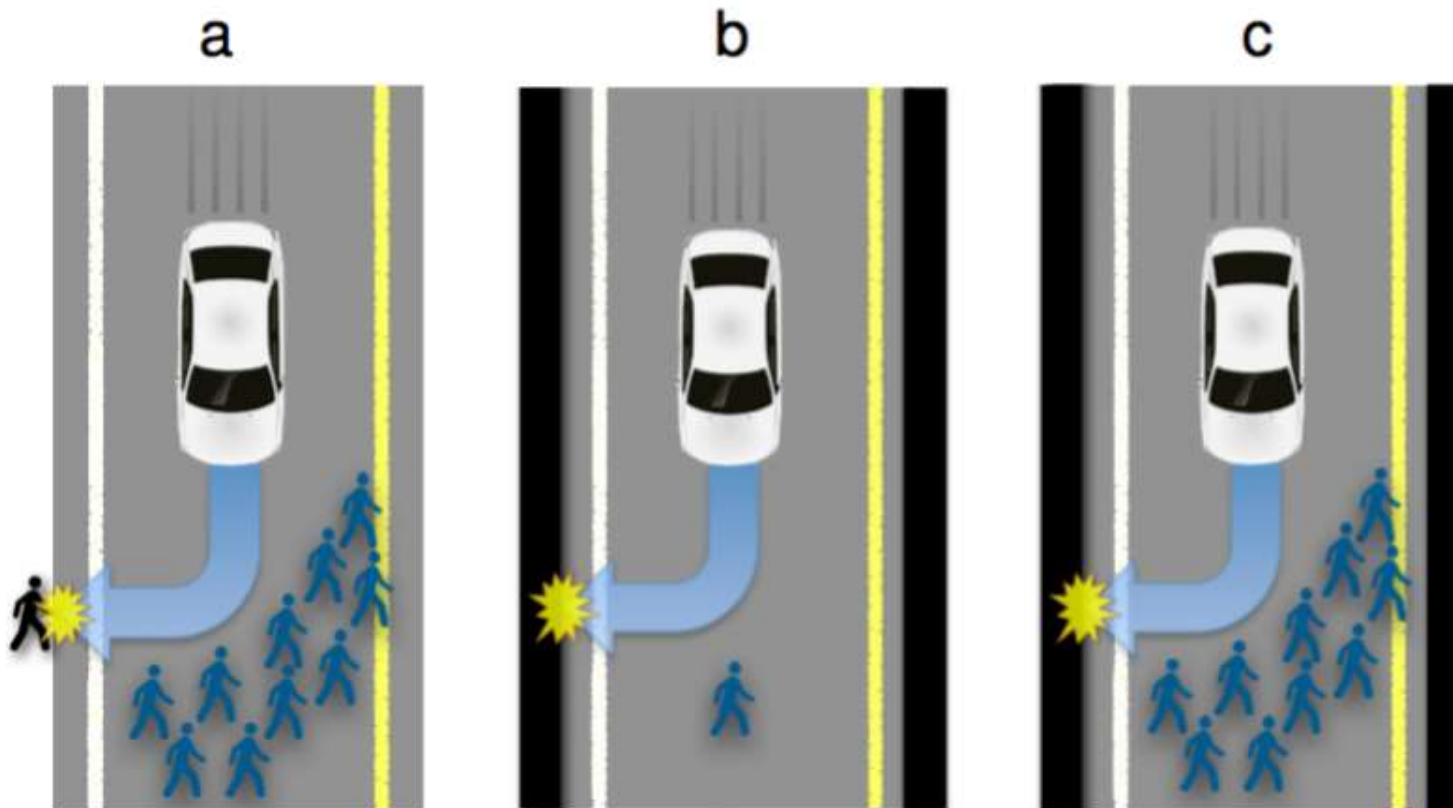
"Why Self-Driving Cars Must Be Programmed to Kill",
MIT Tech Review
https://www.technologyreview.com/s/542626/why-self-driving-cars-must-be-programmed-to-kill/

IoT is getting popular

The Internet Of Everything

Source: BI Intelligence Estimates

Business Insider
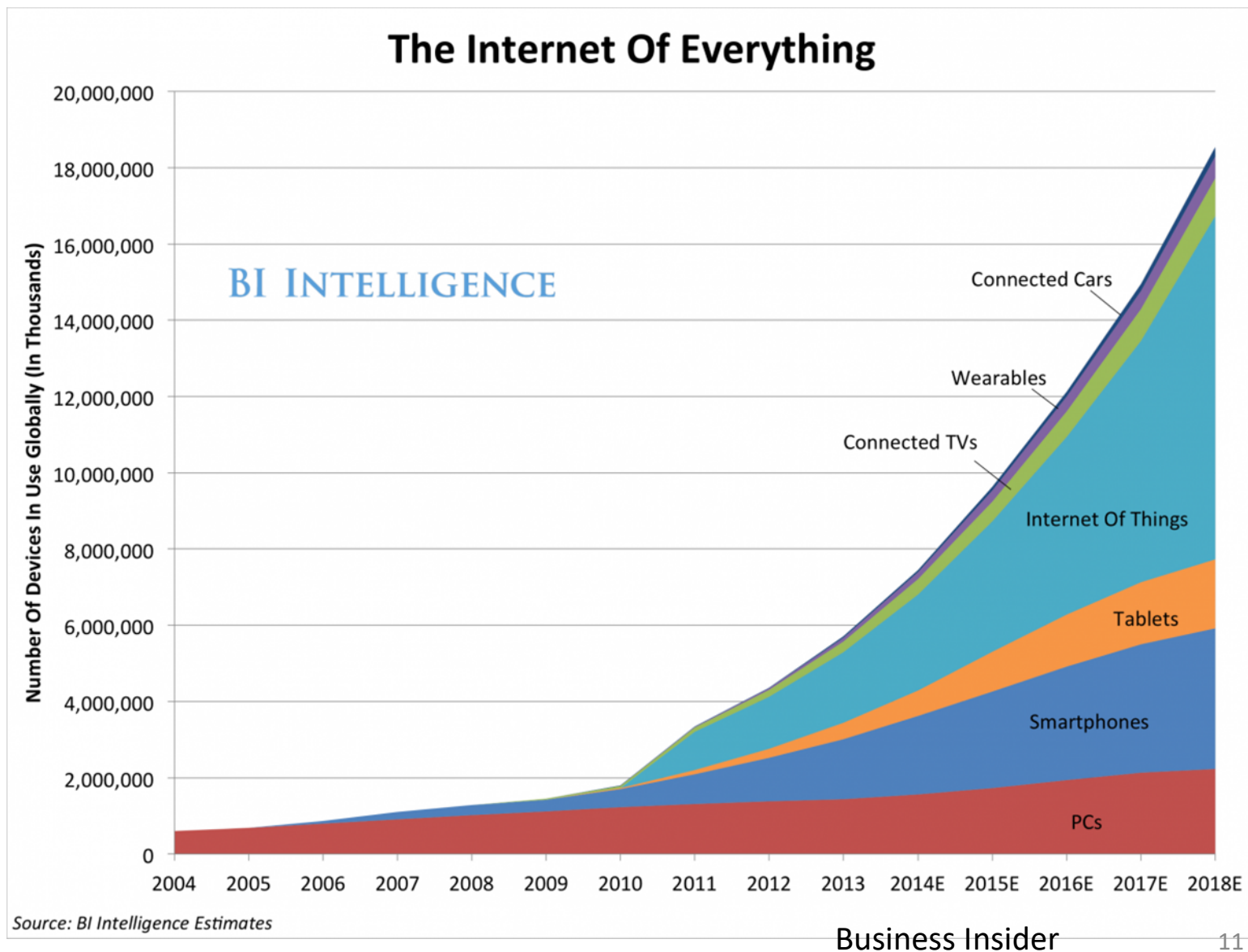
IoT is trending these days.
Would you be able to predict it?

It's hard to tell what's going to happen.

How did it happen?

http://uday.io/2015/10/15/predicting-the-future-and-exponential-growth/

Growth of the IoT technology

- **Rapid growth of the IoT was based on...**

  - The overall development of computing and telecommunication technology

  - **Killer apps**

    - Spreadsheet, word processor → PC

    - Voice communication → Phone

    - ??? → Wearables

  - **Critical mass of infrastructure**

    - Long-term investments

D. Kellmereit and D. Obodovski, "The Silent Intelligence - The Internet of Things" ₁₃

Driving force of the IoT

- **Miniaturization**

  - Smaller but more powerful (Moore's law)

  - <u>Power management</u>

- **Affordability**

  - Cost (Moore's law)

- **De-wireization**

  - Wireless power

  - <u>Power management</u>

D. Kellmereit and D. Obodovski, "The Silent Intelligence - The Internet of Things"

Driving force of the IoT

- **The first iPhone (2007)**

- iPod + Phone + Internet

- At that time, each technology was widely used in general population

- iPhone is now available for everyone since it is **small**, **not too expensive**, and **wireless**
- "Once the necessary prerequisites are in place, the technology adoption that follows happens extremely fast" (*The Silent Intelligence*)

Challenges in getting products to market

- Availability of networks and equipment, and cost
  - Price of cellular wireless module: $1400 → $20
  - Long-term investment on infrastructure for cellular and wireless communication
  - More pervasive networks and cheaper hardware have enabled new services
- Simplicity of use is required
- How much value you get by using new IoT services? Are they really useful?
  - Health
  - Safety
  - Saving money

D. Kellmereit and D. Obodovski, "The Silent Intelligence - The Internet of Things" 16

Summary

- Definition of the IoT

- Examples of IoT services

- Benefits and Risks of the IoT

- Importance of killer apps and pre-installed infrastructure for exponential growth of technology

- Driving force of the IoT development

  - Miniaturization

  - Affordability

  - De-wireization

What is Arduino?

- 오픈소스를 기반으로 한 **microcontroller**로 완성된 보드와 관련 개발 도구 및 환경
- **Arduino** is an **open-source** electronics platform based on easy-to-use hardware and software.
- Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.
- You can tell your board what to do by sending a set of instructions to the microcontroller on the board.
- To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

https://www.arduino.cc/en/Guide/Introduction

Arduino vs. Raspberry Pi

- The biggest difference: **OS**

- The Arduino
    - A microcontroller
    - Good for controlling small devices
    - Best used for projects like building a wake-up light, motion detector alarm, or a small robot.

Arduino vs. Raspberry Pi

- Raspberry Pi
  - Fully functional computer with its own OS
  - Great at acting as a server
  - Communicate with other computers

- Raspberry Pi can be used as an independent computer which runs an OS
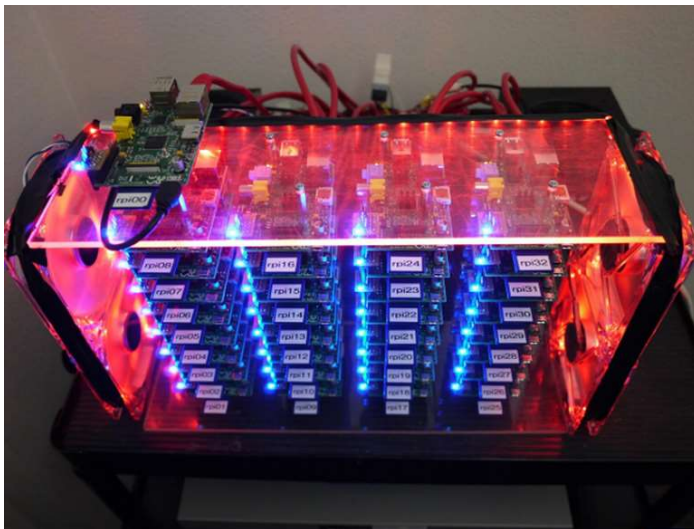
Supercomputer made from Pis

HTTP://WWW.ZDNET.COM/ARTICLE/BUILD-YOUR-OWN-SUPERCOMPUTER-OUT-OF-RASPBERRY-PI-BOARDS/

Arduino Uno

- ATmega328P
- 14 digital input/output pins (of which 6 can be used as PWM outputs),
- 6 analog inputs
- 16 MHz quartz crystal
- A USB connection
- A power jack
- An ICSP header and a reset button

https://store.arduino.cc/usa/arduino-uno-rev3
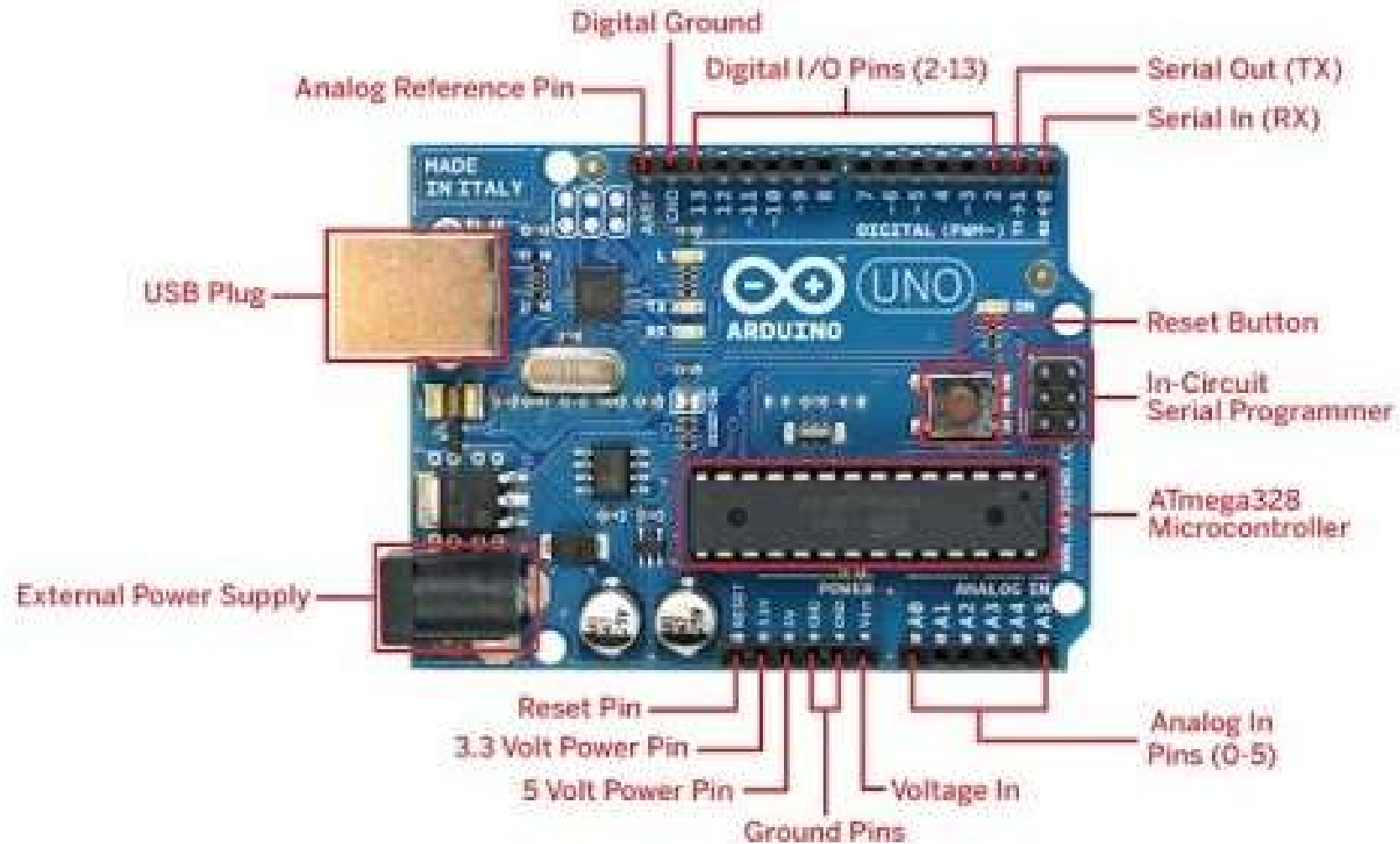
Arduino Uno

Arduino Uno

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

https://store.arduino.cc/usa/arduino-uno-rev3

Various types of Arduino boards

CURRENTLY SOLD OUT

CURRENTLY SOLD OUT

$22.00
Arduino Uno Rev3

$19.80
Arduino Micro

$43.89
Arduino Esplora

CURRENTLY SOLD OUT

CURRENTLY SOLD OUT

CURRENTLY SOLD OUT
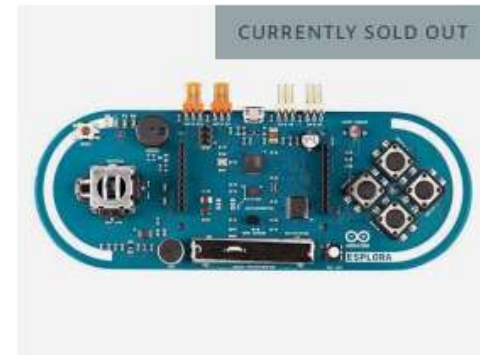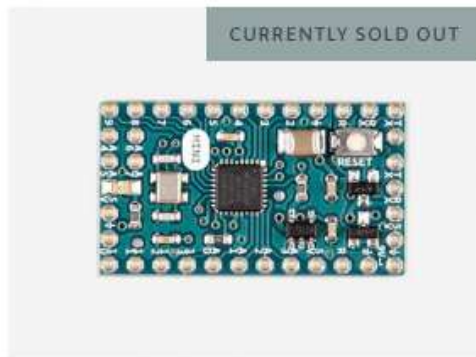
$15.40
Arduino Mini 05

$22.00
Arduino Nano

$38.50
Arduino Mega 2560 Rev3

Arduino projects

https://www.hackster.io/arduino/projects

https://maker.pro/projects/arduino

Arduino projects

Alexa, Launch a Paper Plane
https://www.hackster.io/jonathanmv/alexa-launch-a-paper-plane-acf175

Arduino Uno-Based, Easy-to-Build Pet Feeder
https://www.hackster.io/edr1924/arduino-uno-based-easy-to-build-pet-feeder-86c1ef

아두이노를 사용하는 이유와 아두이노의 역할은?

Arduino projects

아두이노를 사용하는 이유와 아두이노의 역할은?

- Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.
- You can tell your board what to do by sending a set of instructions to the microcontroller on the board.

fritzing

http://doolox.com/p/0304/
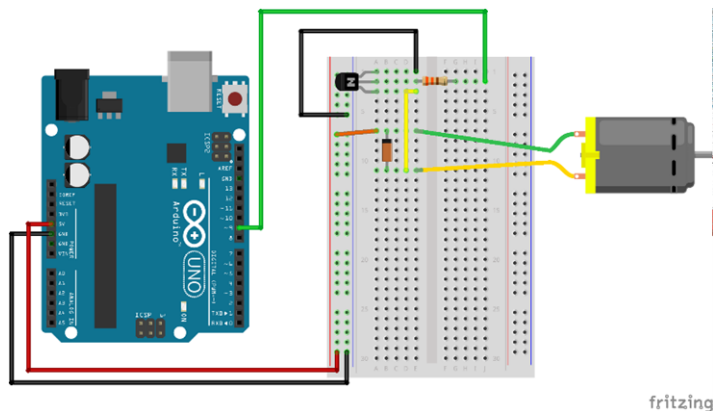
모터를 전원과 바로 연결하는 경우와의 차이점은?

**모터의 제어가 가능
제어를 위한 인터페이스 제공**

MCU, microcontroller unit

- ATmega328P
- MCU란?
  - PC를 소형화시켜 칩 하나에 제작한 형태
  - PC의 CPU를 사용하기 위해서는 메인보드, 비디오 카드, 램, 하드디스크, 파워 등의 주변장치들 필요하지만 MCU는 칩 그 자체 하나로 작동이 가능함.
  - 기본적인 작동을 위한 회로가 MCU 칩 안에 모두 구현되어 있음 (CPU, 내장메모리, 산술/논리회로, 입출력 인터페이스 등)
  - PC 만큼의 성능이 필요 없는 특수한 목적으로 제작되며 저가 생산, 저전력이 가능함.
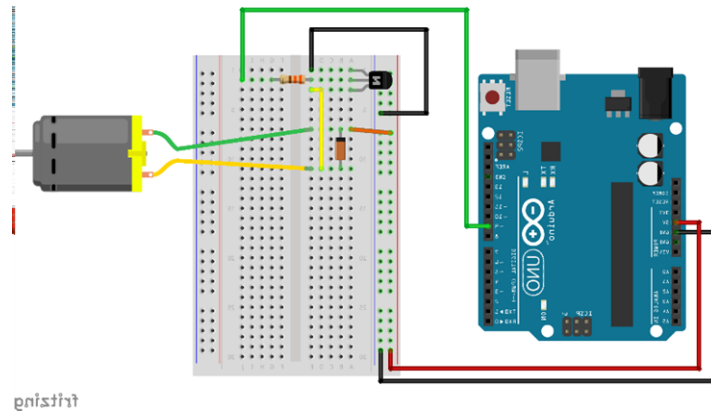

Inside a Modern PC

Case
Motherboard
CPU
Fans
Heatsink
RAM
Opt. Drive
Hard Drive
Video Card
Other Exp. Cards
Cables

Microcontroller

https://image.slidesharecdn.com/takecarecomputer-2012-05-24-120605111952-phpapp01/95/take-care-of-your-computer-part-5-how-to-work-on-your-own-pc-15-728.jpg?cb=1338895259

http://maxembedded.com/2011/06/mcu-vs-mpu/

MCU, microcontroller unit

http://doolox.com/p/0304/

Inside a Modern PC

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https://image.slidesharecdn.com/takecarecomputer-
2012-05-24-120605111952-phpapp01/95/take-care-of-
your-computer-part-5-how-to-work-on-your-own-pc-
15-728.jpg?cb=1338895259

모터 제어, LED 제어 등 제한적이고 특수한 목적이 있는 경우 MCU를 사용하면 간편하게 기능을 구현할 수 있다.

발표과제 (3/20)

- 발표 주제: 스마트시스템 혹은 IoT 기술의 예
- 참고 문헌: DBPIA, IEEE Xplore, Google Scholar 등에서 검색 가능한 **_논문_**으로 제한 (학교에서 접속 가능)
- 발표 시간: 10분
  - 핵심 기술에 대한 설명 포함
  - 기술의 장·단점은?
  - 보완 사항 제안
  - 수식, 이론 등을 모두 이해할 필요 없음
- 수업 시간 전까지 이러닝에 발표자료 제출
- 발표자: 4명 선발

발표과제 (3/20)

사물인터넷 기반의 낙상 감지 시스템

정필성[1] · 조양현[2*]

Fall Detection System based Internet of Things

Pil-Seong Jeong[1] · Yang-Hyun Cho[2*]

[1]FNS Value Corporation, 358-25, Hosu-ro, Ilsandong-gu, Goyang-si, Gyeonggi-do, Korea
[2*]Division of Computer Science, Sahmyook University, Seoul 139-742, Korea

Ⅱ. 관련 이론

2.1. 낙상 감지 기법

낙상을 감지하는 방법은 영상 정보를 분석하여 낙상을 검출하는 방법과 센서 정보를 이용하여 낙상 감지 대상자의 움직임을 판별하여 낙상을 검출하는 방법으로 분류될 수 있다. 영상 정보를 분석하는 방법은 감지 대상의 움직임과 넘어지는 모양을 분석하여 낙상 여부를 판별하게 된다.

3.1. 시스템 모델

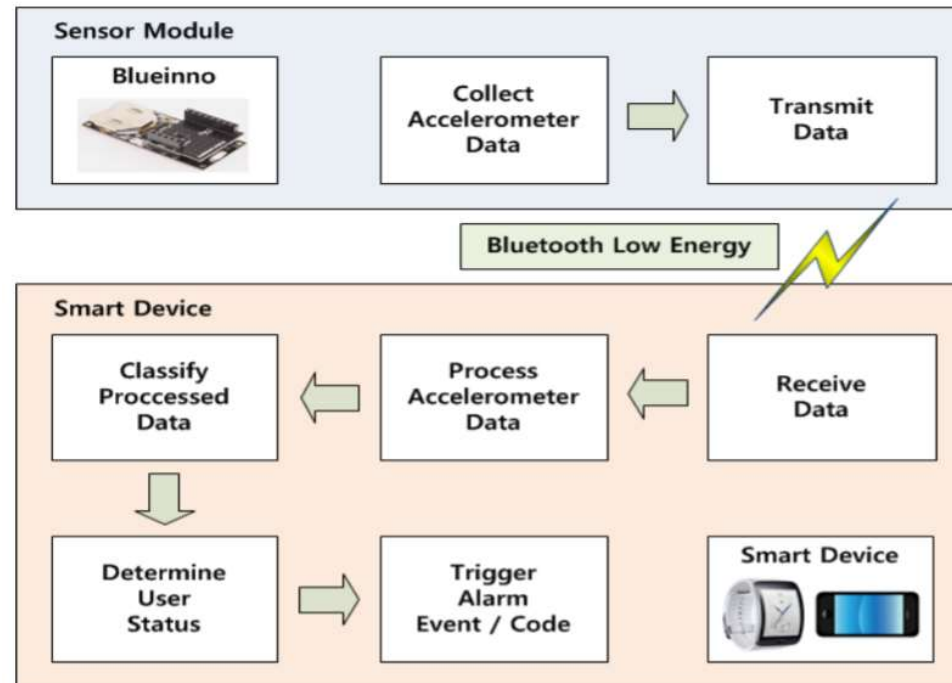본 논문에서 제안하는 낙상 감지 시스템 모델은 그림 1과 같다. 센서 모듈은 가속도 센서 모듈과 결합한 아두이노 기반의 블루이노 센서 모듈로 이루어진다. 장기간

Fig. 1 System Model

정필성, 조양현, "사물인터넷 기반의 낙상 감지 시스템 "