

Latihan Riset Kecil

iTCLab Sebagai Media Pembelajaran IoT-AI

Assoc. Prof. Dr. Basuki Rahmat, S.Si, MT, ITS-AI



Assoc. Prof. Dr. Basuki Rahmat, S.Si, MT, ITS-AI

Email: basukirahmat.if@upnjatim.ac.id

- Programmmer (Staf EDP) PT. Behaestex Gresik (1995-1996)
- Dosen dan Peneliti di STIKOM Surabaya Skrg. Univ. Dinamika (1996-2006)
- Dosen dan Peneliti di UPN “Veteran” Jawa Timur (2006-skrg)
- Founder i-ot.net, io-t.net
- ASIOTI, IAENG, & IEEE Member
- Wakil Dekan 3 Fasilkom UPN “Veteran” Jawa Timur
- PIC Klaster Keilmuan Computer Science and Information Center Majelis Rektor Perguruan Tinggi Negeri Indonesia (MRPTNI)
- International Credit Transfer (ICT) Program Coordinator UPN “Veteran” Jawa Timur (2020-2021)
- Ketua Pusat Studi Teknologi Informasi dan Komunikasi UPN “Veteran” Jawa Timur (2018-2024)
- Ketua Intelligent Control, Robotics & Automation Systems (INCONTRAST) Research Center

Agenda

- Internet of Things (IoT)
- Gambaran Riset IoT
- Mengenal Kit iTCLab
- Praktek Pemrograman IoT-AI

Internet of Things (IoT)

Internet of Things (IoT) adalah area yang muncul di mana milyaran objek pintar saling berhubungan satu sama lain menggunakan internet untuk berbagi data dan sumber daya

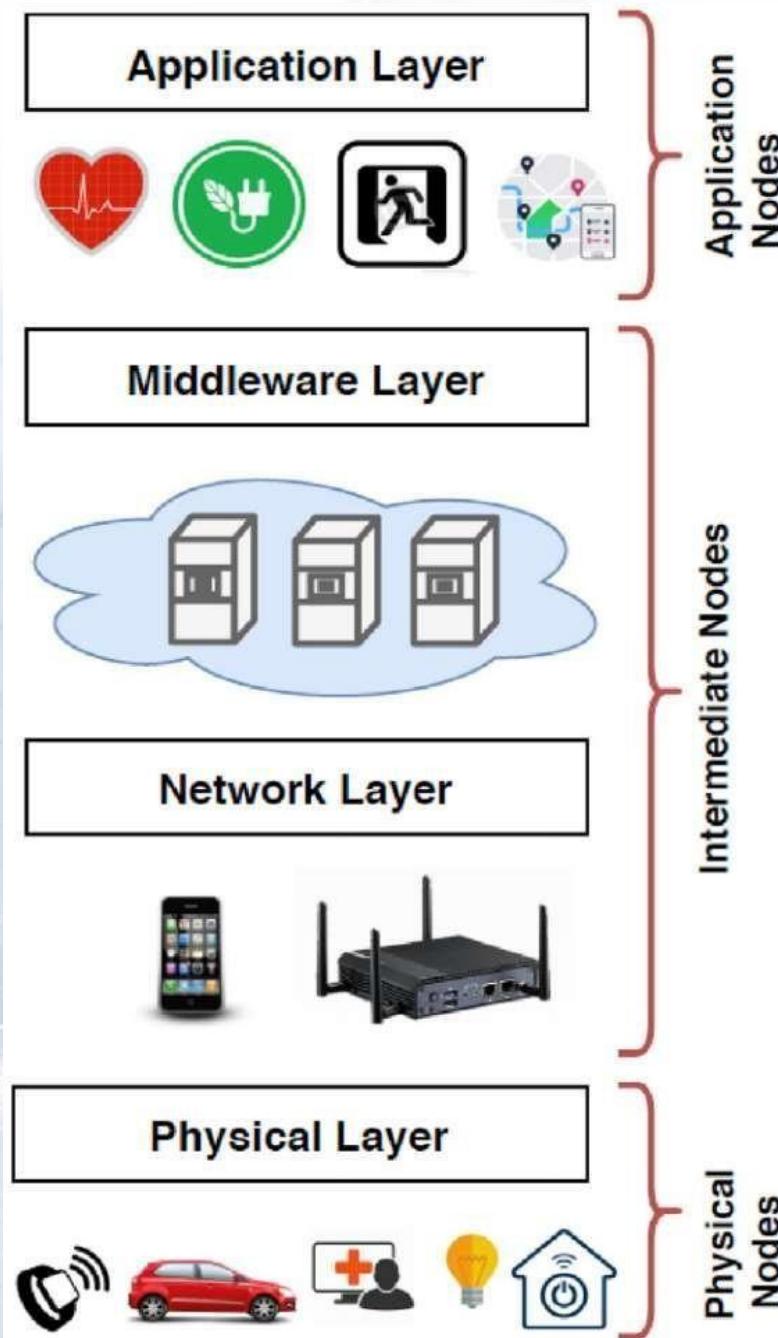
(Chahal, Kumar and Batra, 2020)



Arsitektur IoT

- **Application Layer**
 - ✓ Layanan ke user
 - ✓ Komunikasi dengan middleware
 - ✓ Antarmuka user akses layanan
- **Middleware Layer**
 - ✓ konektivitas dan interoperabilitas dalam ekosistem IoT.
- **Network Layer**
 - ✓ Mendukung jaringan dan transfer data antar simpul.
 - ✓ Protokol komunikasi yang diperlukan untuk pertukaran data dalam ekosistem IoT
- **Physical Layer**
 - ✓ Mengkarakterisasi kemampuan penginderaan dan kontrol dari sistem IoT
 - ✓ Berupa simpul fisik seperti sensor dan aktuator yang merasakan lingkungan dan berinteraksi dengannya dalam menanggapi perubahan atau permintaan user

(Ravidas *et al.*, 2019)



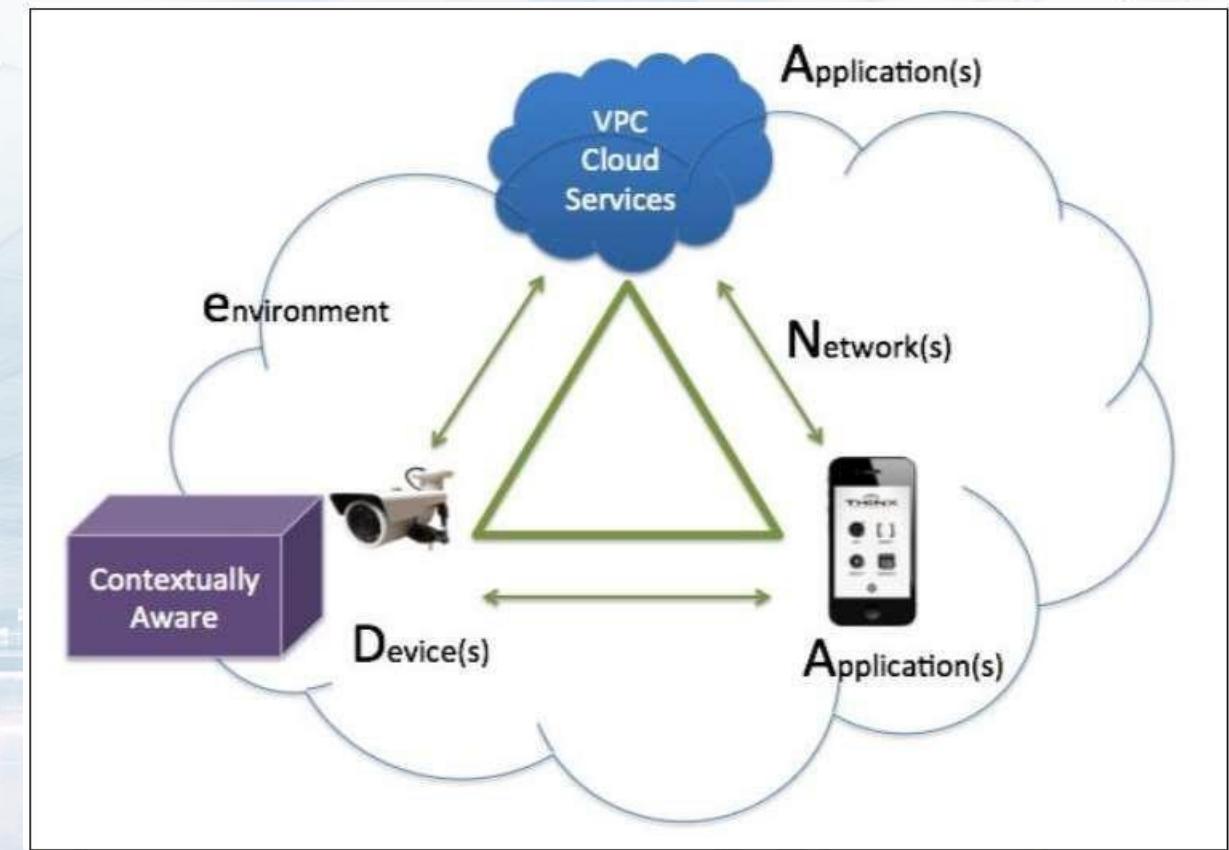
Beberapa Contoh Aplikasi IoT

- **Smart Home** (sistem keamanan rumah berbasis internet, dapat mengetahui keadaan rumah serta mengontrol peralatan rumah tangga melalui jaringan internet).
- **Smart Farming** (sistem pertanian cerdas berbasis internet, untuk pemantauan dan pengendalian kualitas air dan tanah pertanian serta pertumbuhan tanaman melalui jaringan internet).
- **Internet industry** (pemantauan dan pengendalian peralatan serta proses di industri)
- **Kesehatan** (pemantauan kondisi kesehatan seseorang).
- **Transportasi** (majemen dan informasi lalulintas).

Sistem IoT

Sistem dasar dari IoT, yaitu:

1. Hardware/fisik (*Things*).
2. Koneksi internet.
3. *Cloud data center* sebagai tempat untuk menyimpan atau menjalankan aplikasinya.



Yang dibutuhkan

Application

Bisa menggunakan
IoT MQTT Panel di
HP Android

Cloud IoT

hivemq.com

Device

Kit iTCLab



IoT MQTT Panel

Rahul Kundu Tools

Everyone

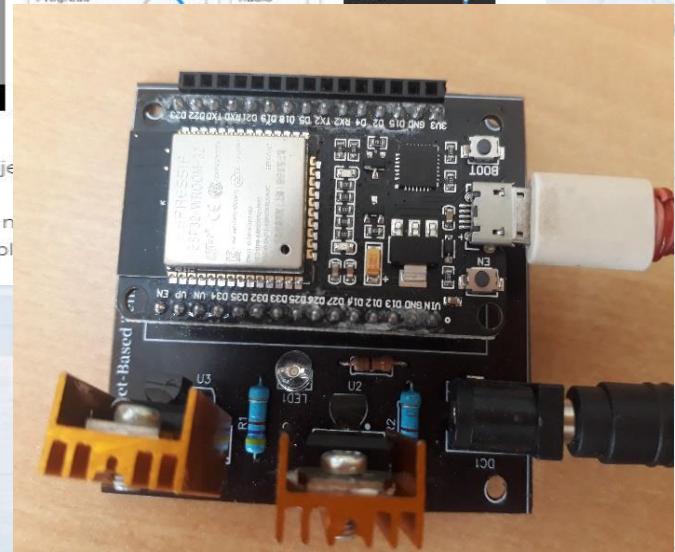
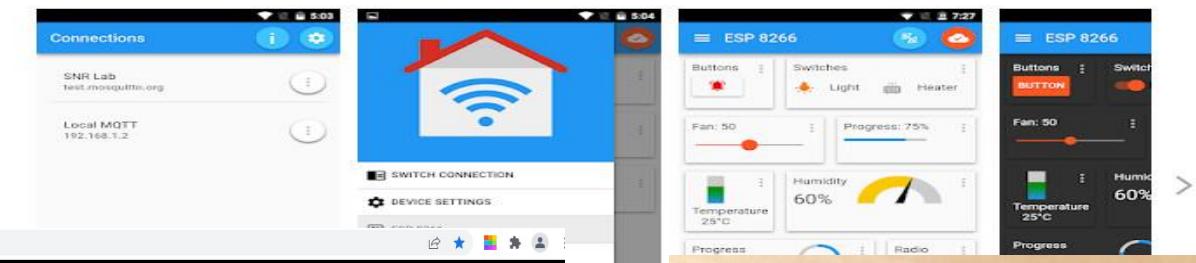
Contains Ads

This app is compatible with some of your devices.

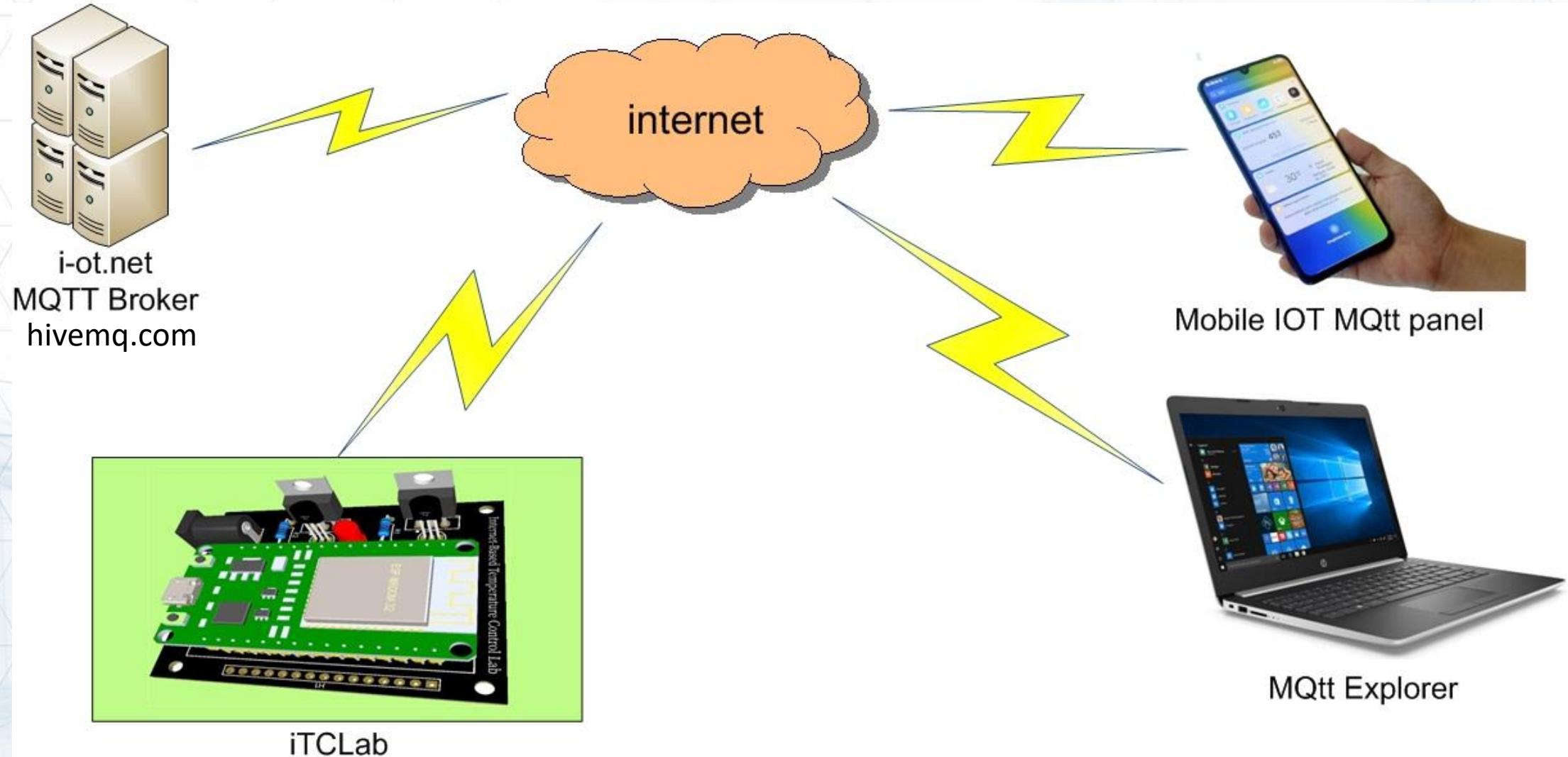
★★★★★ 390

Installed

The screenshot shows the HiveMQ website homepage. At the top, there's a navigation bar with links for Product, Cloud, Developers, MQTT, Solutions, Blog, and Company. Below the navigation, a large banner features the text "Reliable Data Movement for Connected Devices" over a background image of a city skyline at night. Underneath the banner, there's a paragraph about HiveMQ's MQTT broker and three call-to-action buttons: "Learn more", "Get HiveMQ", and "Contact Us". At the bottom of the page, there's a section for "HiveMQ Cloud for free" with a "Get started now!" button.



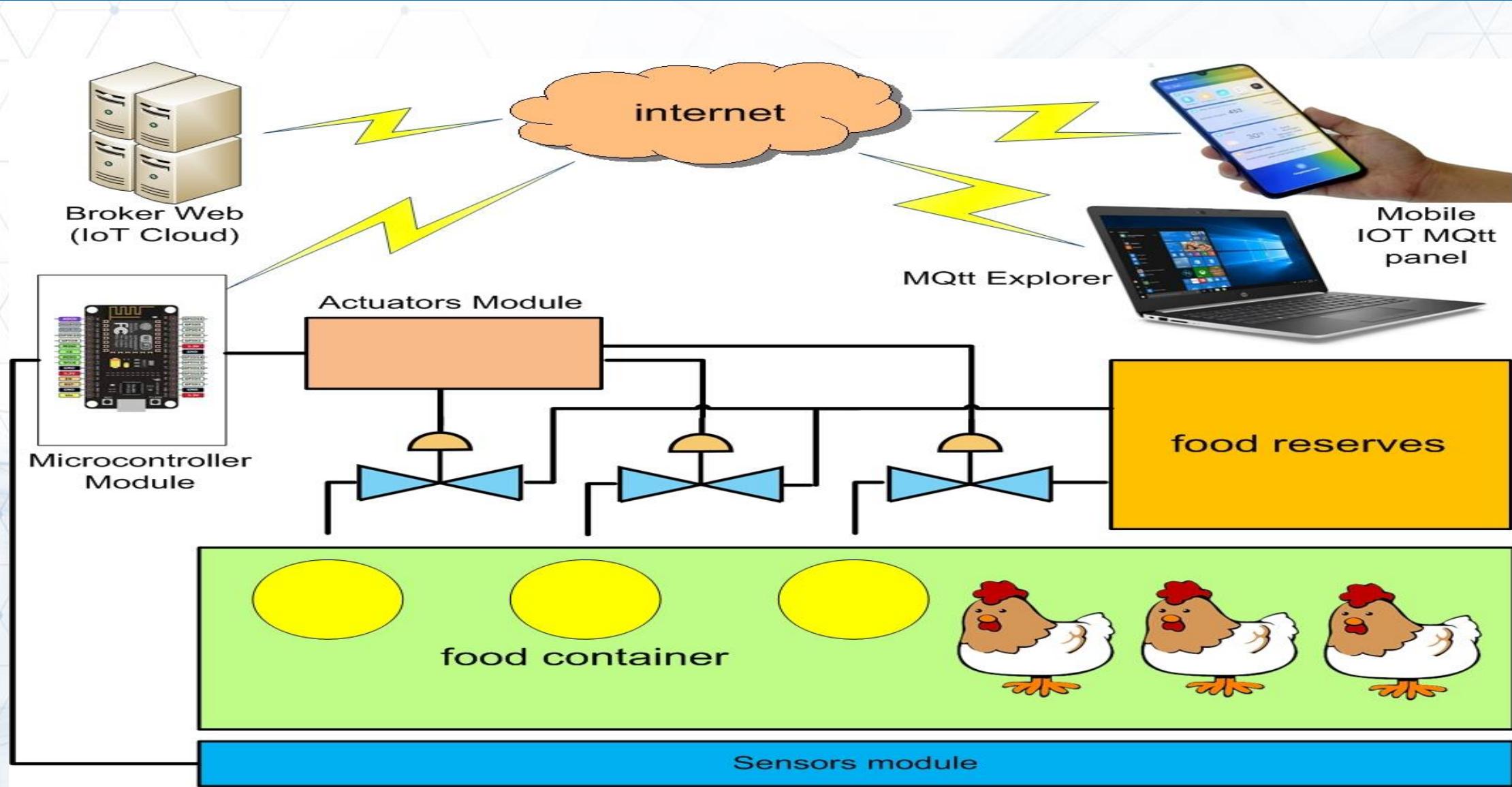
Arsitektur Umum IoT-Based iTCLab



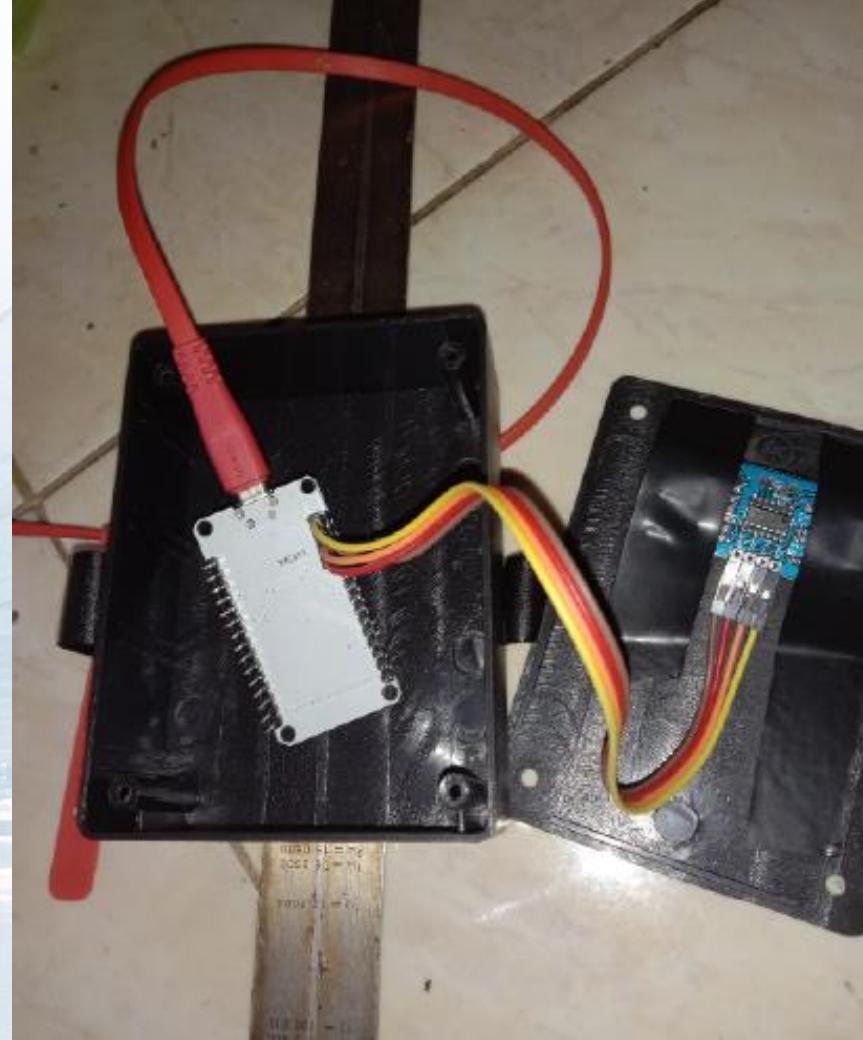
Gambaran Riset Internet of Things (IoT)

- Smart Kandang
- Smart Farming
- FishCareLab
- DLL

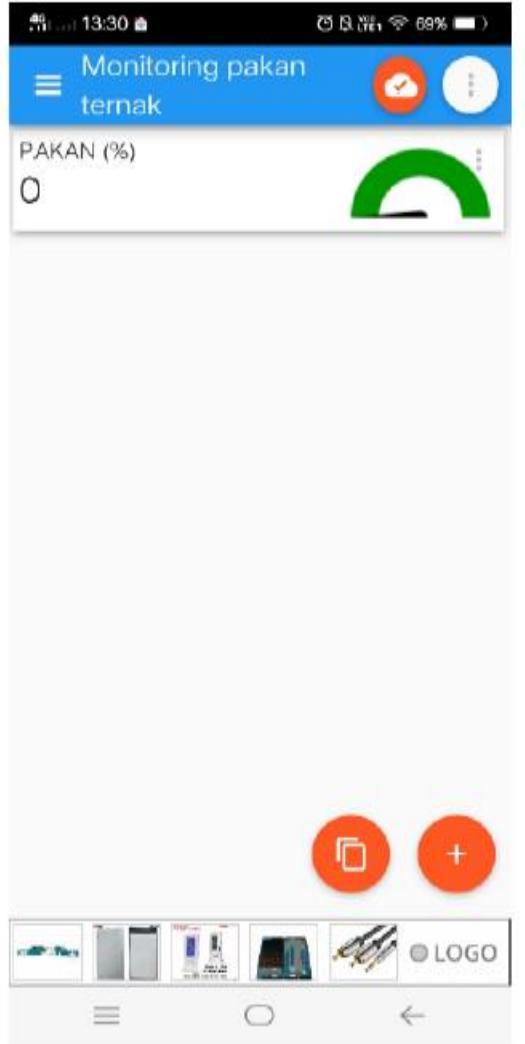
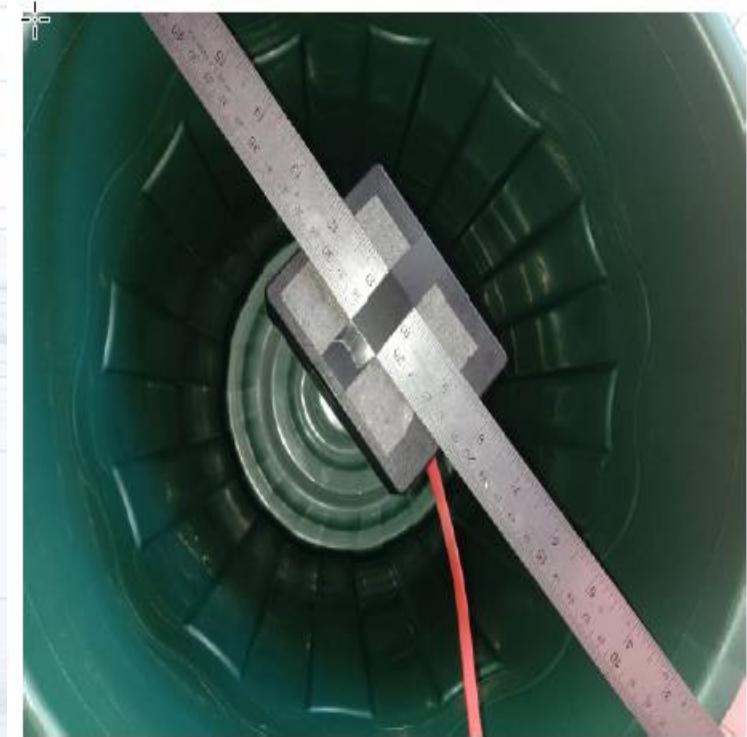
Smart Kandang



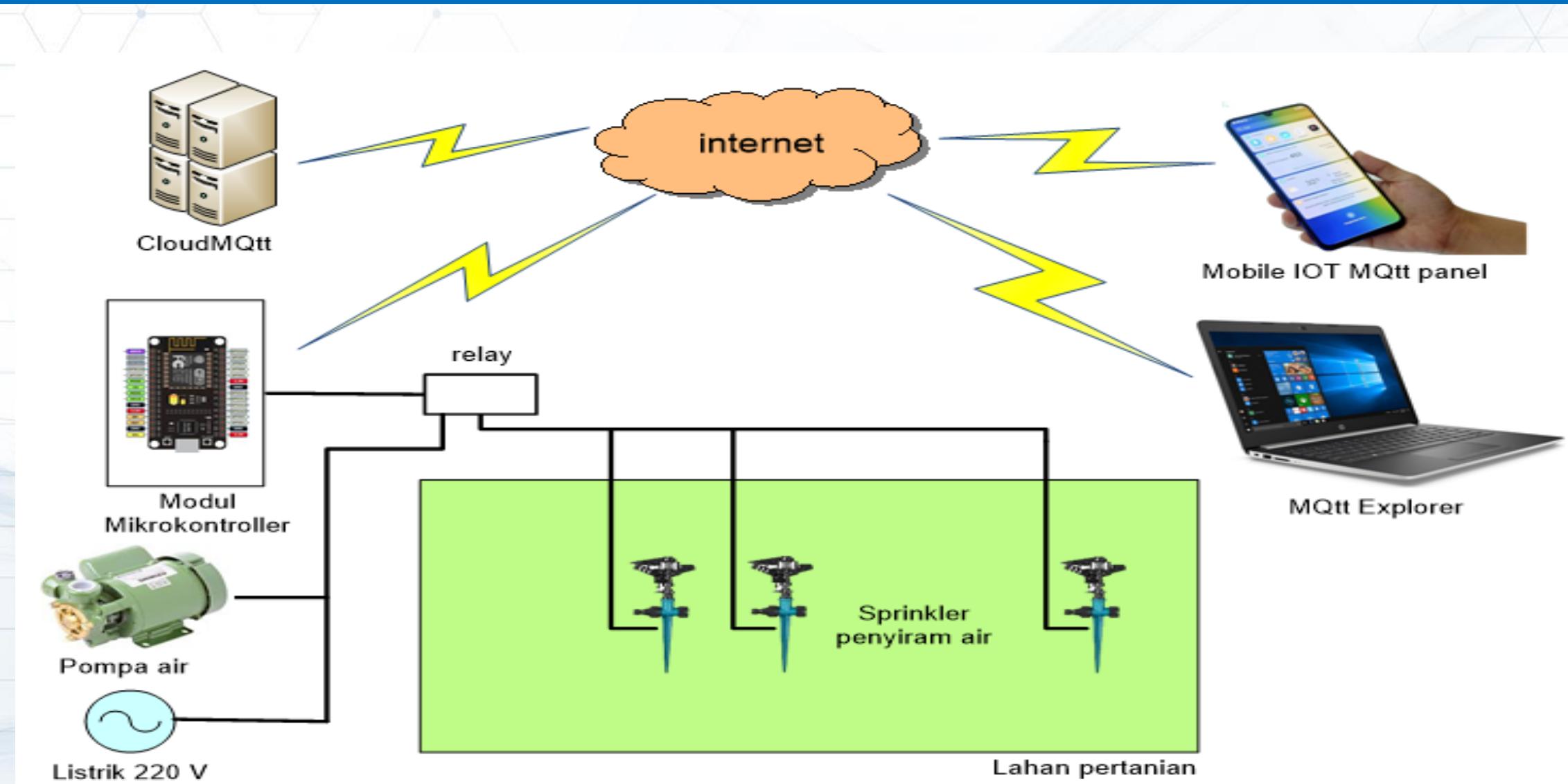
Smart Kandang



Smart Kandang



Smart Farming



Smart Farming



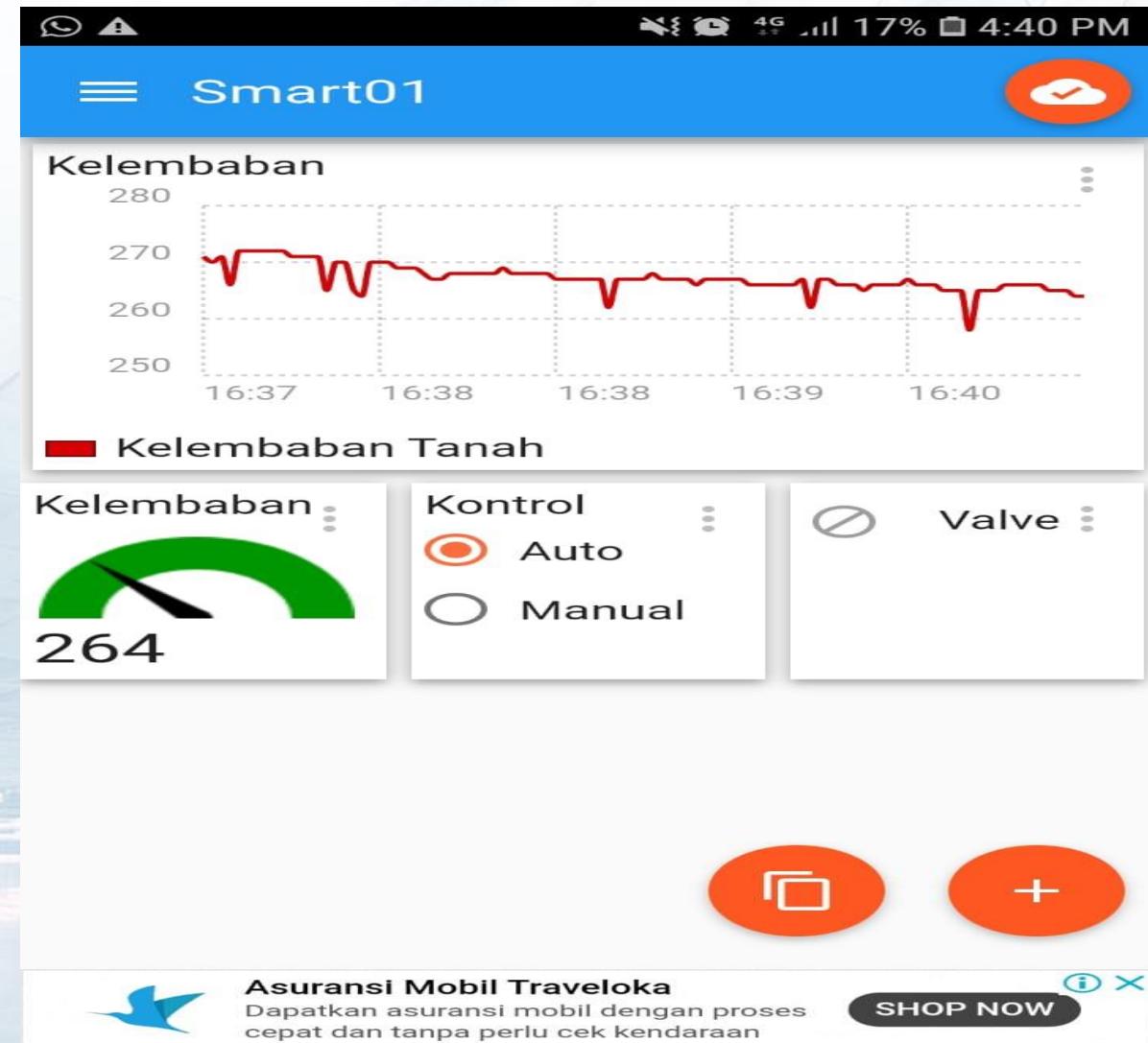
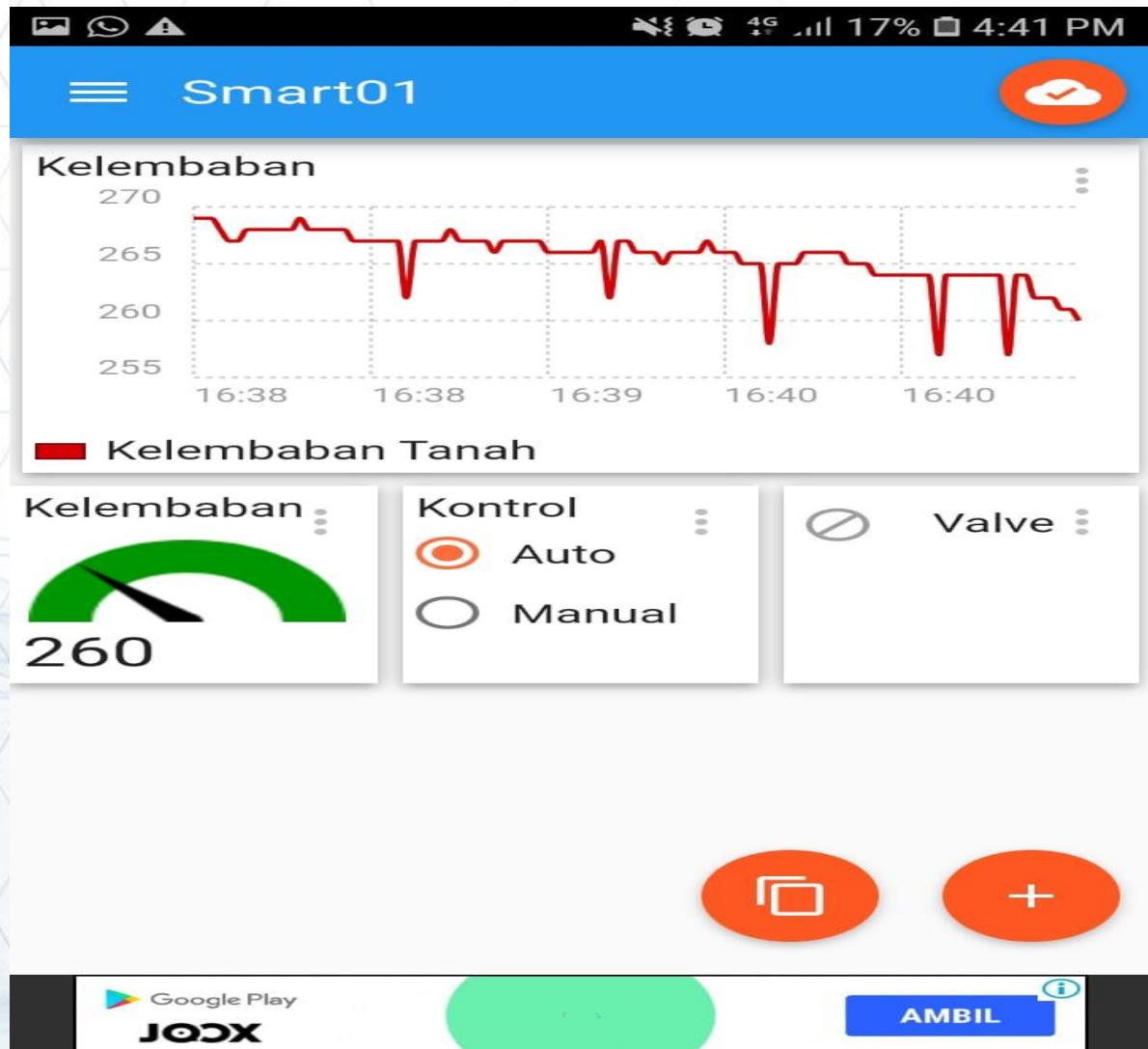
Smart Farming



Smart Farming



Smart Farming

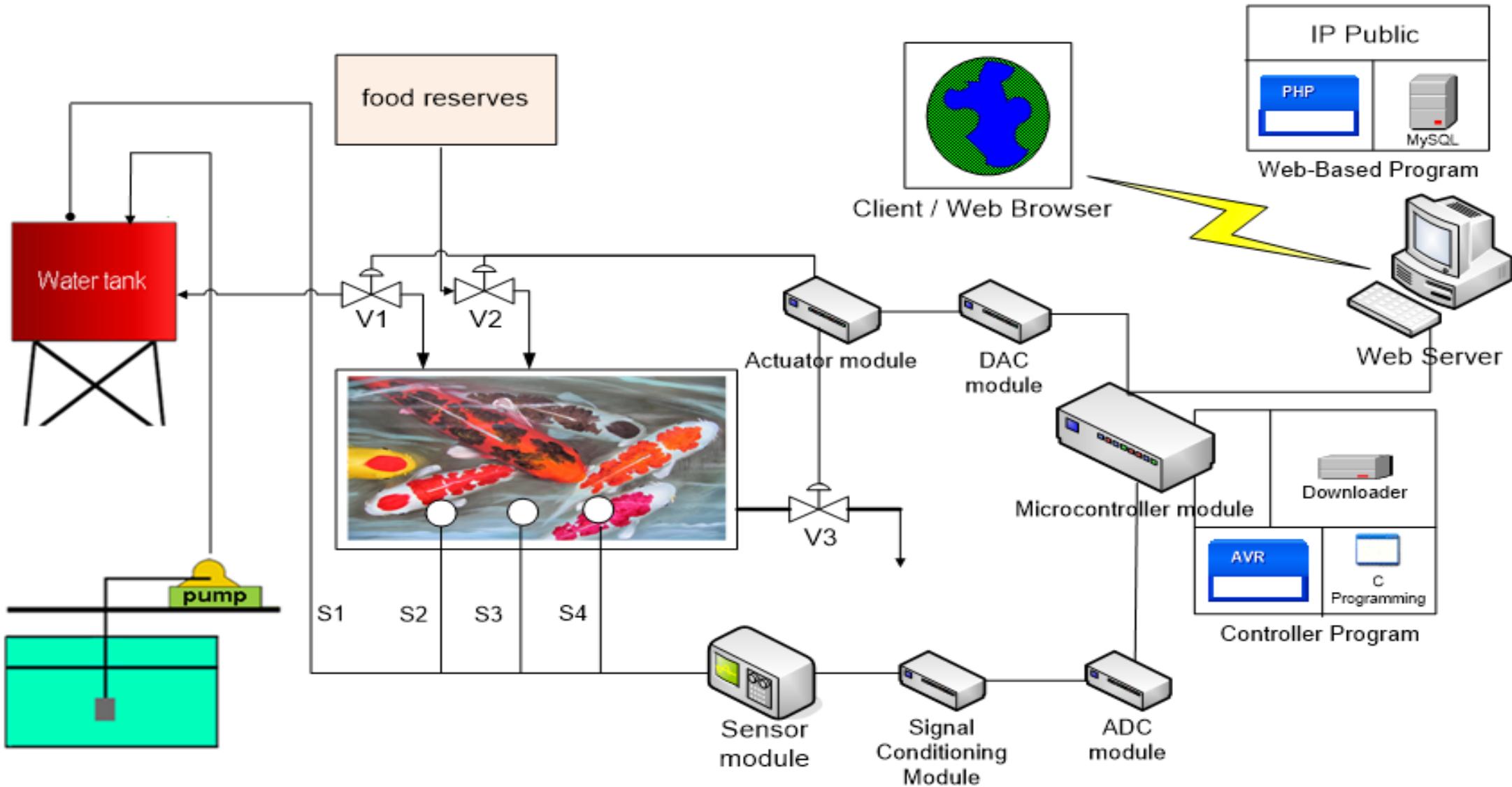


Asuransi Mobil Traveloka

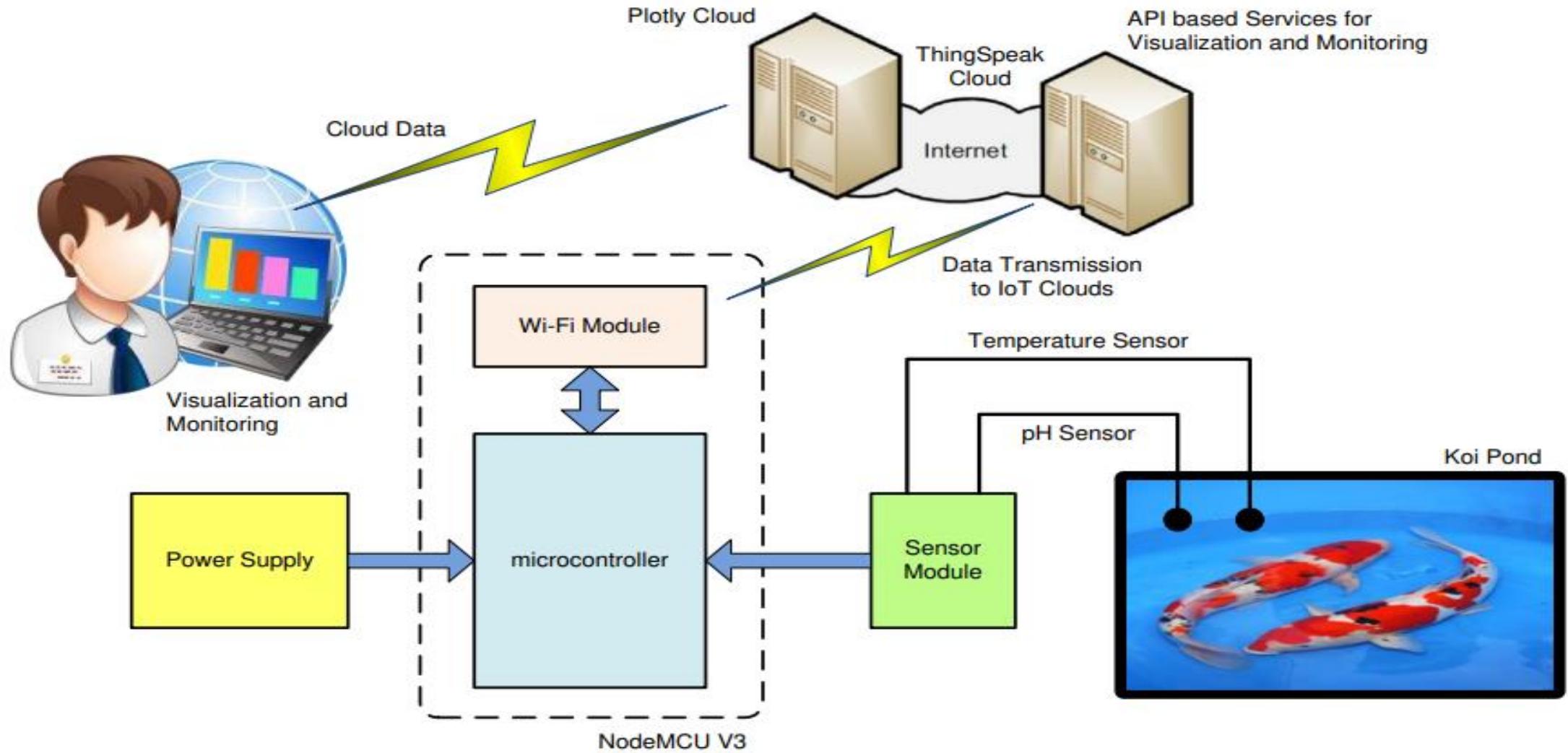
Dapatkan asuransi mobil dengan proses cepat dan tanpa perlu cek kendaraan

SHOP NOW

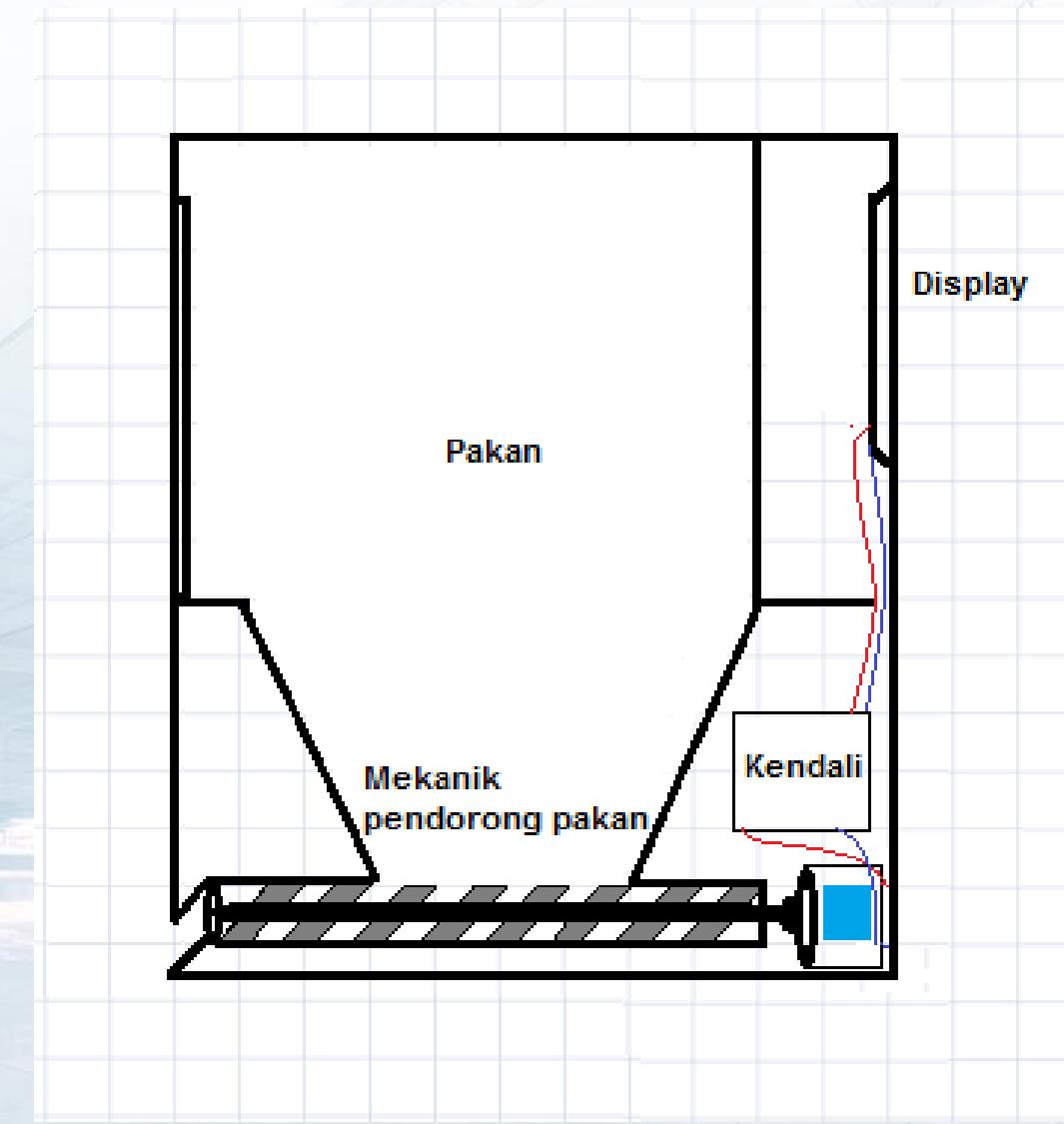
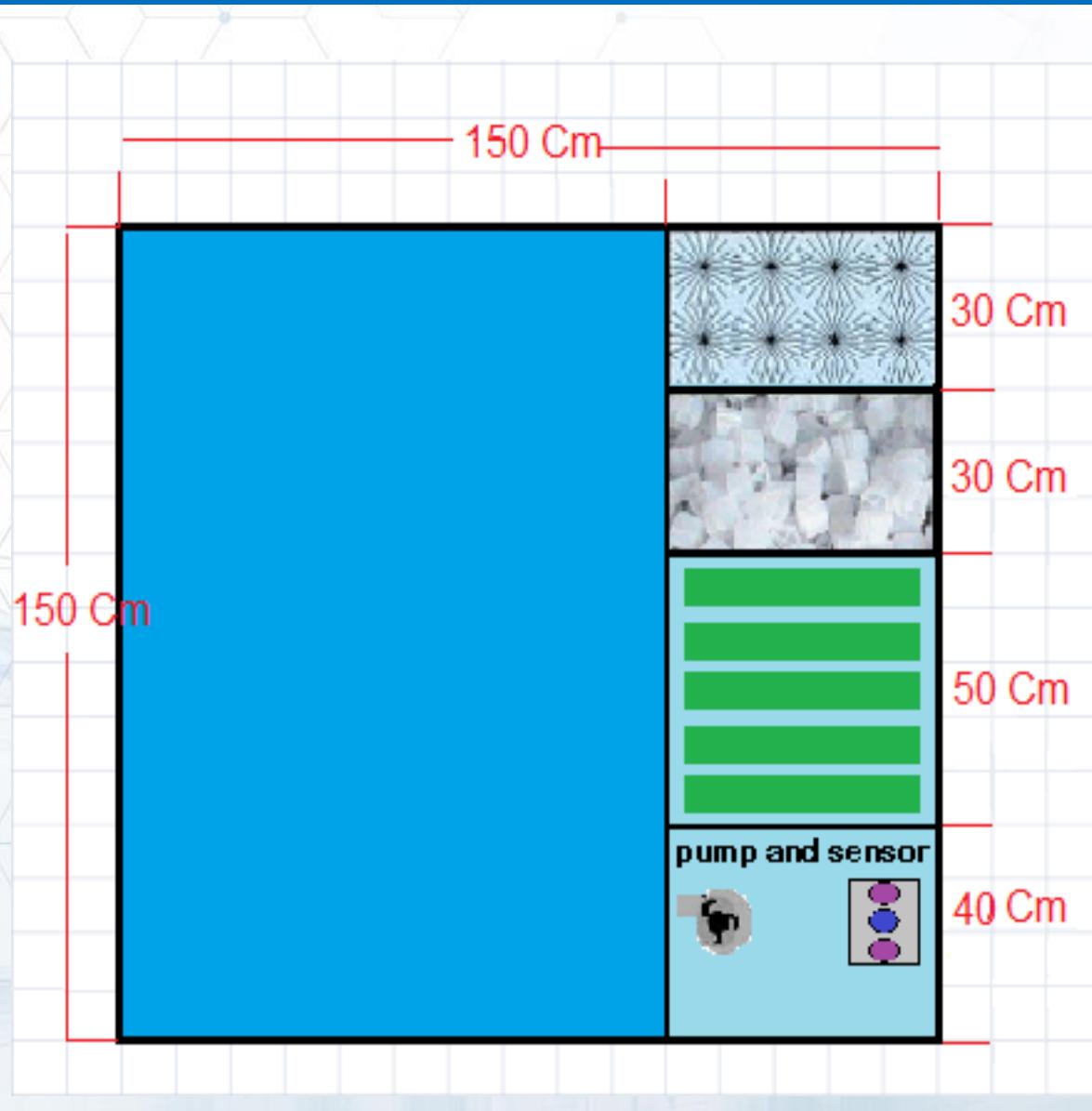
Intelligent FishCareLab System (IFS)



Intelligent FishCareLab System (IFS)



Intelligent FishCareLab System (IFS)



Intelligent FishCareLab System (IFS)



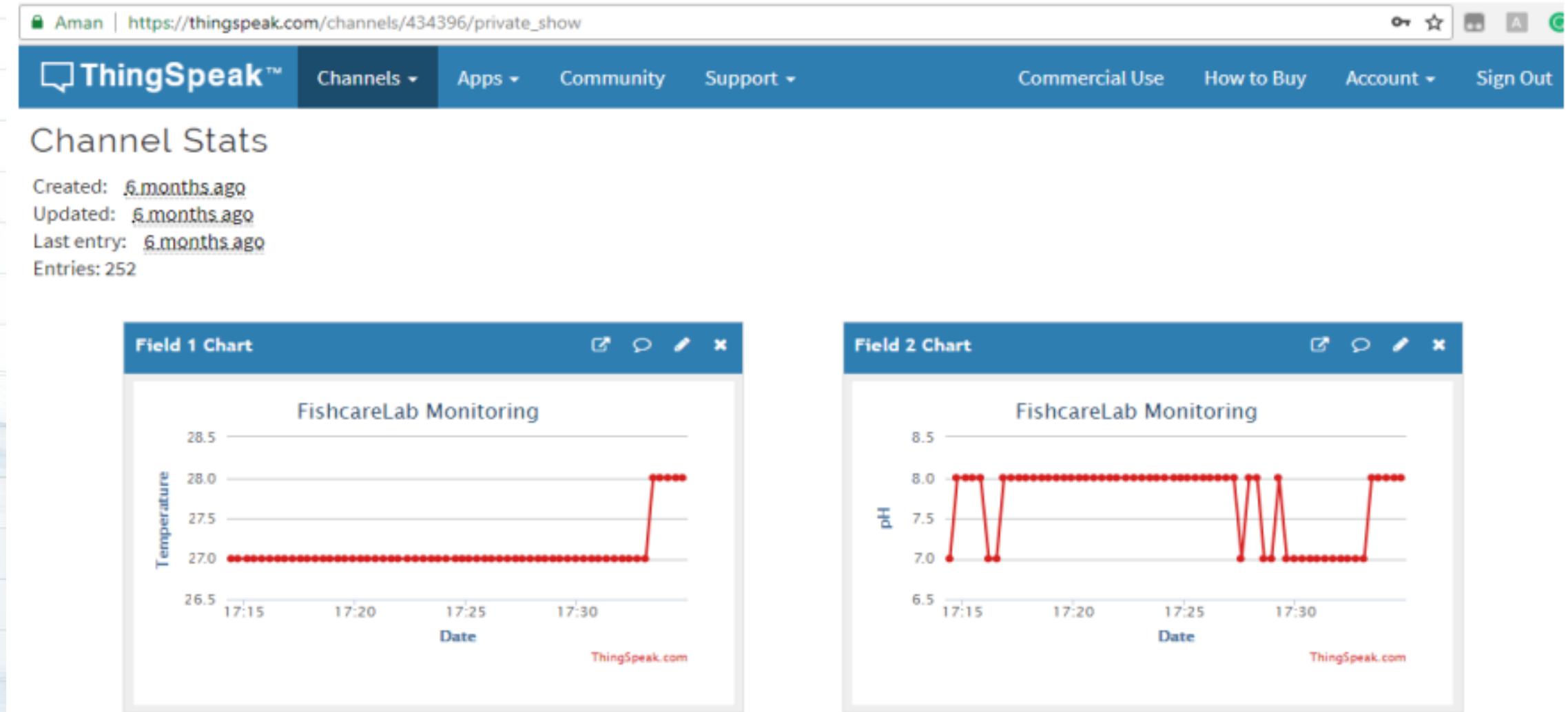
Intelligent FishCareLab System (IFS)



Intelligent FishCareLab System (IFS)



Intelligent FishCareLab System (IFS)



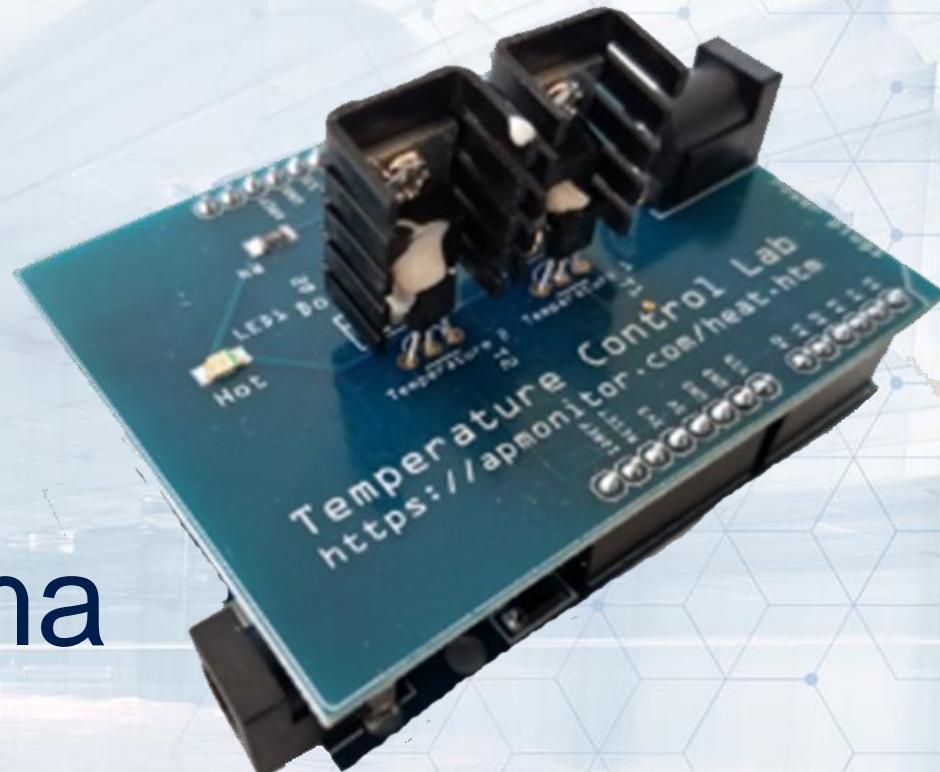
Kit Internet of Things (IoT)

iTCLab

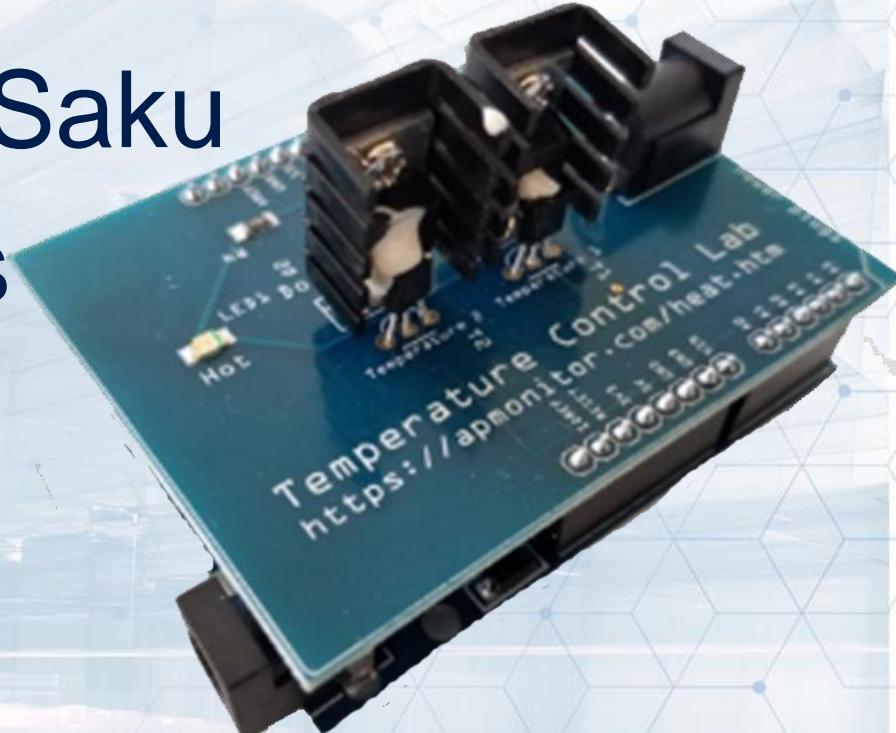
Internet-Based Temperature Control Lab

<https://shopee.co.id/product/78709625/11589970517/>

- Motivasi iTCLab
- Apa itu TCLab?
- Bagaimana dengan iTCLab?
- Sebagai Media Kerjasama Nasional/Internasional



- ❑ Terinspirasi TCLab Produk BYU
- ❑ Miniatur Sistem Kendali dalam Saku
- ❑ Paket Pembelajaran IoT Praktis
 - ✓ Pengenalan Sistem IoT
 - ✓ Pemrograman IoT
 - ✓ Praktek Sistem Kendali Berbasis IoT
- ❑ Produk Indonesia Mendunia



<http://apmonitor.com/pdc/index.php/Main/ArduinoTemperatureControl>



A screenshot of a course page titled 'Temperature Control Lab'. The page includes a search bar, course information links (Course Overview, Syllabus, Schedule, Course Objectives, Info Sheet, Video Playlist), and assignment sections. The URL <https://apmonitor.com/heat.htm> is visible at the bottom of the page.



Temperature Control Lab

The PID TCLab and MPC TCLab use the same hardware with an Arduino Leonardo, TCLab shield, 2A power supply, 20AWG power cable, and USB communication cable.



Over 7000 lab kits have been produced for destinations around the world to individuals, companies, and universities. They are used in courses such as **Begin Python, Process Dynamics and Control, and Cyber-Physical Optimization with Machine Learning**



Gambaran Sistem TCLab



Sensor



Actuator



Controller

Temperature 1

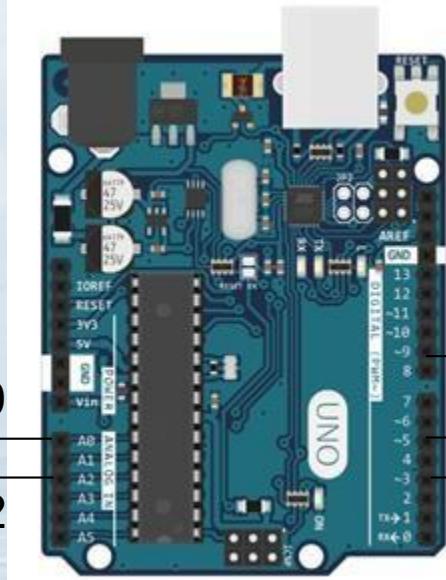


Analog Pin 0



Analog Pin 2

Temperature 2



USB Serial Connection

LED



Digital Pin 9

Digital Pin 5

Digital Pin 3

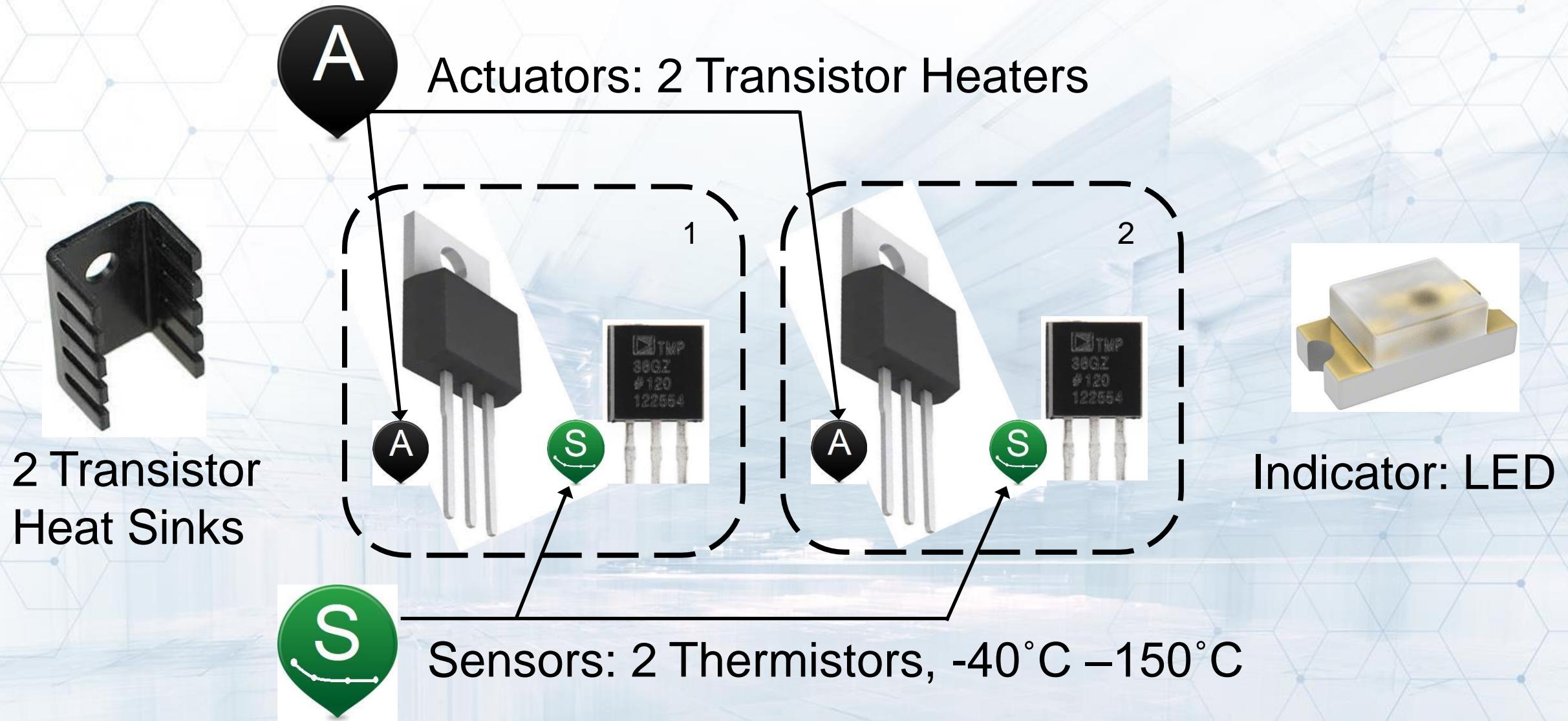


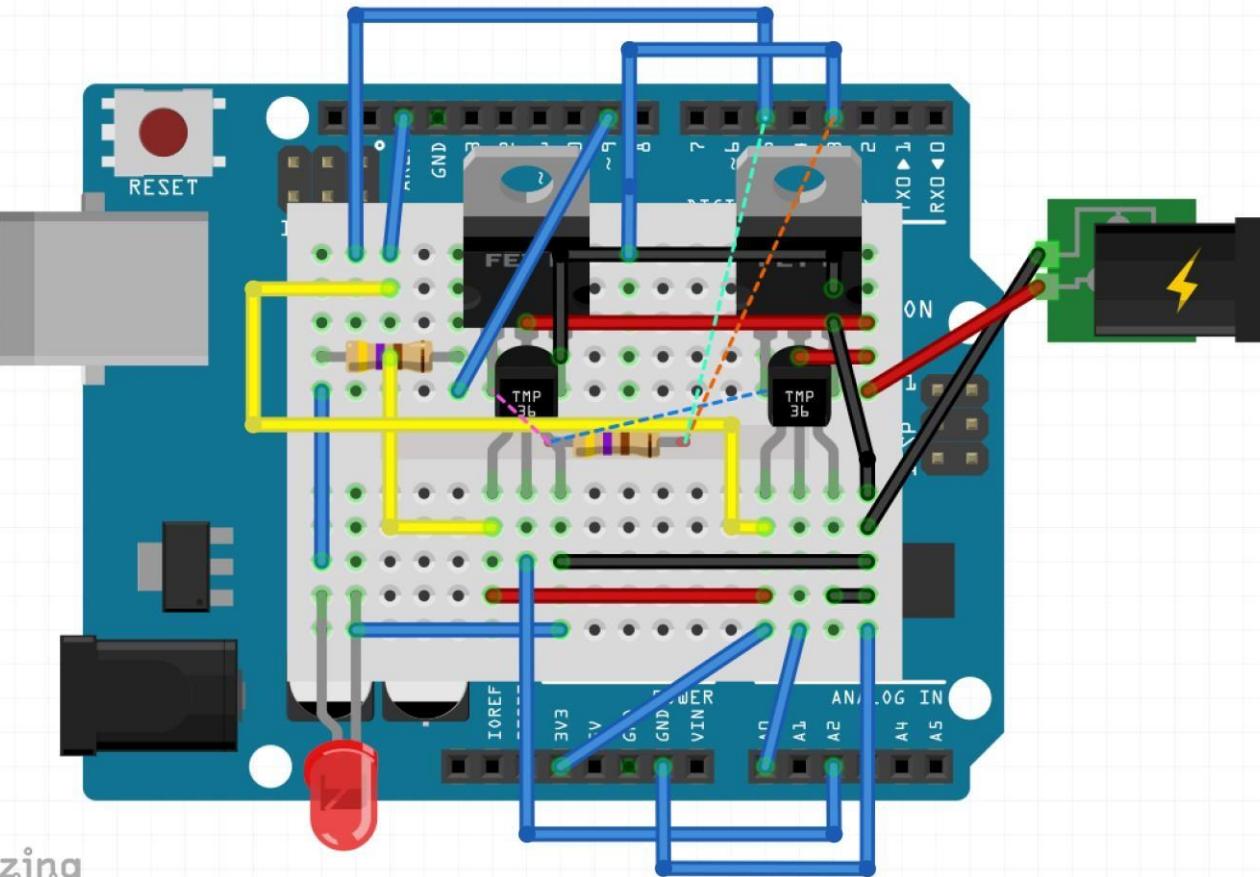
Heater 2



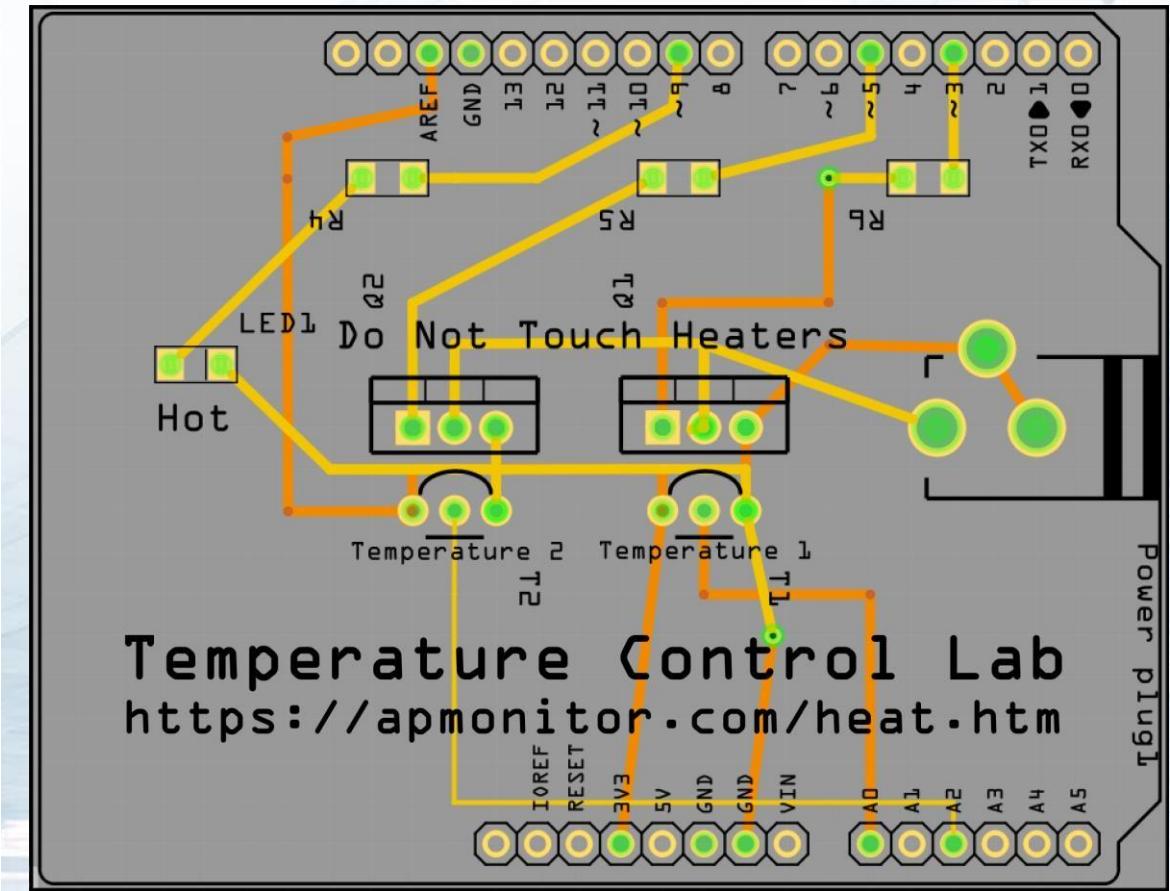
Heater 1

Gambaran Sistem TCLab



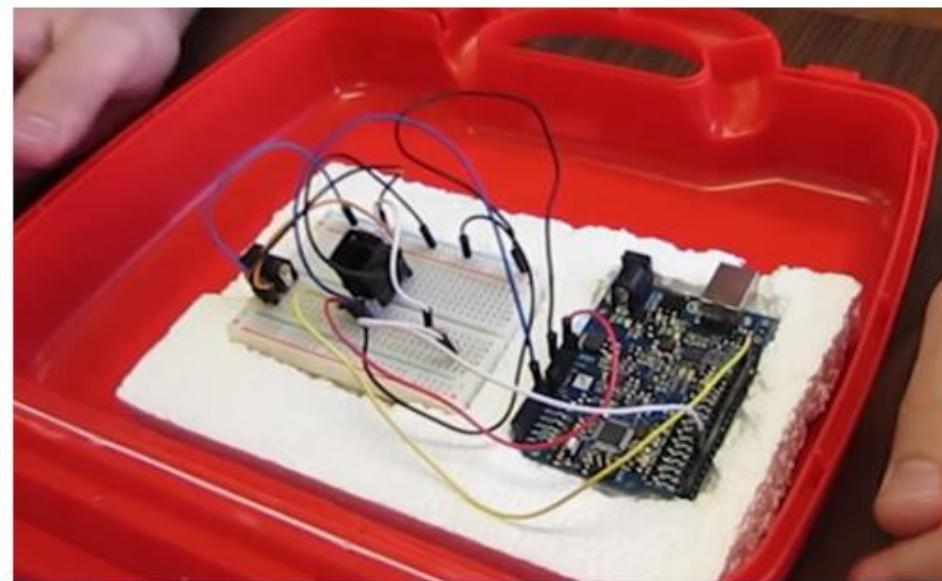


2014: Bread Boarded Lab



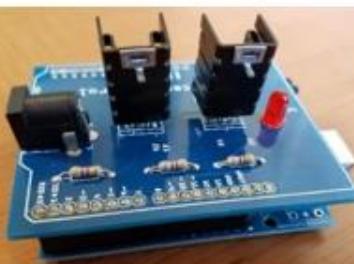
2017: PCB Printed and Assembled

Perkembangan TCLab



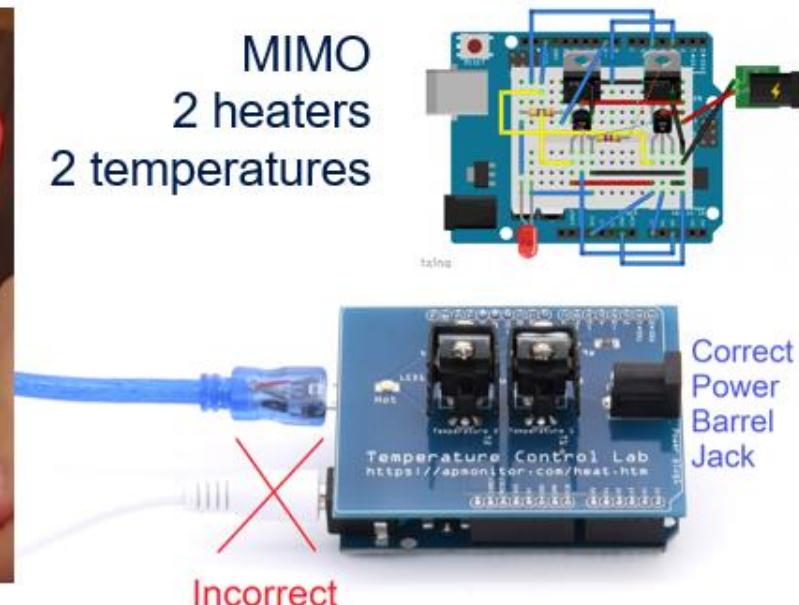
First Prototype (SISO)

Students Attempt to
Bread Board 40 Labs
Half Successful
Many Mistakes, Melted Parts



PCB Print 10 Labs
Assembly Required
Improved Student Experience

MIMO
2 heaters
2 temperatures



FAQ Online to Install / Troubleshoot
Build and Verify 10 Labs



PCB Printed and Assembled
Adopted at 40 Universities



2014

2015

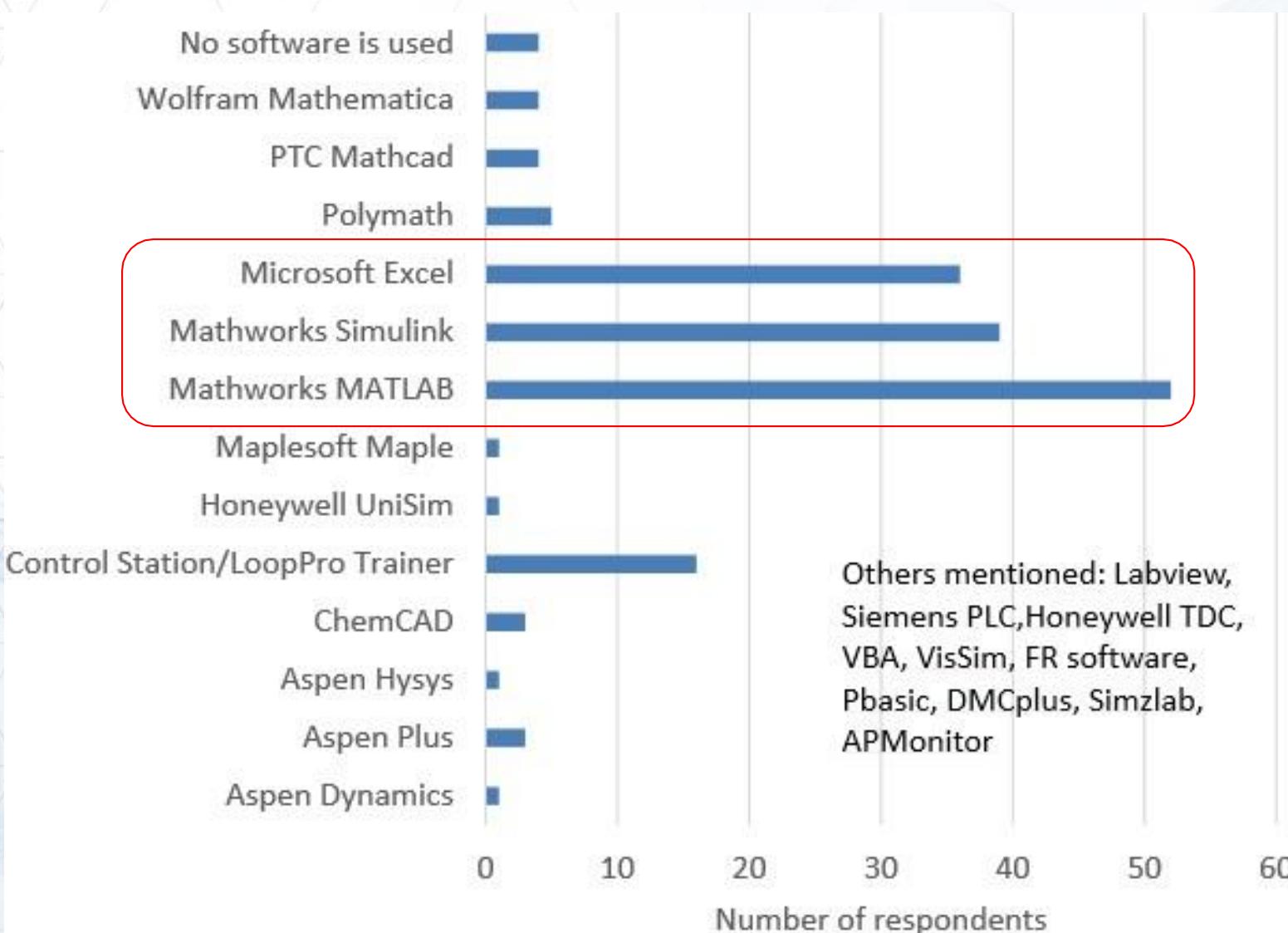
2016

2017

2018

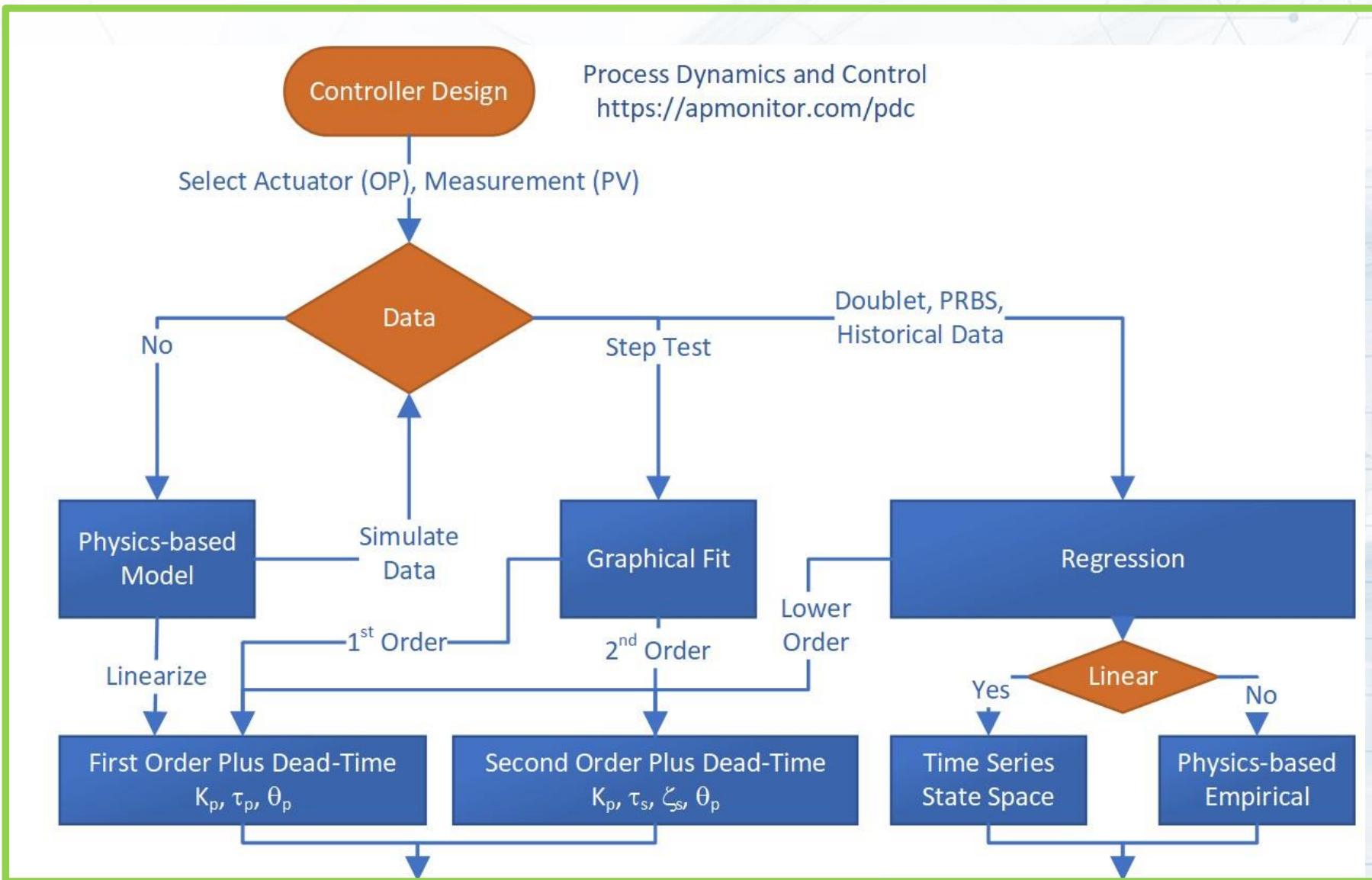
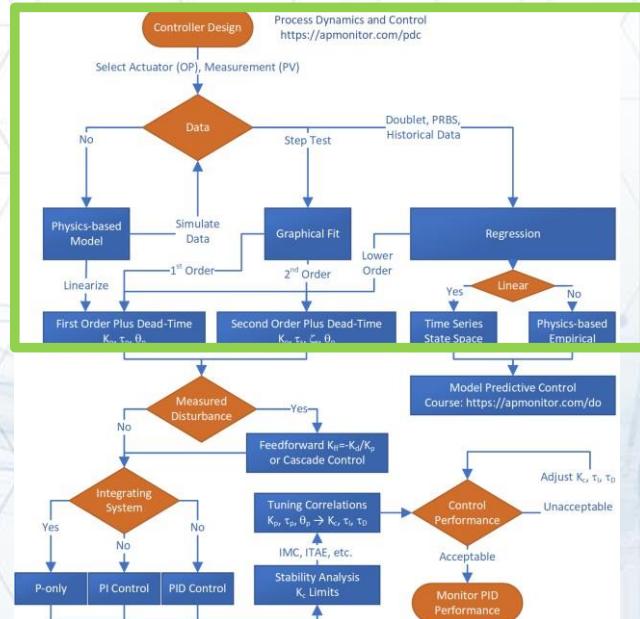
2019

Belajar Dinamika dan Kontrol serta Pemrograman dengan TCLab

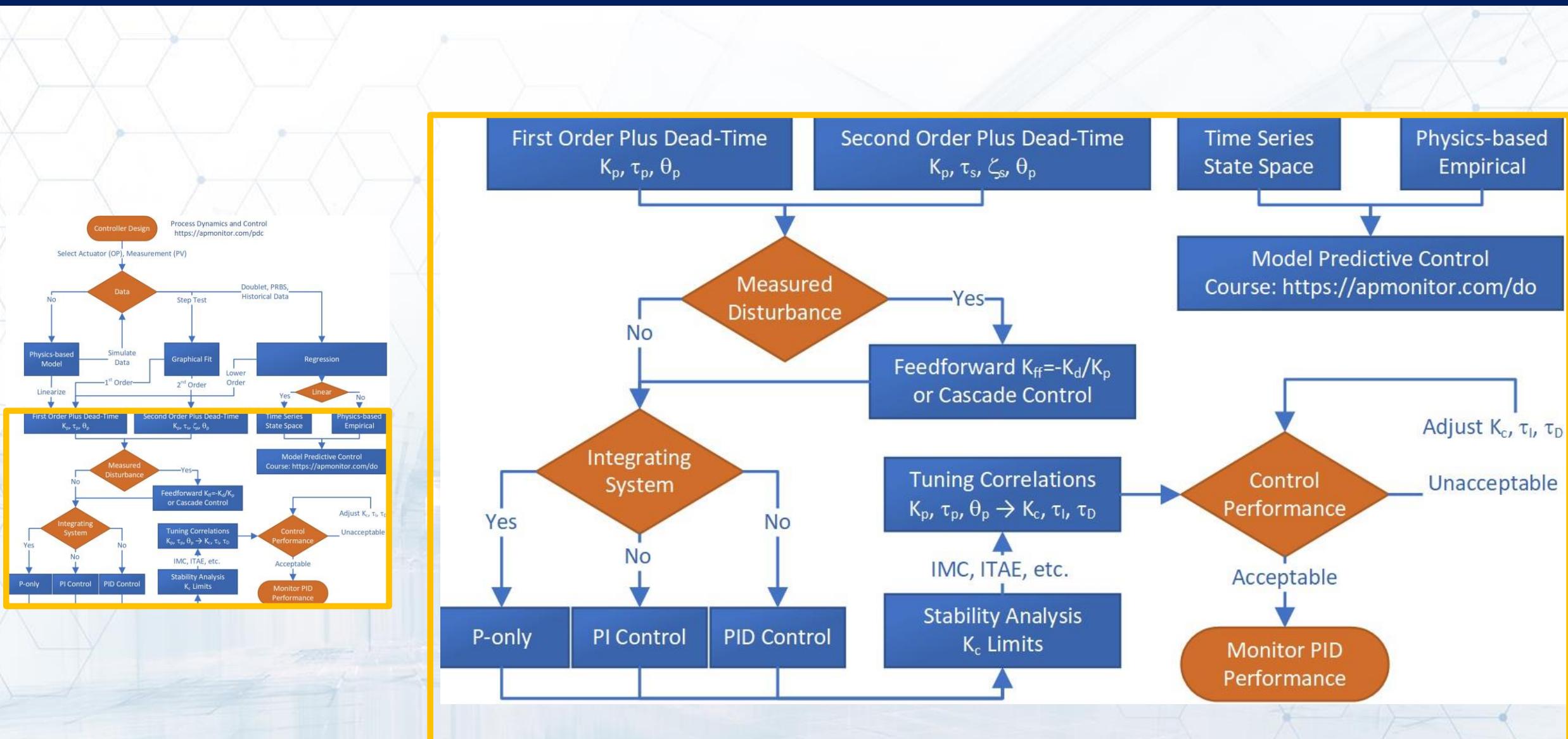


How We Teach Process Control:
2015 Survey Results
Silverstein, D.L., Vigant, M.A.,
Staehle, M.

Belajar Dinamika dan Pemrograman dengan TCLab

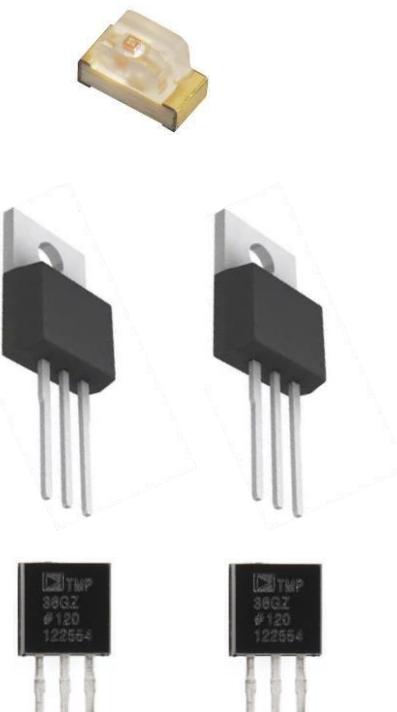
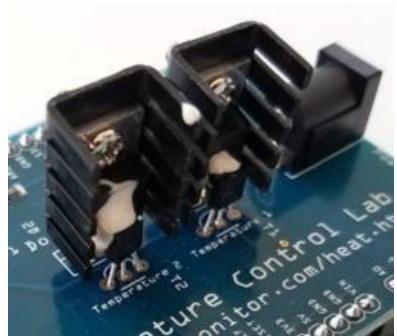
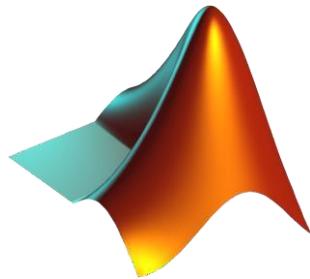


Belajar Kontrol dan Pemrograman dengan TCLab



MATLAB Interface

```
close all; clear all; clc  
  
tclab; % load TCLab  
  
disp('Flash LED')  
led(1)  
pause(2);  
led(0)  
  
disp('Heaters')  
h1(50); h2(50);  
pause(5);  
h1(0); h2(0);  
  
disp('Temperatures')  
disp(T1C())  
disp(T2C())
```

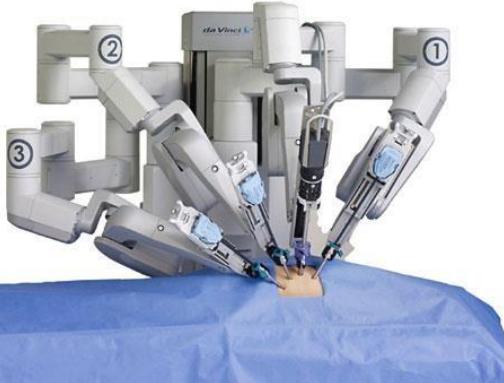


Python Interface

```
import tclab  
import time  
lab = tclab.TCLab() # Connect  
  
print("Flash LED")  
lab.LED(100)  
time.sleep(2)  
lab.LED(0)  
  
print("Heaters")  
lab.Q1(50); lab.Q2(50);  
time.sleep(5)  
lab.Q1(0); lab.Q2(0);  
  
print("Temperatures")  
print(lab.T1)  
print(lab.T2)
```



Gambaran Penerapan Sistem Kendali di Dunia Nyata



Medical Automation



People Transportation



Product Transportation

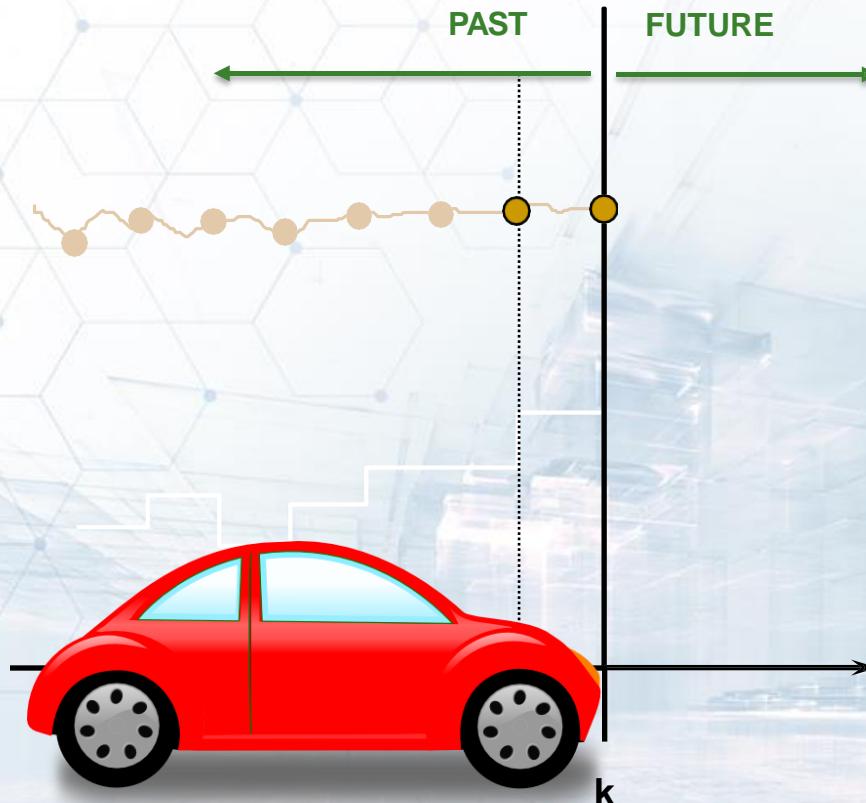
Oil and Gas Industry



New Topics: Data Science, Analytics, Machine Learning, Cybersecurity, Digitalization

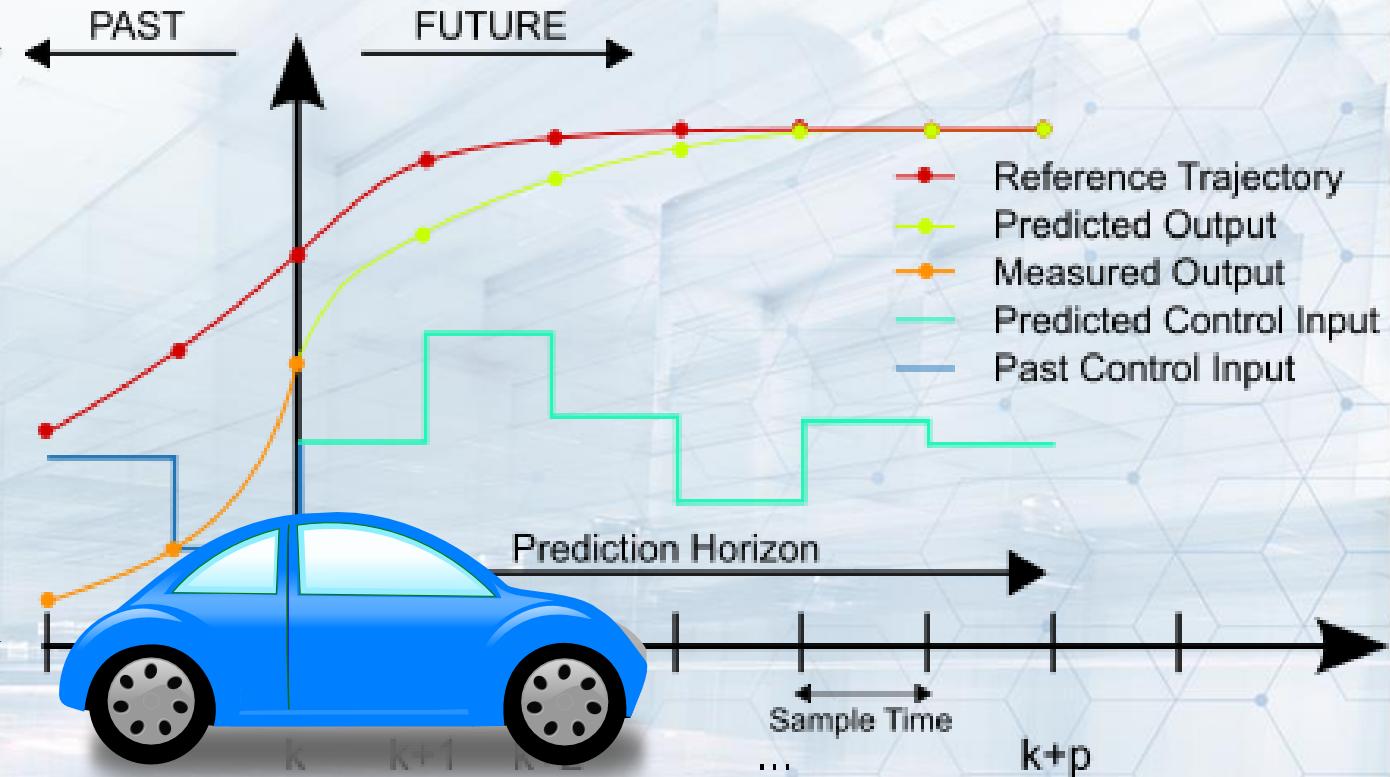
Gambaran Penerapan Sistem Kendali di Dunia Nyata

Conventional Feedback Control



Driving While Looking in Reverse
(Feedback)

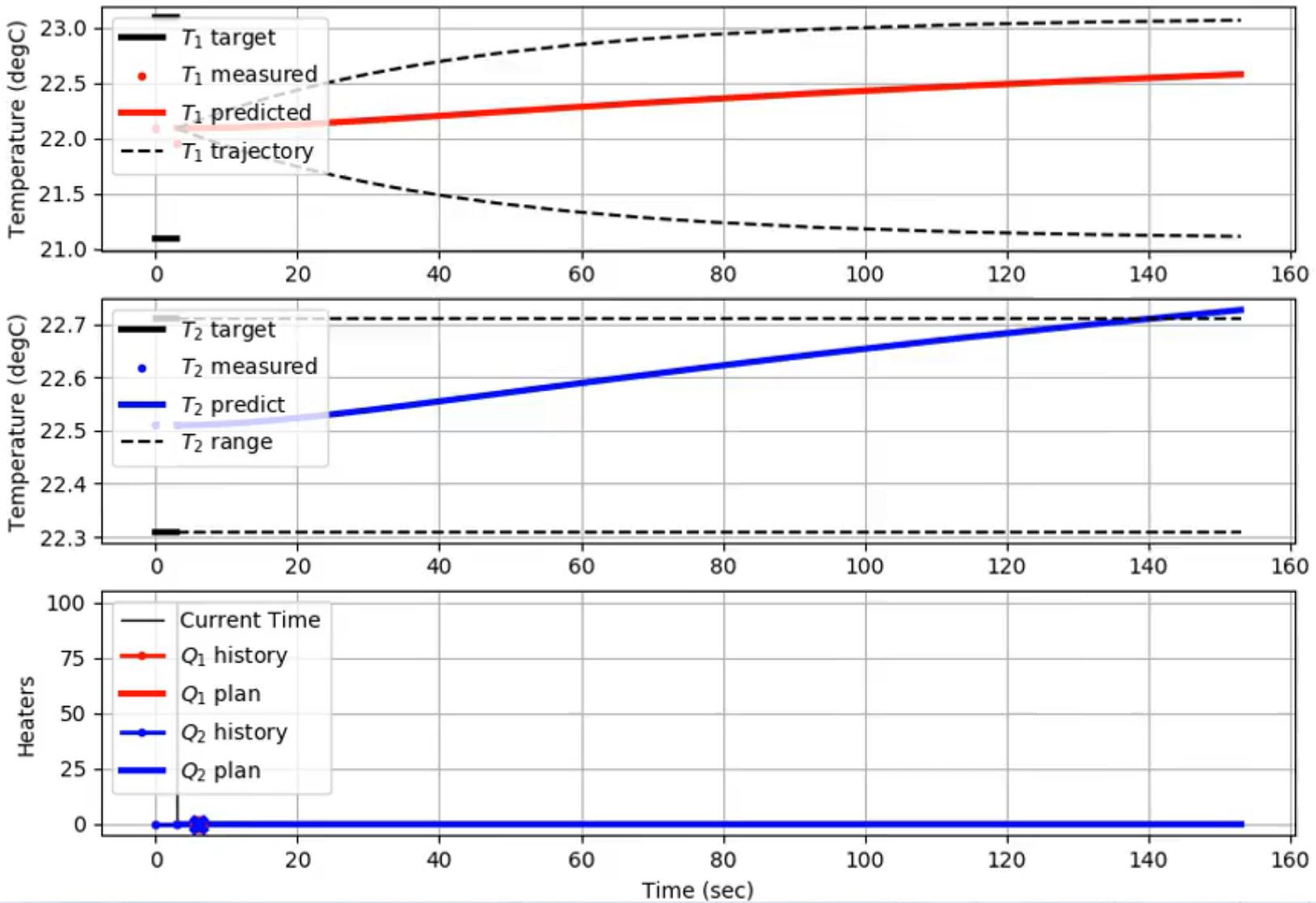
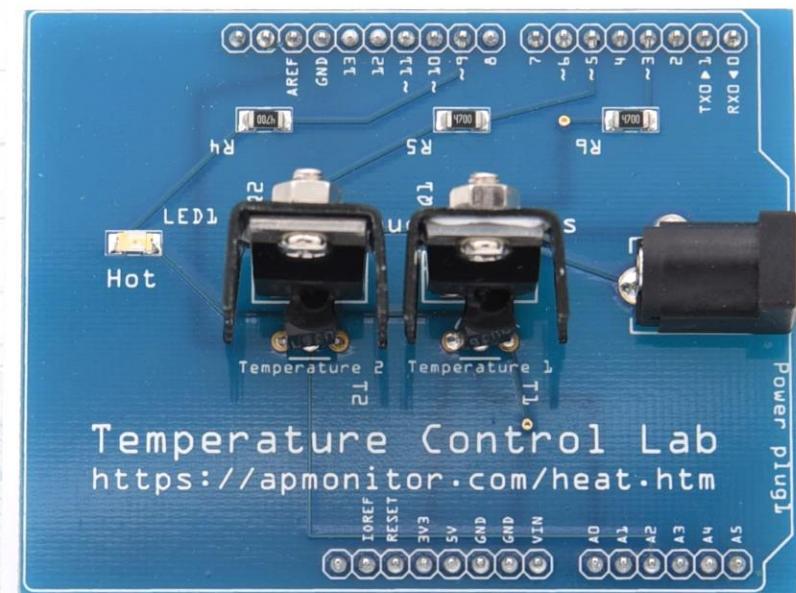
Model Predictive Control



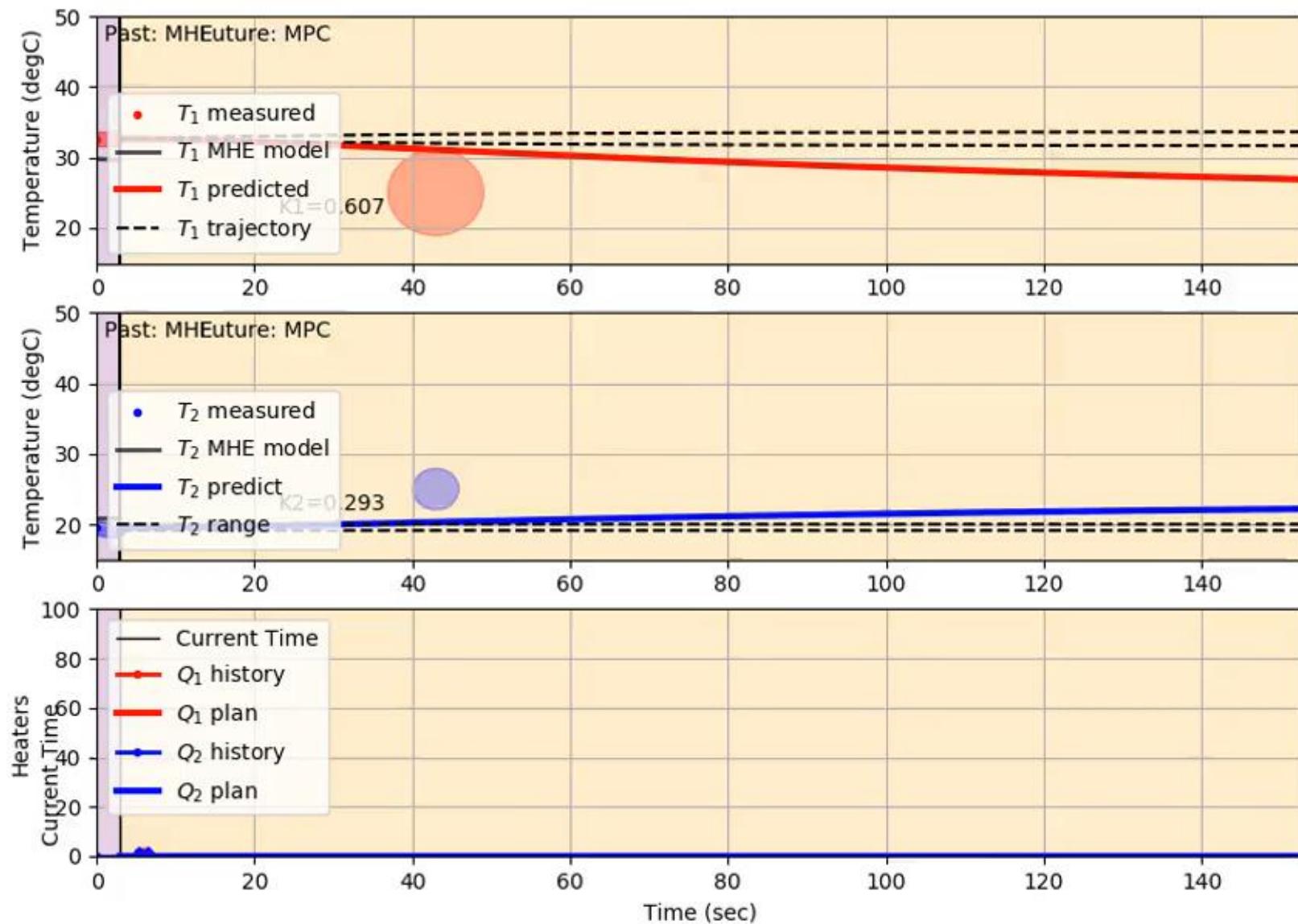
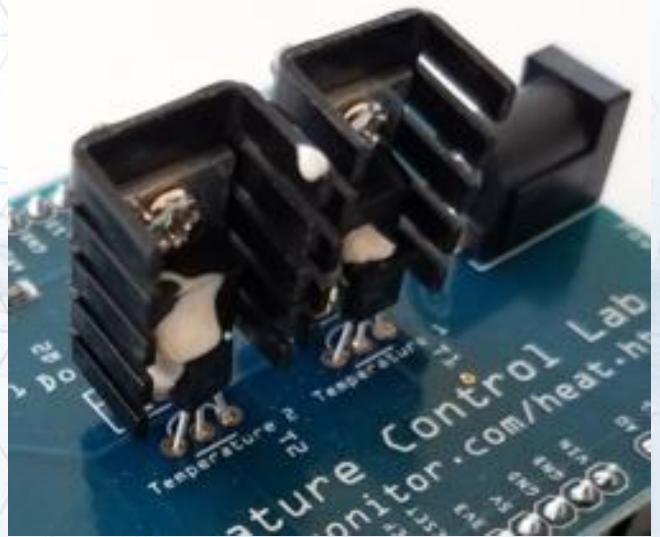
Driving While Looking Forward
(Predictive or Feedforward)

- Reference Trajectory
- Predicted Output
- Measured Output
- Predicted Control Input
- Past Control Input

Gambaran Sistem TCLab

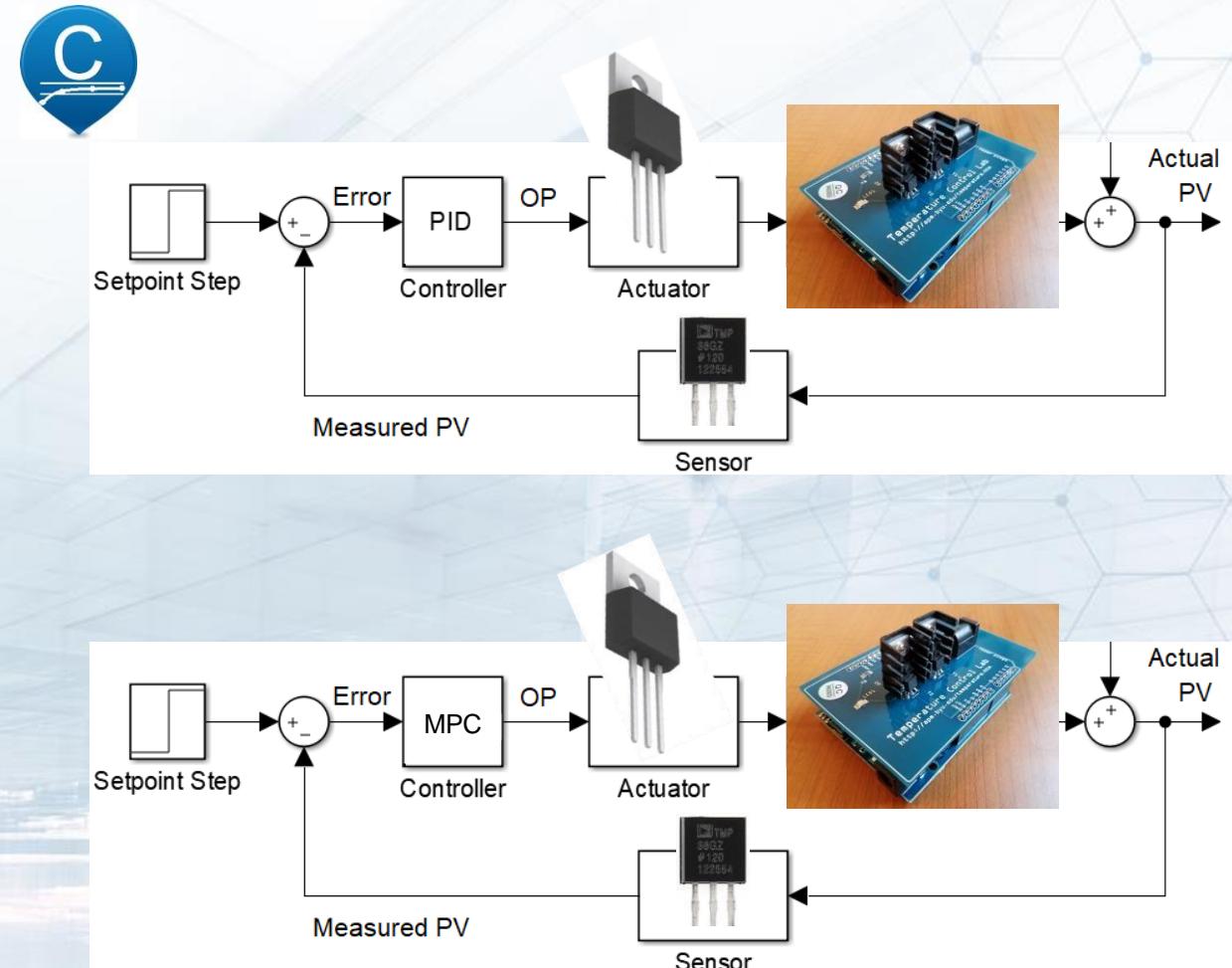


Gambaran Sistem TCLab



Gambaran Sistem TCLab

- Controller Options
 - Open or Closed Loop
 - SISO or MIMO
 - On / Off Control
 - PID Feedback Control
 - Feedforward Trim
 - Model Predictive Control
- Identification and Estimation
 - Step Response Model
 - Kalman Filter
 - Moving Horizon Estimation



Pengguna TCLab



Teaching Process Dynamics & Control

Hands-On TCLab in Simulink and Python

John Hedengren, Ph.D.

To be presented at AIChE 2019 with co-authors

R. Abraham Martin
Jeffrey Kantor
Nigel Reuel



Webinar, Tues Oct 29, 2019



<https://youtu.be/4oICU3ZOxRs>



BAGAIMANA DENGAN iTCLab

Permit for TCLab Development

External

Inbox x



Basuki Rahmat <basukirahmat.if@upnjatim.ac.id>

to john.hedengren, Ni, Intan, Widi ▾

Thu, Mar 21, 2019, 4:13 PM



Dear Mr. John Hedengren,

I am Basuki Rahmat, one of the lecturers at the Universitas Pembangunan Nasional "Veteran" Jawa Timur (<http://www.upnjatim.ac.id>). One of the state universities in Indonesia. I am the Deputy Dean for Student Affairs, Entrepreneurship and Cooperation, Faculty of Computer Science.

We thank you for the TCLab your shipment has been received (picture attached).

Furthermore, to facilitate the need for practice at our campus or the people we want to train in how to use TCLab as one of the control devices, we ask permission to learn about the possibility that we will make this product ourselves.

For this purpose, whether there must be special permission from the BYU campus (<https://www.byu.edu>) or just enough to ask permission through this email.

Thus, we request your response.

Thank you,

Dr. Basuki Rahmat, S.SI, MT

https://www.researchgate.net/profile/Basuki_Rahmat2

<https://scholar.google.com/citations?user=BjCi4AgAAAAJ&hl=en>

<https://fitri.academia.edu/BasukiRahmat>

BAGAIMANA DENGAN iTCLab

 John Hedengren <john_hedengren@byu.edu>

Thu, Mar 21, 2019, 7:42 PM



to me ▾

Dear Basuki,

Yes, please feel free to use the TCLab kit however you would like. The software and hardware are open source. Here is additional information that may help:

<https://www.dropbox.com/s/9lyr6k9c4r28p9n/Hands%20On%20Process%20Control.pptx?dl=0>

If you need any additional TCLab kits, I have them available for \$25 each (orders of 10+) for university instructors.

Best regards,

John Hedengren

Gambaran Sistem iTCLab



Sensor



Actuator



Controller

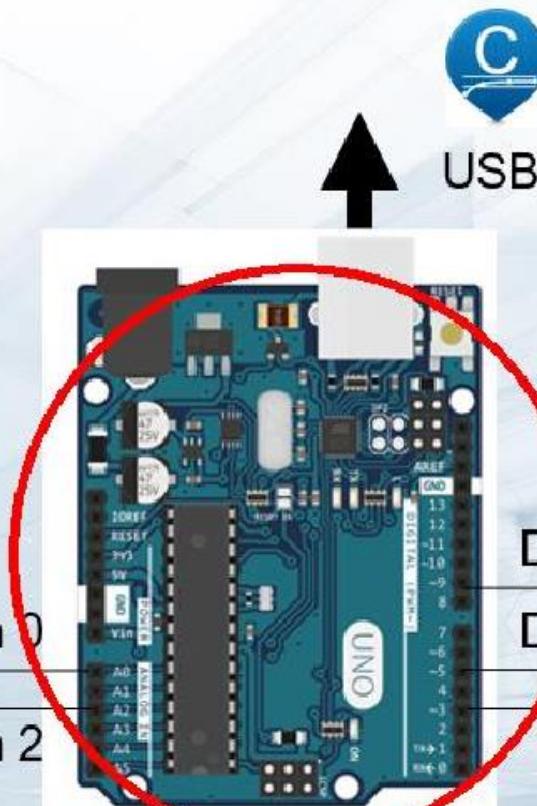
Temperature 1



Analog Pin 0



Temperature 2



USB Serial Connection

LED



Digital Pin 9

Digital Pin 5

Digital Pin 3

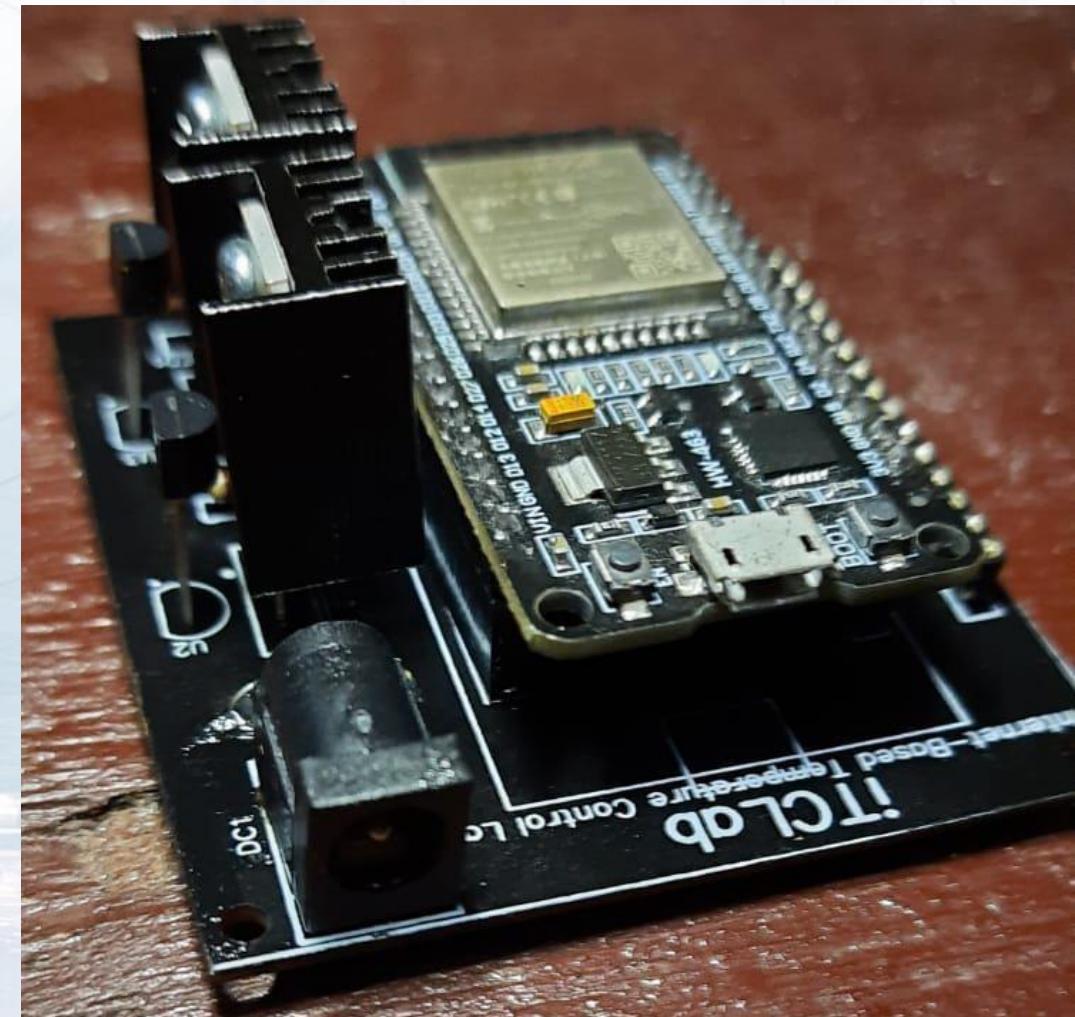
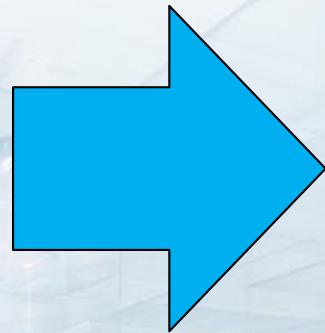
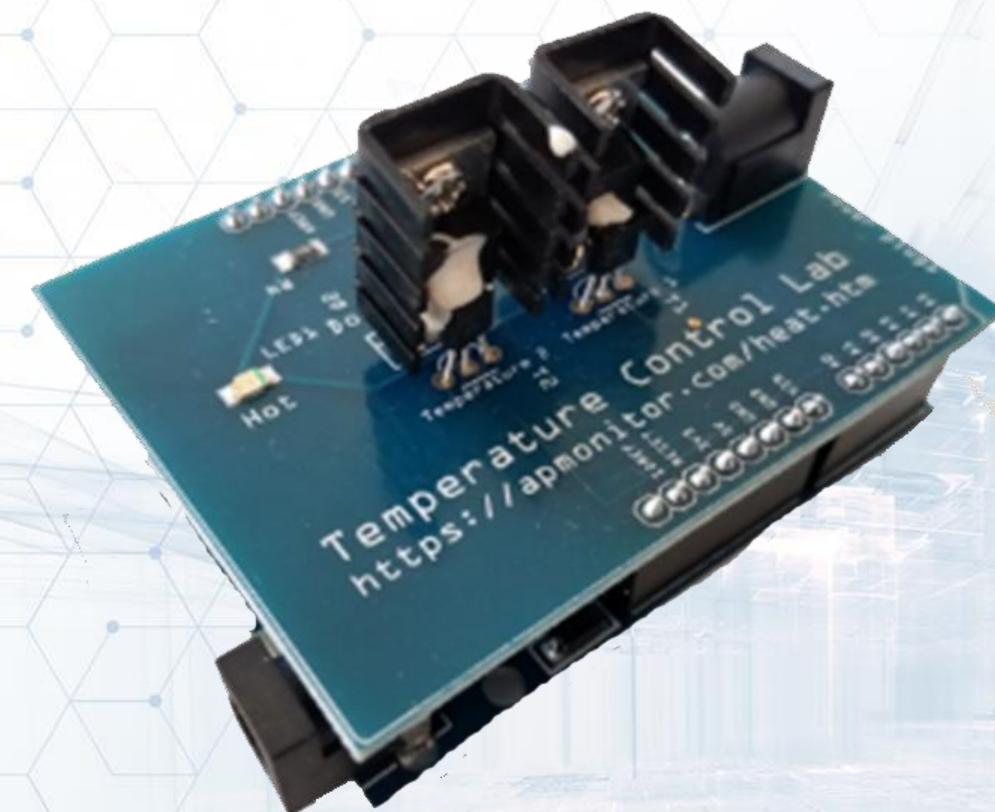


Heater 2

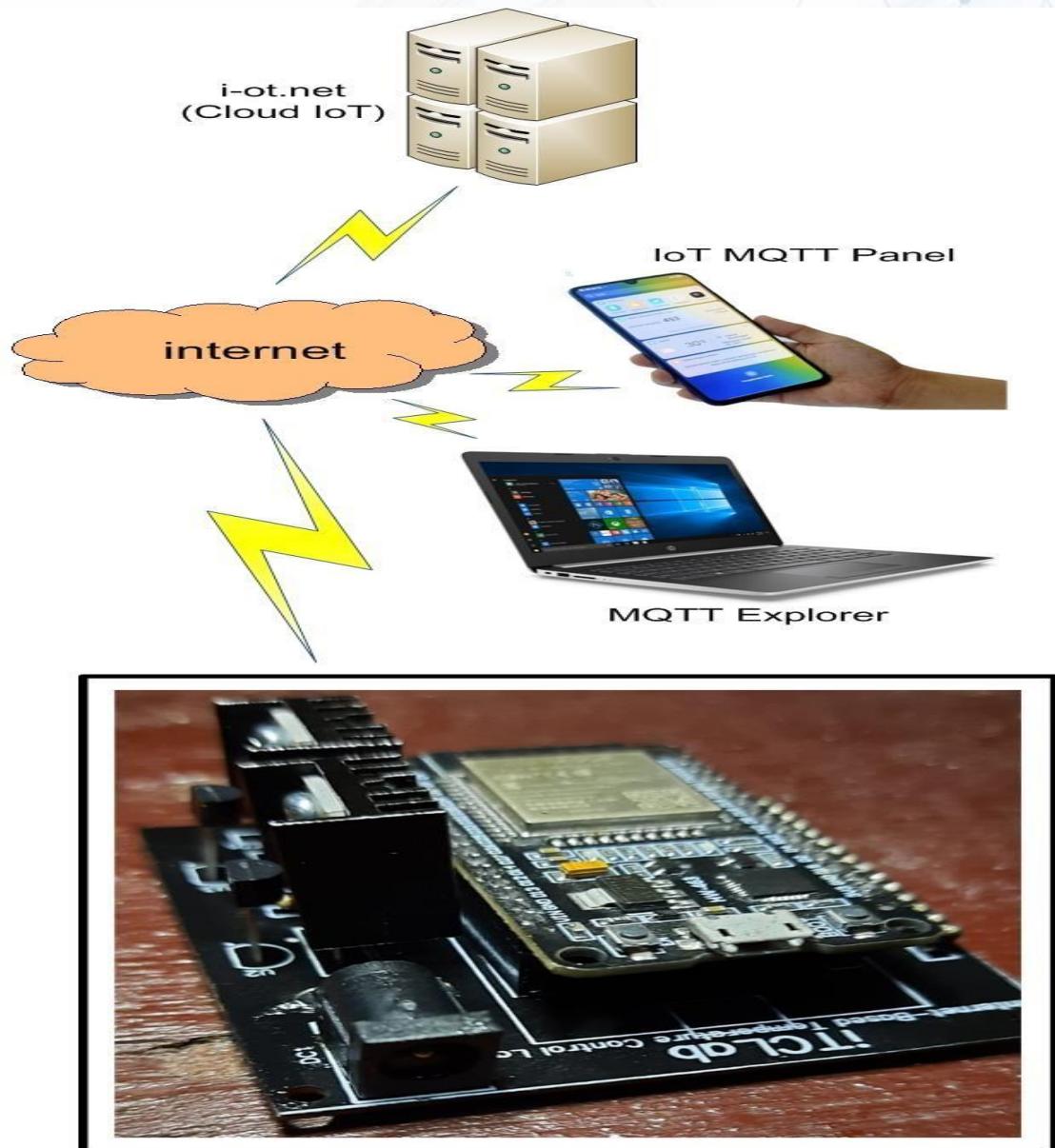
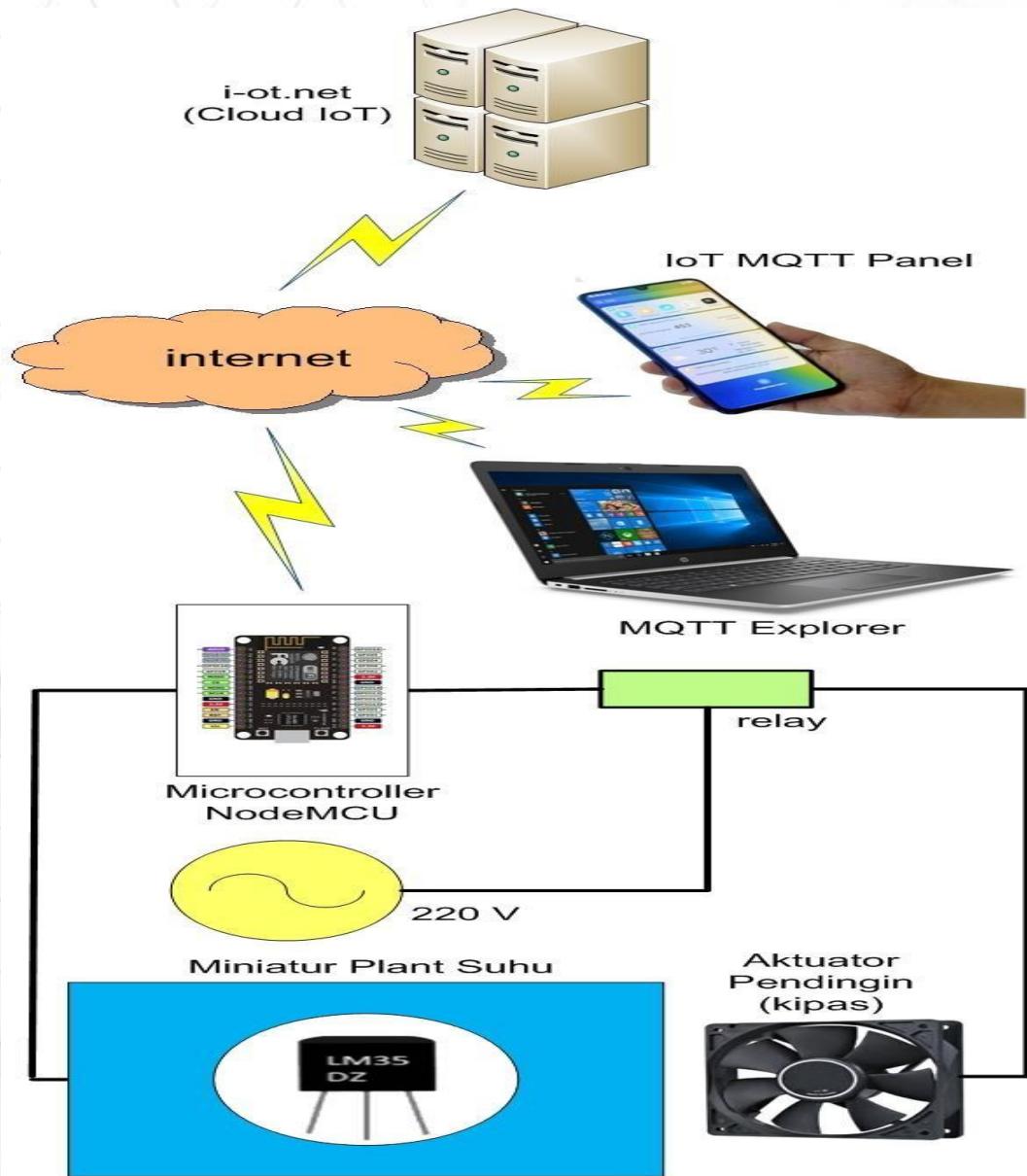


Heater 1

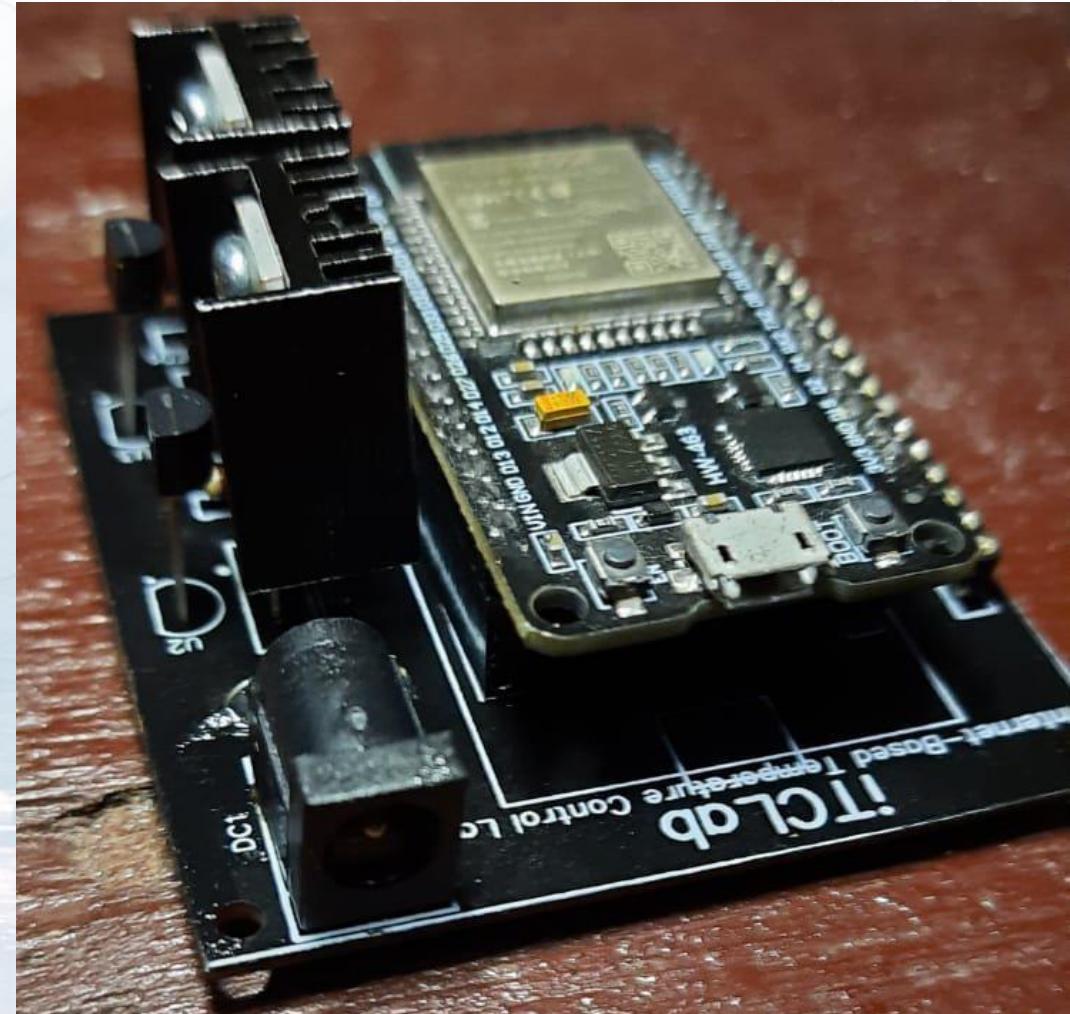
Gambaran Sistem iTCLab



Gambaran Sistem iTCLab

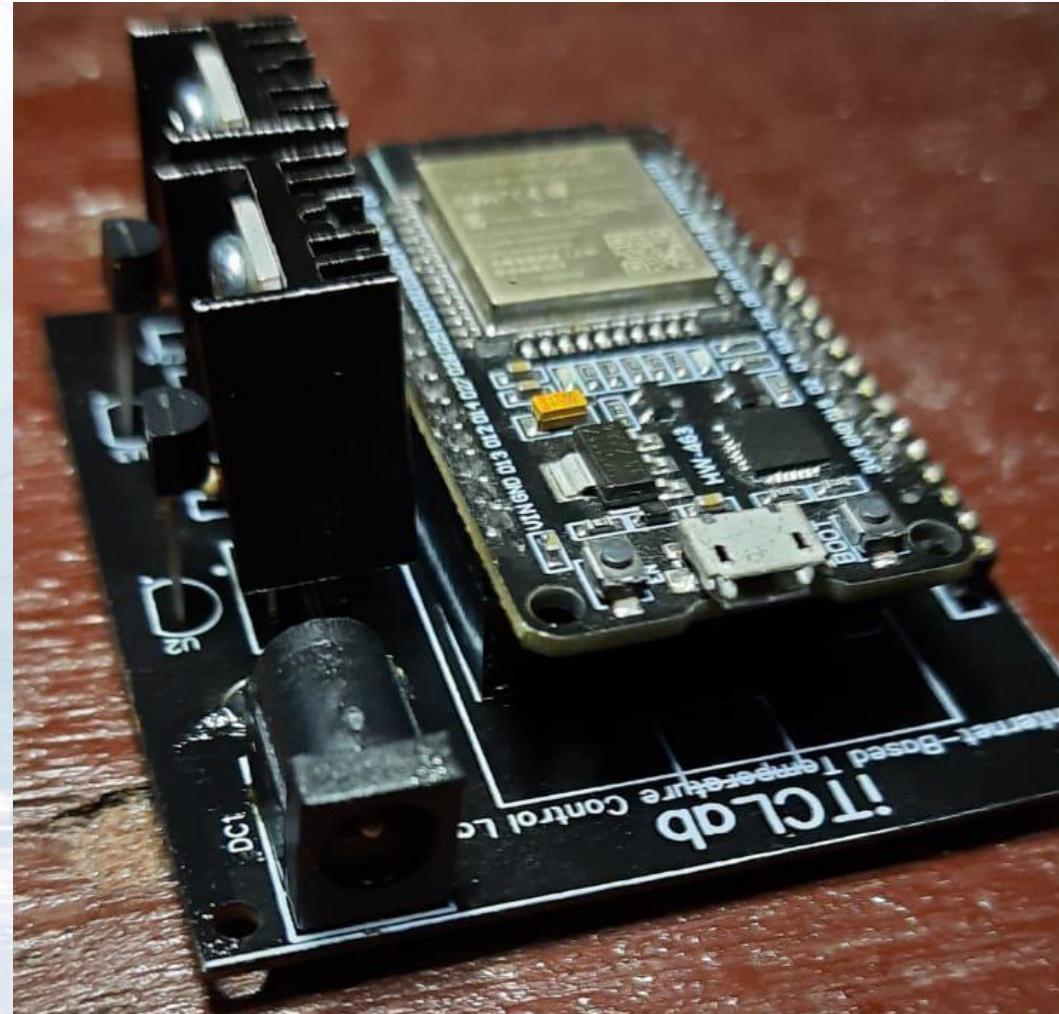


- ❑ TCLab Plus
- ❑ Bisa koneksi IoT
- ❑ Tidak perlu beli jauh-jauh ke BYU Provo US, cukup main ke BNU



iTCLab Bisa digunakan untuk Apa saja?

- ❑ Belajar IoT
- ❑ Belajar Dinamika Sistem
- ❑ Belajar Sistem Kontrol
- ❑ Belajar Machine Learning
- ❑ Belajar Pemrograman Arduino dan Python



PRAKTEK PEMROGRAMAN IoT-AI

Praktek Pemrograman IoT-AI

