Technology & Application of Intelligent Internet of Things

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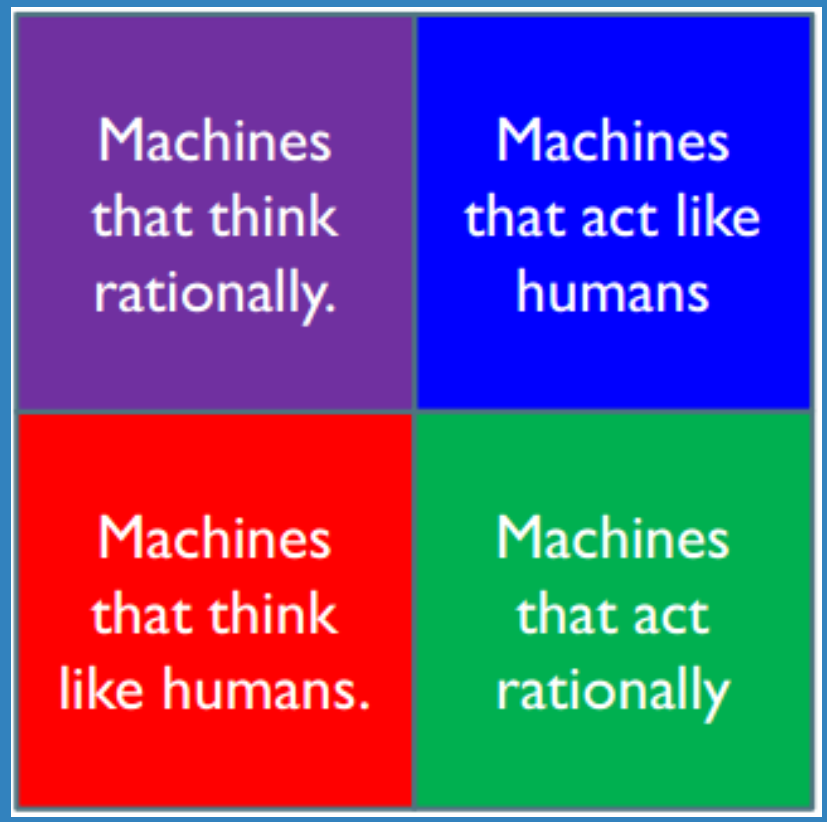
Agenda

- Definition of Artificial Intelligence (AI)
- Some Approaches in AI
- 19 AI Technologies That Are Currently Dominating
- Internet of Things (IoT)
- Applications in Intelligent IoT: Case Study

Definition of Artificial Intelligence

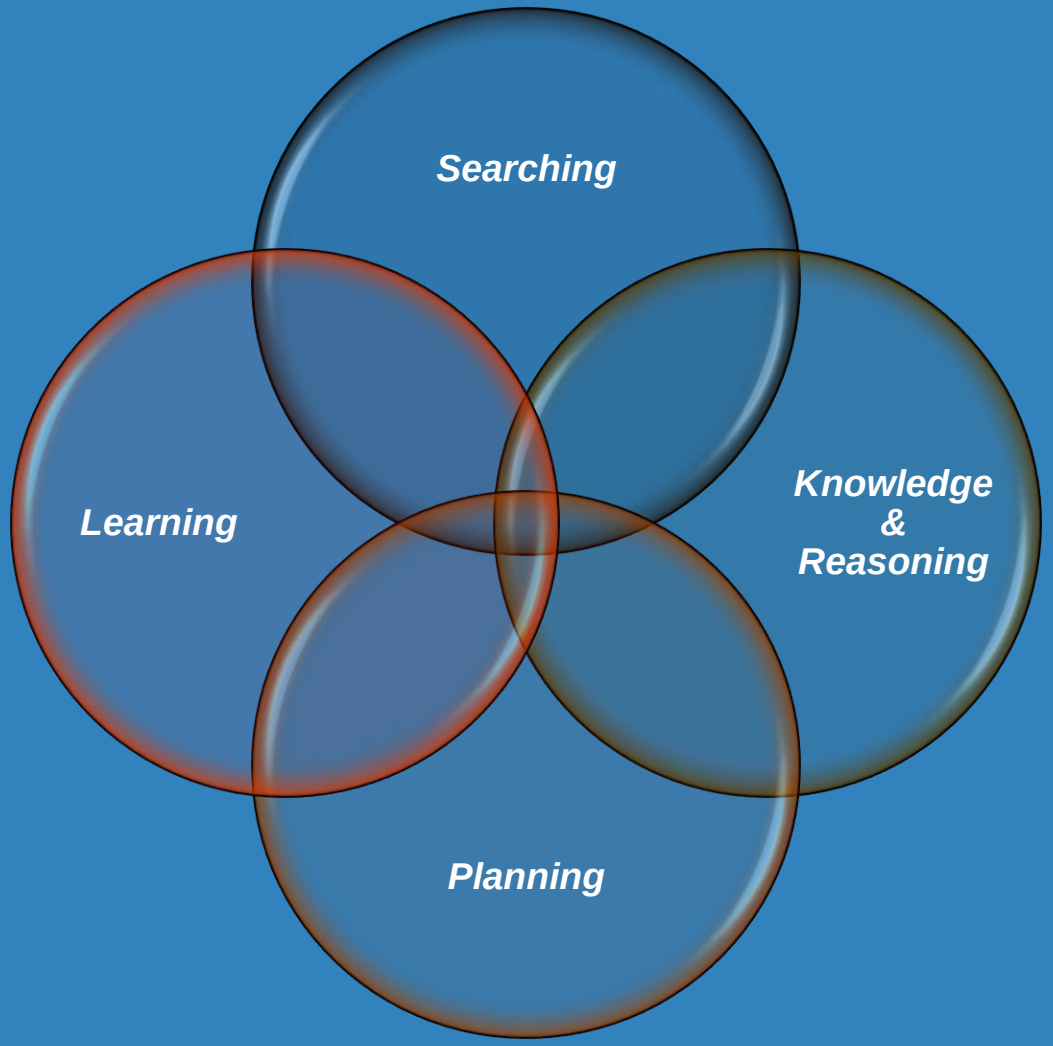
- Define intelligence: The ability to learn and understand, to solve problems and to make decisions.
- Artificial intelligence (AI) scientific goal: To make machines do things with intelligence as done by humans.



4 Categories for Definition of AI

(Russell & Norvig, 1995)

Some Approaches in AI



(Russell & Norvig, 1995)

Searching Approach

- Un-informed Searching
  - ✓ *Breadth-First Search* (BFS)
  - ✓ *Depth-First Search* (DFS)
  - ✓ *Depth-Limited Search* (DLS)
  - ✓ *Uniform Cost Search* (UCS)
  - ✓ *Iterative-Deepening Search* (IDS)
  - ✓ *Bi-Directional Search* (BDS)
- Informed Searching
  - ✓ *Hill Climbing*
  - ✓ *Greedy Best-First Search*
  - ✓ *A**
  - ✓ *Iterative Deepening A* (IDA*)*
  - ✓ *Simplified Memory-Bounded A* (SMA*)*
  - ✓ *Bi-directional A* (BDA*)*
  - ✓ *Dynamic Weighting A* (DWA*)*
  - ✓ *Beam A* (BA*)*
  - ✓ *Genetic Algoritma*

Performance Measure :

- ***Completeness***
  Apakah metode tersebut **menjamin penemuan solusi** jika solusinya memang ada?
- ***Optimality***
  Apakah metode tersebut menjamin menemukan solusi yang **terbaik** jika terdapat beberapa solusi berbeda?
- ***Time complexity***
  Berapa lama **waktu** yang diperlukan?
- ***Space complexity***
  Berapa banyak **memori** yang diperlukan?

Knowlegde & Reasoning Approach

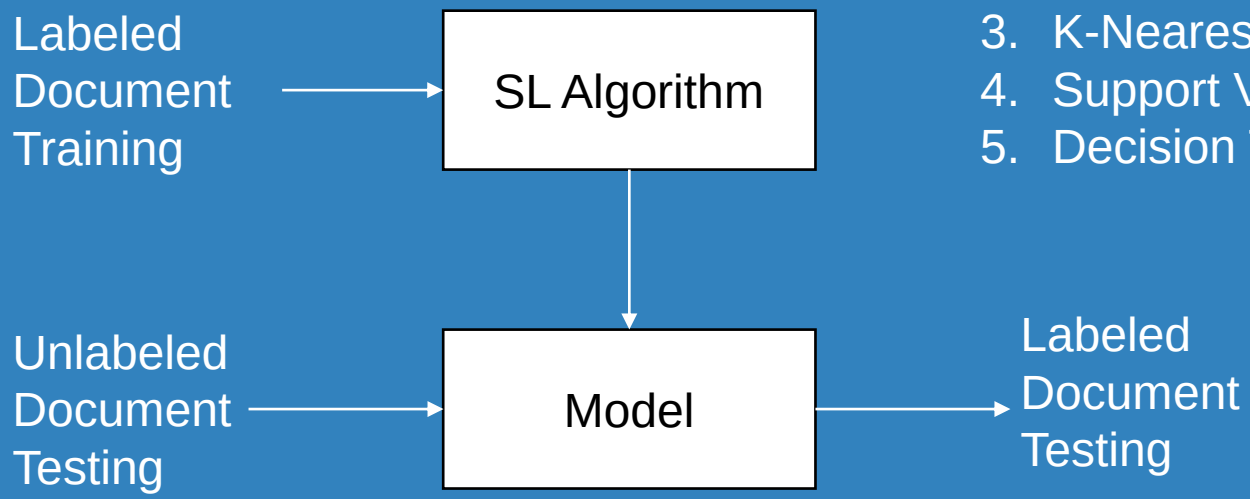
- Propositional Logic
- First-Order Logic
- Fuzzy Systems

Learning Approach

- Supervised Learning
  1. Neural Network
  2. Naïve Bayes
  3. K-Nearest Neighbor
  4. Support Vector Machine
  5. Decision Tree
- Unsupervised Learning
  1. K-Means
  2. K-Medoid
  3. Hierarchical Agglomerative Clustering (HAC)
  4. Fuzzy C-Means (FCM)
  5. Self Organizing Map (SOM)

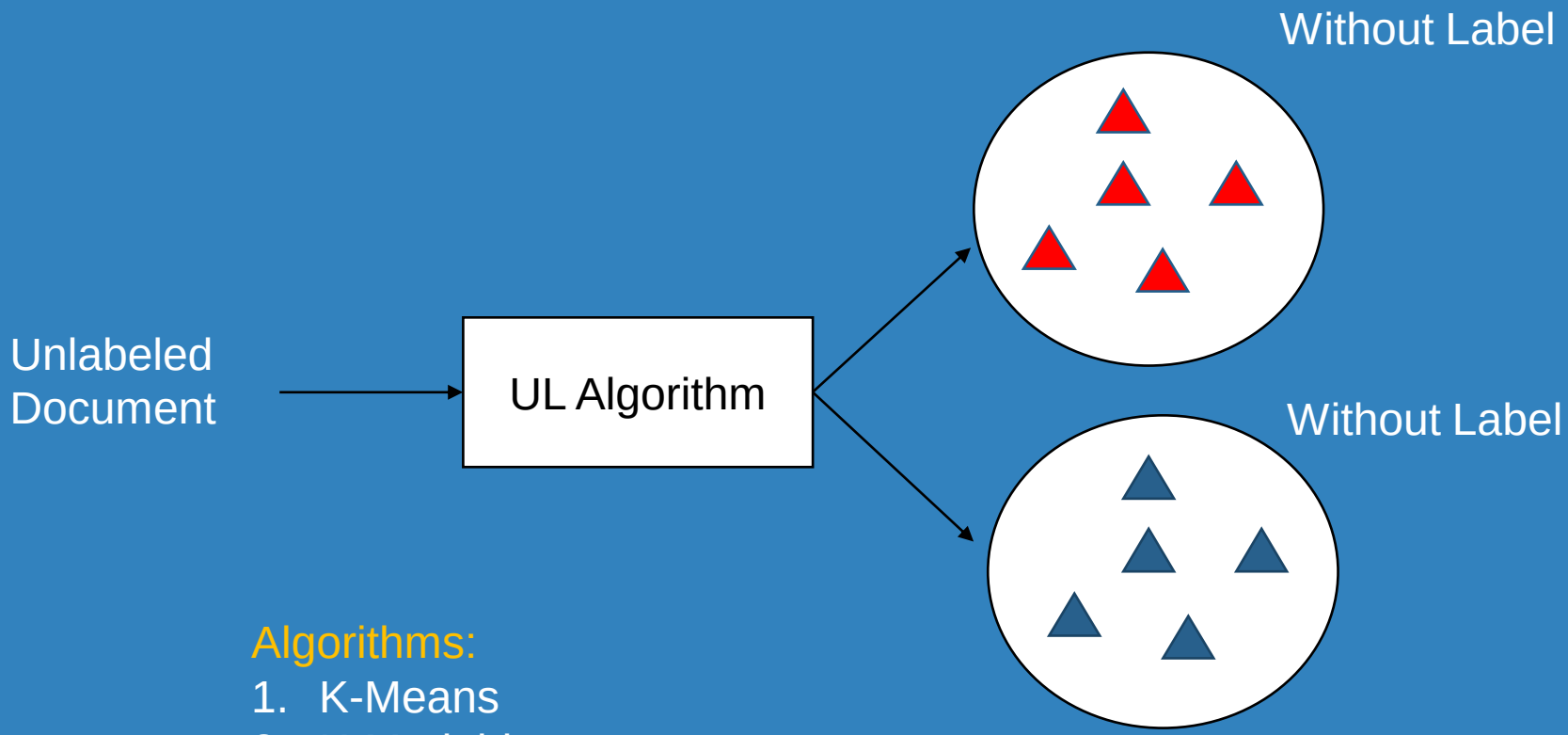
Supervised Learning (SL)

Label:
1. Sport
2. Economy
3. Politic
4. Health



Algorithms:
1. Neural Network
2. Naïve Bayes
3. K-Nearest Neighbor
4. Support Vector Machine
5. Decision Tree

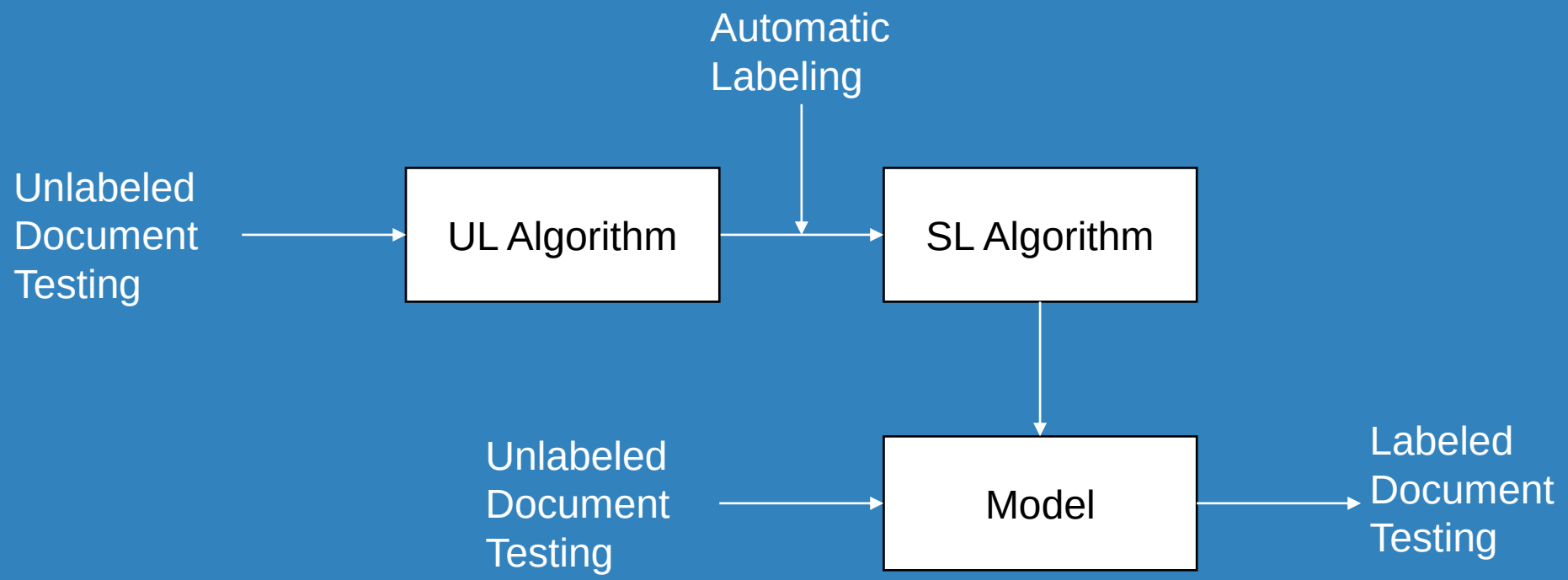
Unsupervised Learning (UL)



Algorithms:

1. K-Means
2. K-Medoid
3. Hierarchical Agglomerative Clustering (HAC)
4. Fuzzy C-Means (FCM)
5. Self Organizing Map (SOM)

Supervised Learning (SL) and Unsupervised Learning (UL)



Planning Approach

Generate sequences of actions to perform tasks and achieve objectives.

- Planning with State-Space Search
- Partial-Order Planning
- Planning Graphs
- Planning with Propositional Logic

19 AI Technologies That Are Currently Dominating

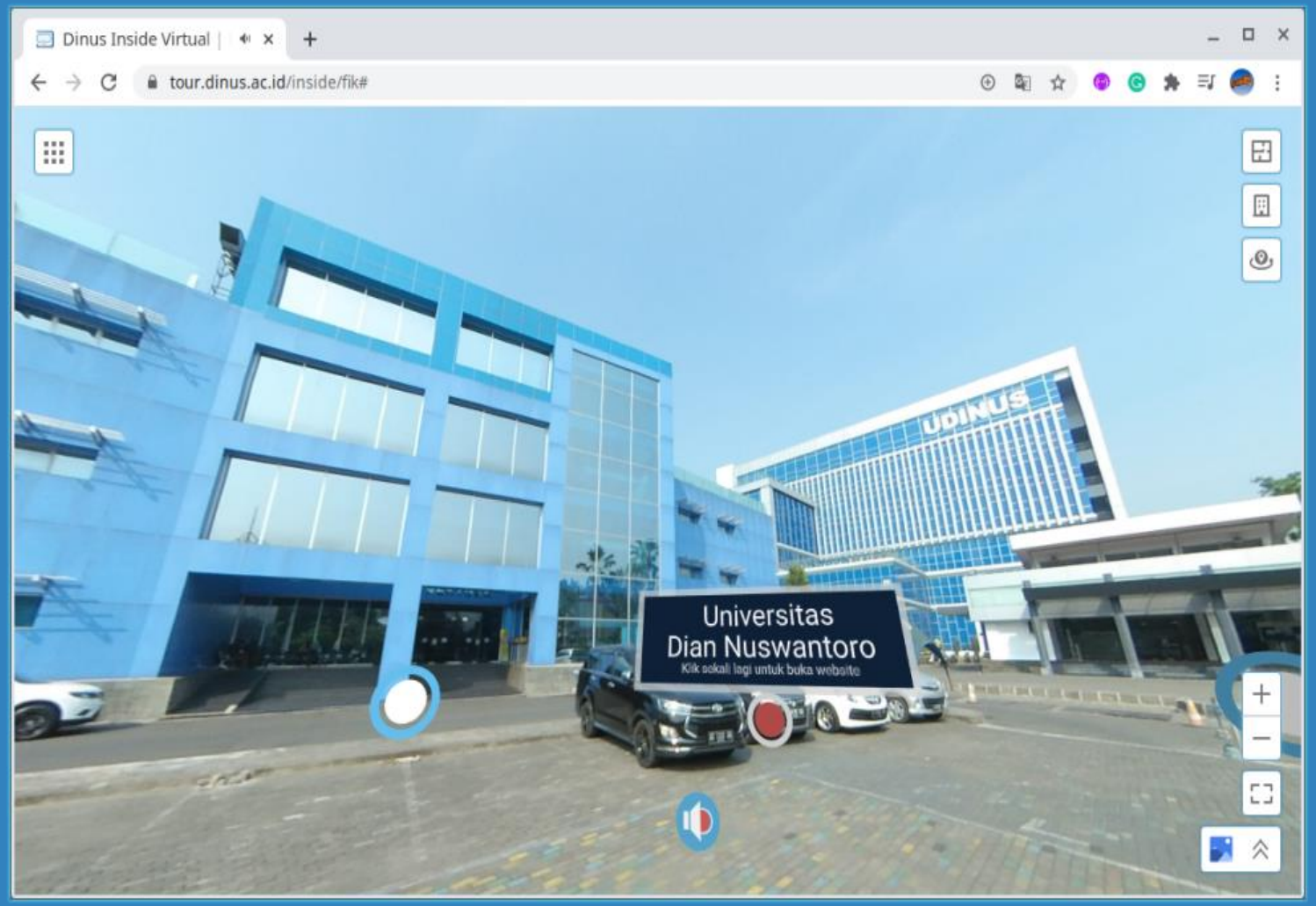
1. Natural Language Generation
2. Speech Recognition
3. Virtual Agents
4. Machine Learning Platforms
5. AI-Optimized Hardware
6. Decision Management
7. Deep Learning Platforms
8. Biometrics
9. Machine Processing Automation
10. Text Analytics and Natural Language Processing
11. Digital Twin/AI Modeling
12. Cyber Defense
13. Compliance
14. Knowledge Worker Aid
15. Content Creation
16. P2P network (Peer-to-Peer Networks)
17. Emotion Recognition
18. Image Recognition
19. Intelligent Marketing (Marketing Automation)

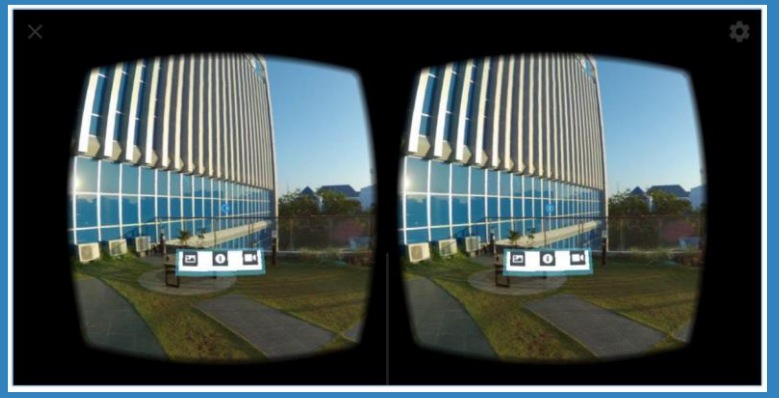
https://tour.dinus.ac.id/

Modul :

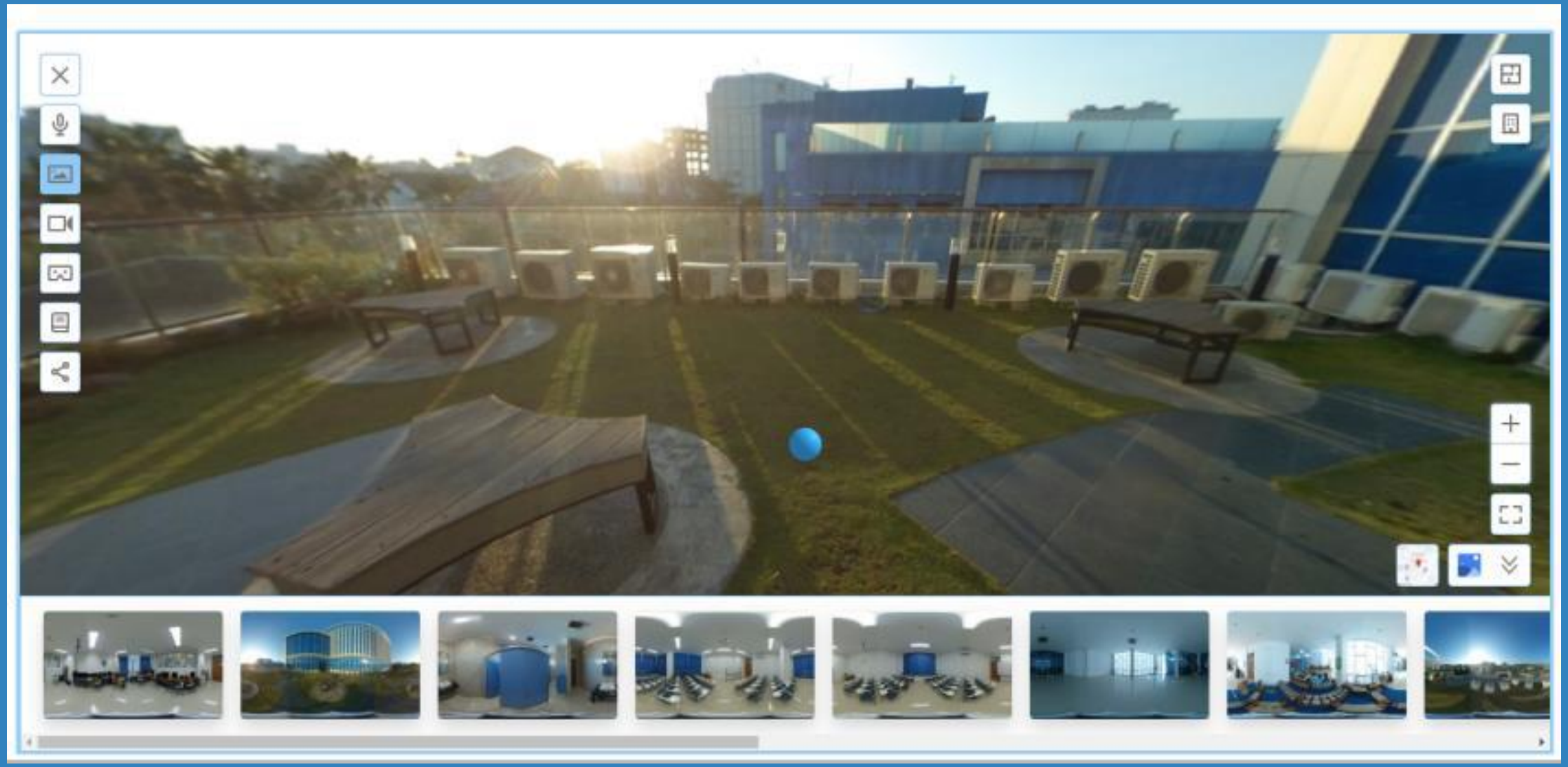
- Virtual Reality
- Automatic Speech Recognition
- Text Processing
- Text Analysis
- Text To Speech

Virtual Reality



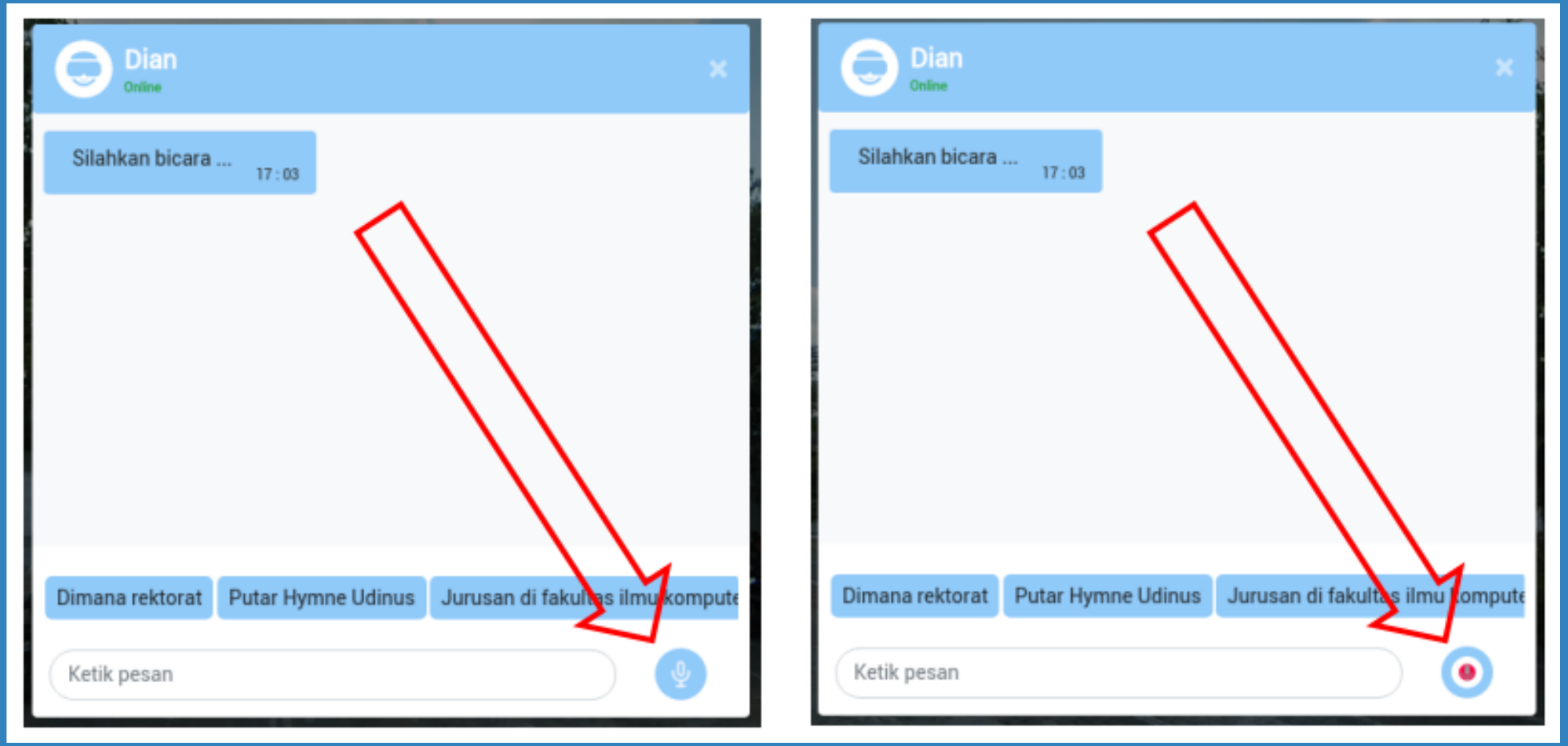


Virtual Reality



Dian Bot

- Automatic Speech Recognition
- Text Processing
- Text Analysis
- Text To Speech



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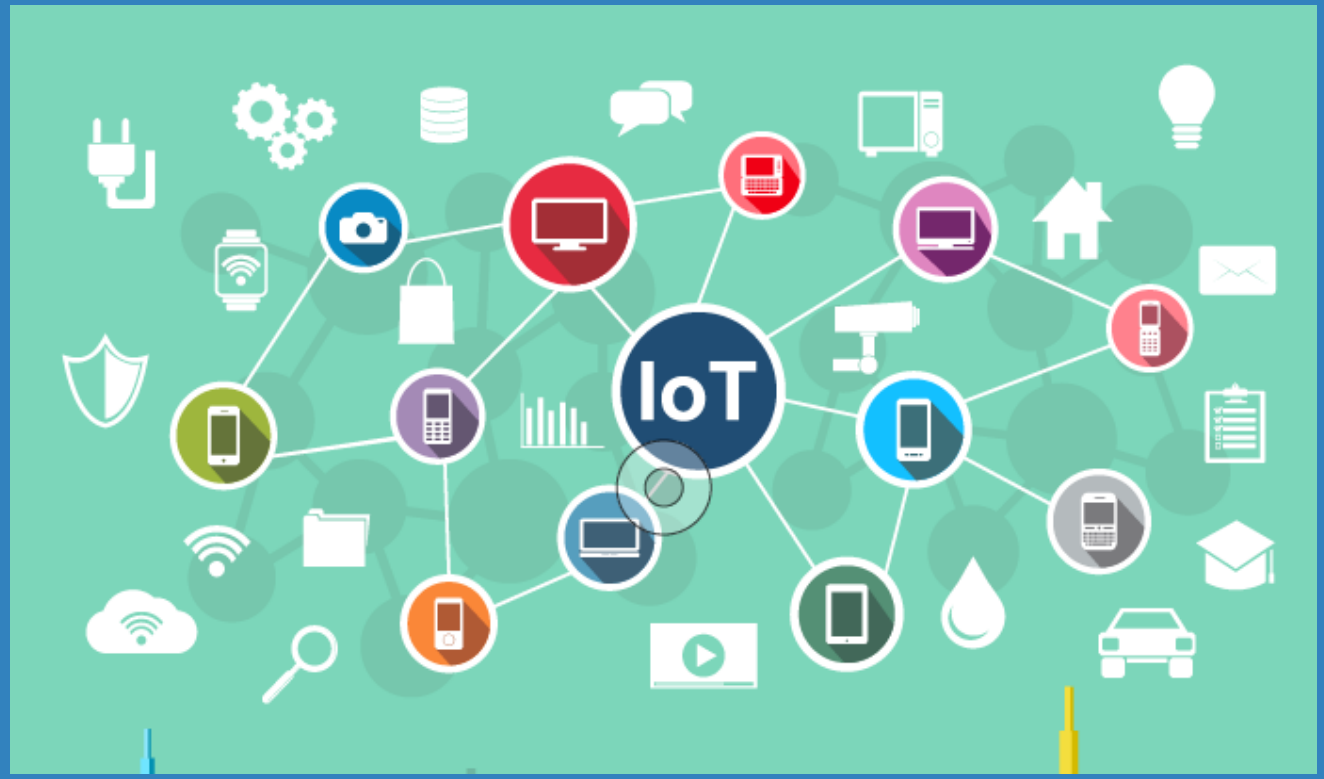
Internet of Things (IOT)

Apakah 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)



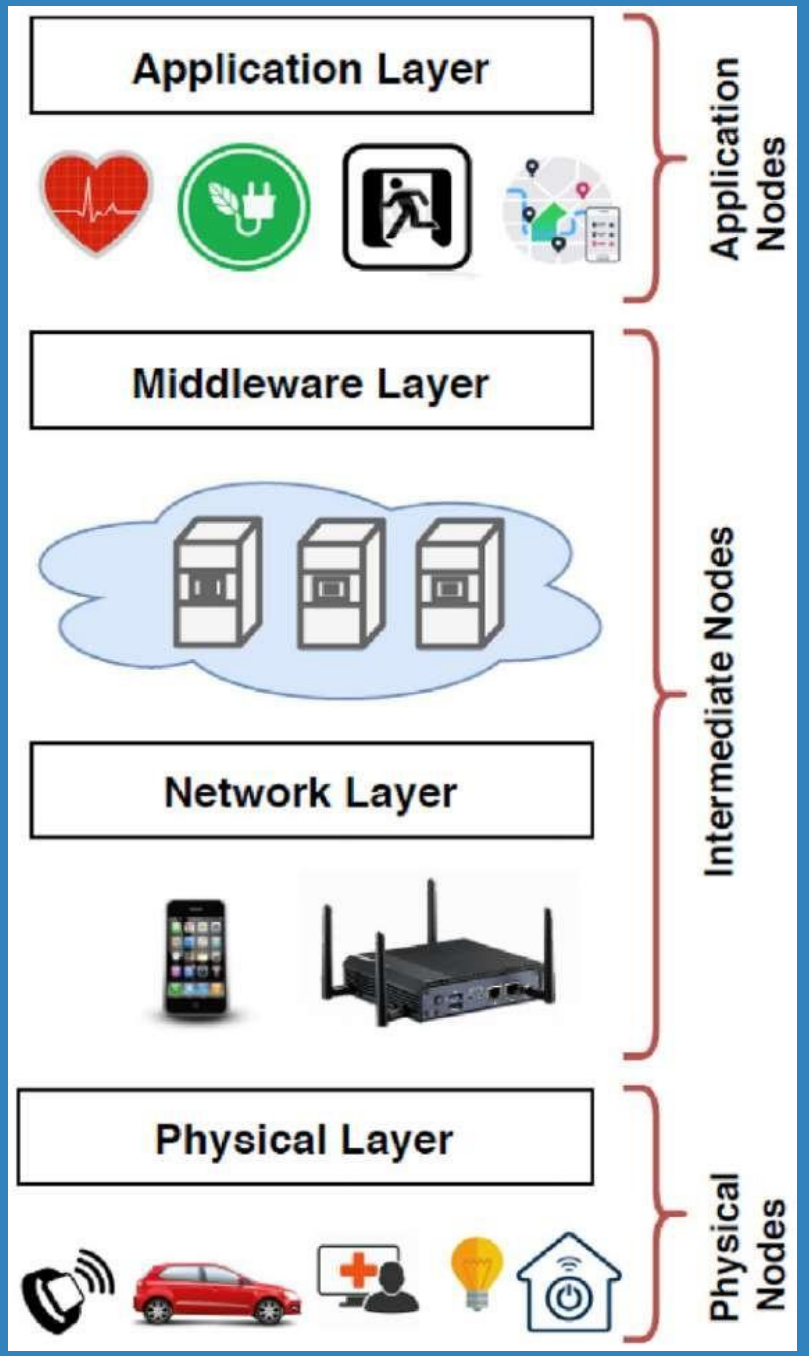
Dimanapun, ada IoT!

(Horn, G. , 2017)

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)

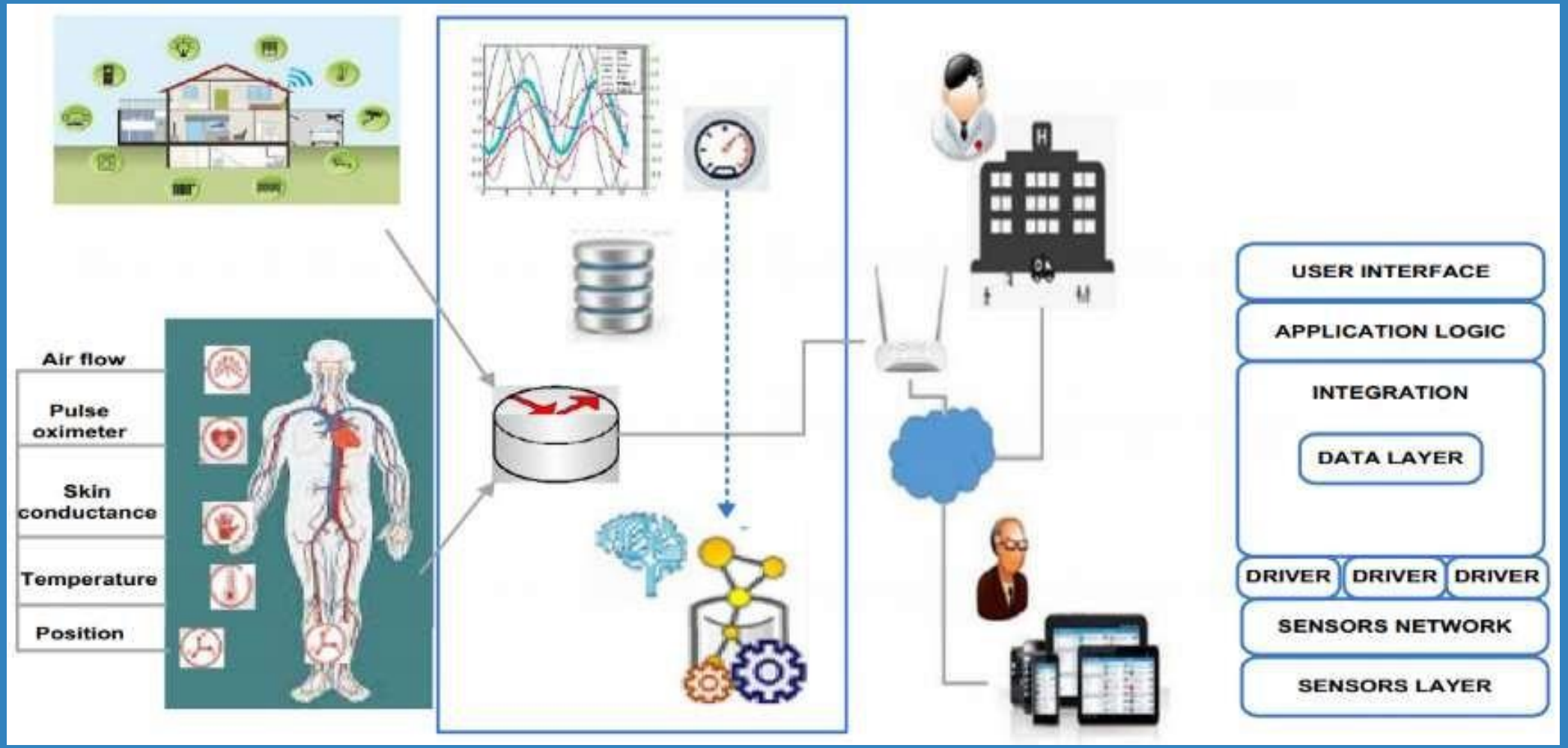


Beberapa Contoh Aplikasi IoT

- ***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).

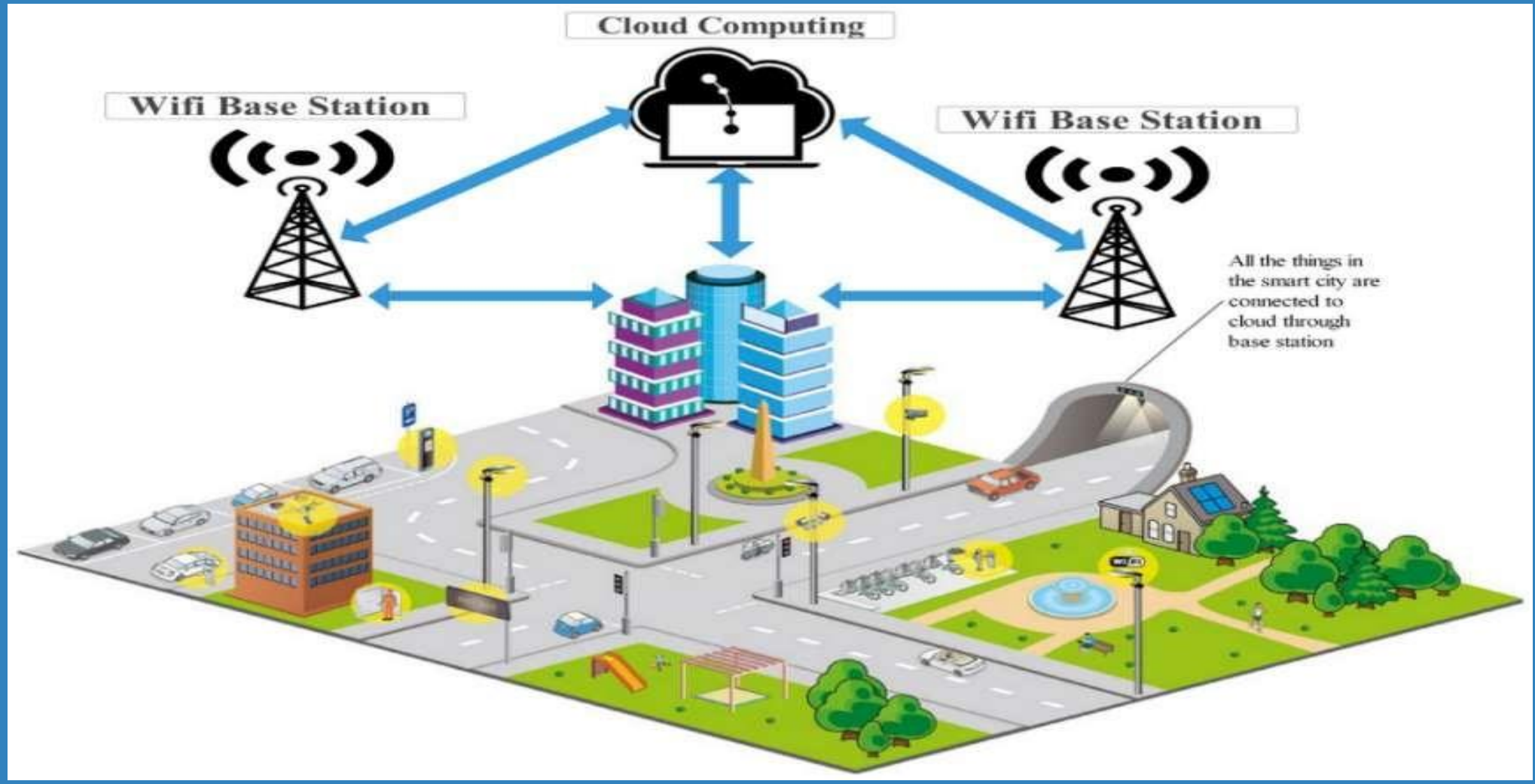
Arsitektur Berbasis IoT untuk Bidang Kesehatan

(Zeadally and Bello, 2019)



Penerapan IoT pada Smart City

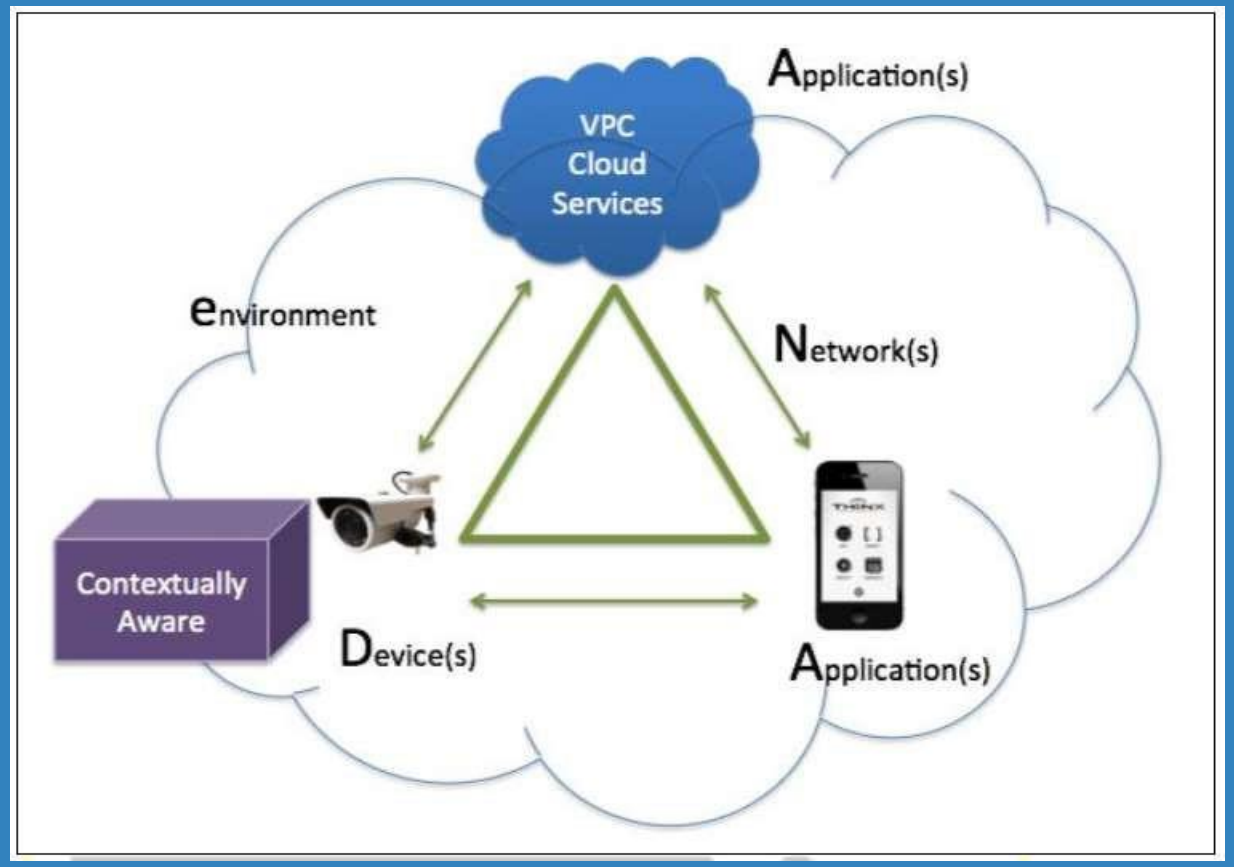
(Gheisari, Wang and Chen, 2020)



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.



Ancaman vs Peluang

- IoT didorong oleh konvergensi tren yang luar biasa: ponsel di mana-mana, perangkat keras, data besar, Kecerdasan Buatan, komputasi awan, pencetakan 3D, dan crowdfunding
- Dunia berkembang dengan cepat kemanapun segala sesuatu akan terhubung
- Jumlah serangan cyber akan meningkat dengan cepat
- Privasi dan keamanan harus ditangani sepenuhnya

Maka …

- Jika salah pemahaman & salah konfigurasi, IoT berisiko terhadap data, privasi, dan keamanan

Tapi …

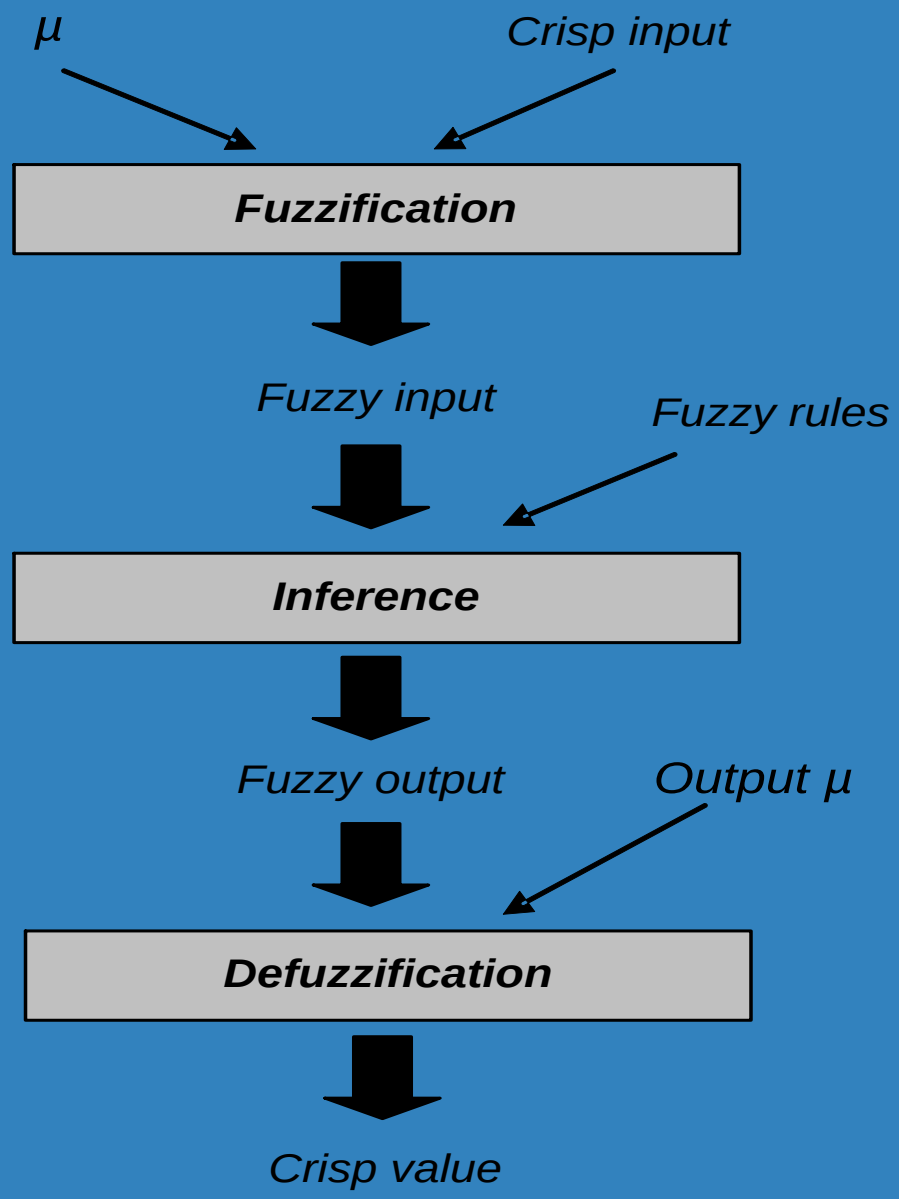
- Jika dipahami & diamankan, IoT akan meningkatkan komunikasi, gaya hidup, dan pengiriman layanan

Case : Sprinkle Control System

- *Input* :
  - Suhu Udara (^{0}C)
  - Kelembaban Tanah (%)
- *Output* : Durasi Penyiraman (menit)
- Misal:
  - Suhu = 37^{0}C, kelembaban = 12%
  - Berapa lama durasi penyiraman yang dilakukan?

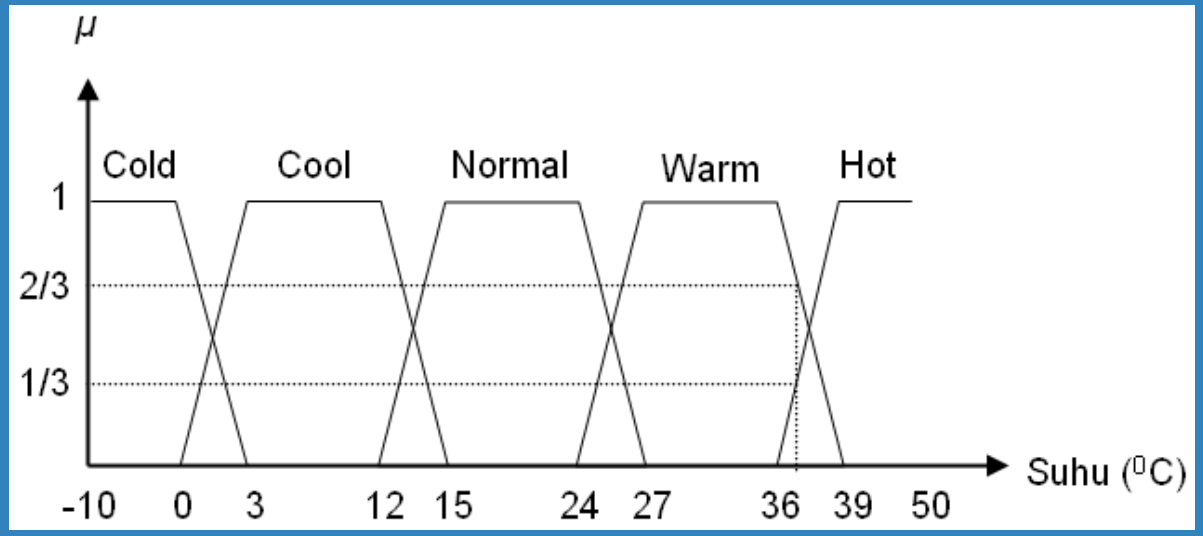
(Suyanto, 2007)

Fuzzy System

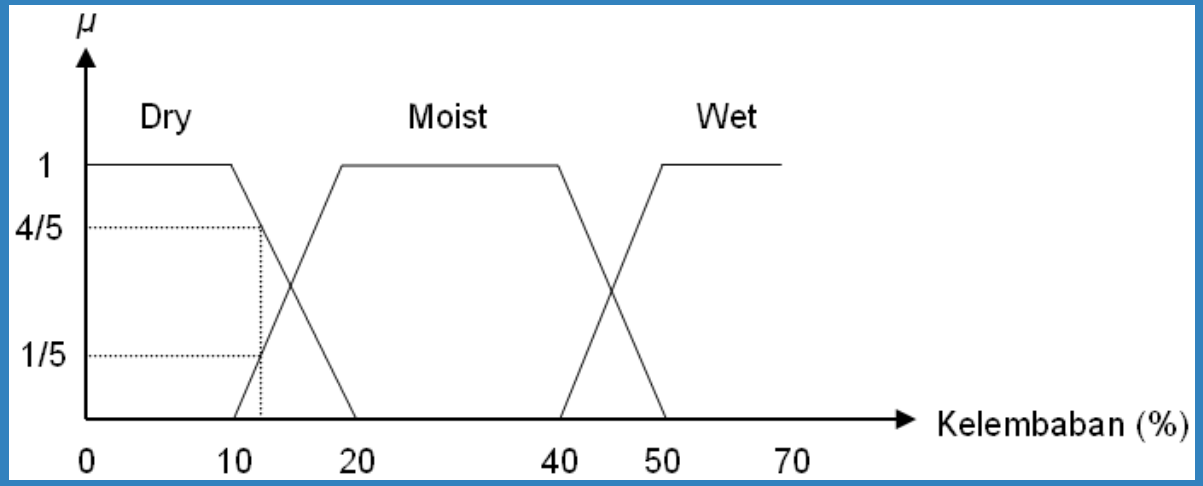


(Suyanto, 2007)

Fuzzification Process



- Warm = -(37-39)/(39-36) = 2/3.
- Hot = (37-36)/(39-36) = 1/3.



- Dry = -(12-20)/(20-10) = 4/5
- Moist = (12-10)/(20-10) = 1/5

(Suyanto, 2007)

Inference Process

Antecedent 1 (Temperature)

Antecedent 2 (Moisture)

	Cold	Cool	Normal	Warm	Hot
Dry	L	L	L	L	L
Moist	L	M	M	M	M
Wet	S	S	S	S	S

Note: L = Long, M = Medium, S = Short

(Suyanto, 2007)

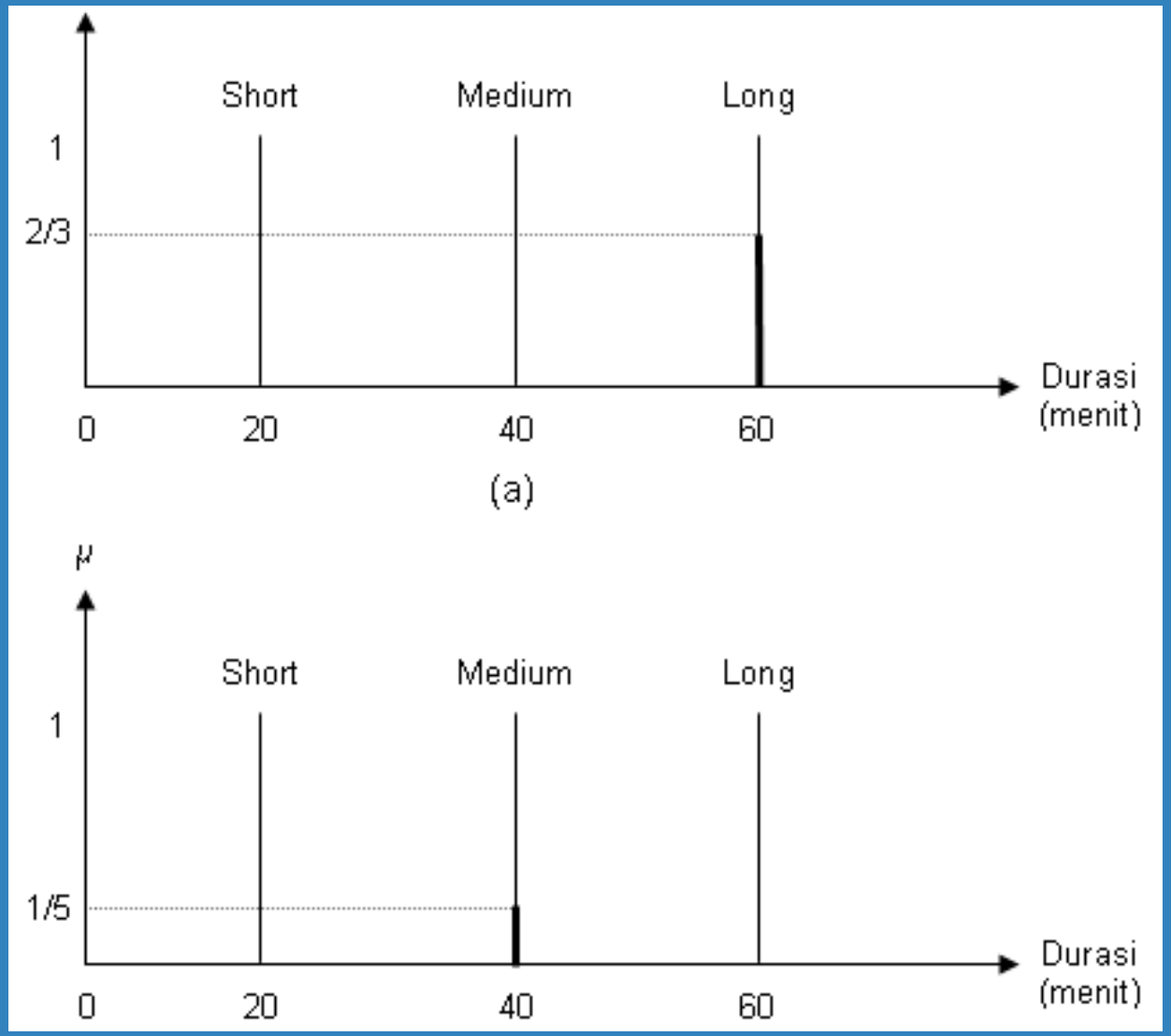
Inference Process

Dari empat data *fuzzy input* di atas, Warm (2/3), Hot (1/3), Dry (4/5) dan Moist (1/5), maka kita mendapatkan 4 aturan (dari 15 aturan) yang dapat diaplikasikan:

- **IF** Suhu is Warm (2/3) **AND** Kelembaban is Dry (**4/5**) **THEN** Durasi is Long (**2/3**)
- **IF** Suhu is Warm (2/3) **AND** Kelembaban is Moist (**1/5**) **THEN** Durasi is Medium (**1/5**)
- **IF** Suhu is Hot (**1/3**) **AND** Kelembaban is Dry (4/5) **THEN** Durasi is Long (**1/3**)
- **IF** Suhu is Hot (1/3) **AND** Kelembaban is Moist (**1/5**) **THEN** Durasi is Medium (**1/5**)

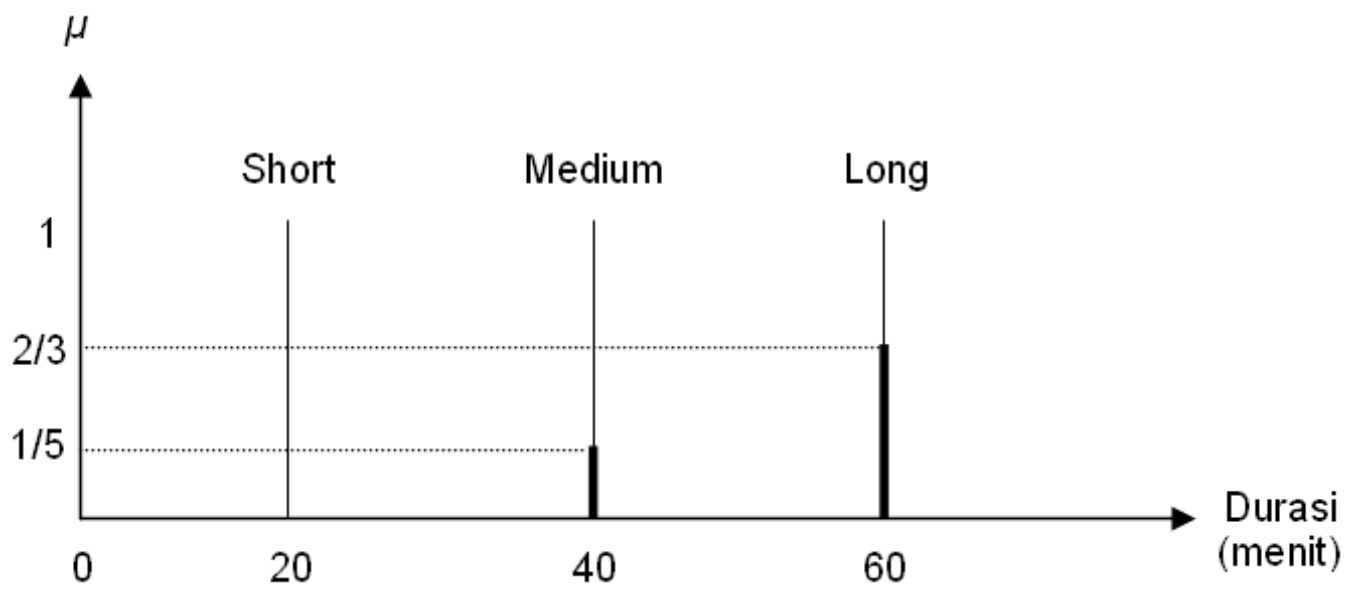
(Suyanto, 2007)

Inference: Model Sugeno



(Suyanto, 2007)

Defuzzyfication: *Weighted Average*



$$y^* = \frac{1/5(40) + 2/3(60)}{1/5 + 2/3} = 55{,}38$$

(Suyanto, 2007)

Case 2: *Sprinkle Control System*

- *Input*:
  - Suhu Udara (^{0}C)
  - Kelembaban Tanah (%)
  - Cahaya Matahari (Cd / Candela)
- *Output*: Durasi Penyiraman (menit)
- Misal:
  - Suhu = 37^{0}C, kelembaban = 12%, Cahaya = 400 Cd.
  - Berapa lama durasi penyiraman yang dilakukan?

(Suyanto, 2007)

Naive Bayes Classifier

Temperature	Humidity	Sprinkle
85	85	no
80	90	no
83	86	yes
70	96	yes
68	80	yes
65	70	no
64	65	yes
72	95	no
69	70	yes
75	80	yes
75	70	yes
72	90	yes
81	75	yes
71	91	no

60	62	?

Apabila ada data baru :

Temperature = 60
Humadity = 62

Apakah keputusannya ?
Sprinkle = yes
ataukah
Sprinkle = no

Naive Bayes Classifier

Temperature	Humidity	Sprinkle
85	85	no
80	90	no
83	86	yes
70	96	yes
68	80	yes
65	70	no
64	65	yes
72	95	no
69	70	yes
75	80	yes
75	70	yes
72	90	yes
81	75	yes
71	91	no

60	62	?

$$\mu = \frac{\sum_{i=1}^{n} X_i}{n}$$

$$\sigma^2 = \frac{\sum_{i=1}^{n} (X_i - \mu)^2}{n-1}$$

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Naive Bayes Classifier

Temperature	Humidity	Sprinkle
85	85	no
80	90	no
83	86	yes
70	96	yes
68	80	yes
65	70	no
64	65	yes
72	95	no
69	70	yes
75	80	yes
75	70	yes
72	90	yes
81	75	yes
71	91	no

Fakta dari Data Latih:

Mean temp | sprinkle=yes	73
Stdev temp | sprinkle=yes	6,2
Mean temp| sprinkle=no	74,6
Stdev temp | sprinkle=no	7,9

P(sprinkle=yes)	0,643
P(sprinkle=no)	0,357

Data Uji :

60	62	?

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Probabilitas dari Data Uji :

f(temp=60|sprinkle=yes)	0,0071
f(temp=60|sprinkle=no)	0,0094
f(hum=62|sprinkle=yes)	0,0096
f(hum=62|sprinkle=no)	0,0018

Naive Bayes Classifier

$$P(X \mid Y) = \underset{x \in X}{\operatorname{argmax}} P(Y \mid X)\, P(X)$$

P(Sprinkle=yes | Temp=60, Humidity=62)

= { P(Temp=60|Sprinkle=yes).P(Humidity=62|Sprinkle=yes) } . P(Sprinkle=yes)

= { (0,0071) . (0,0096) } . (0,643) = 0,438 E-06

P(Sprinkle=no | Temp=60, Humidity=62)

= { P(Temp=60|Sprinkle=no).P(Humidity=62|Sprinkle=no) } . P(Sprinkle=no)

= { (0,0094) . (0,0018) } . (0,357) = 0,060 E-06

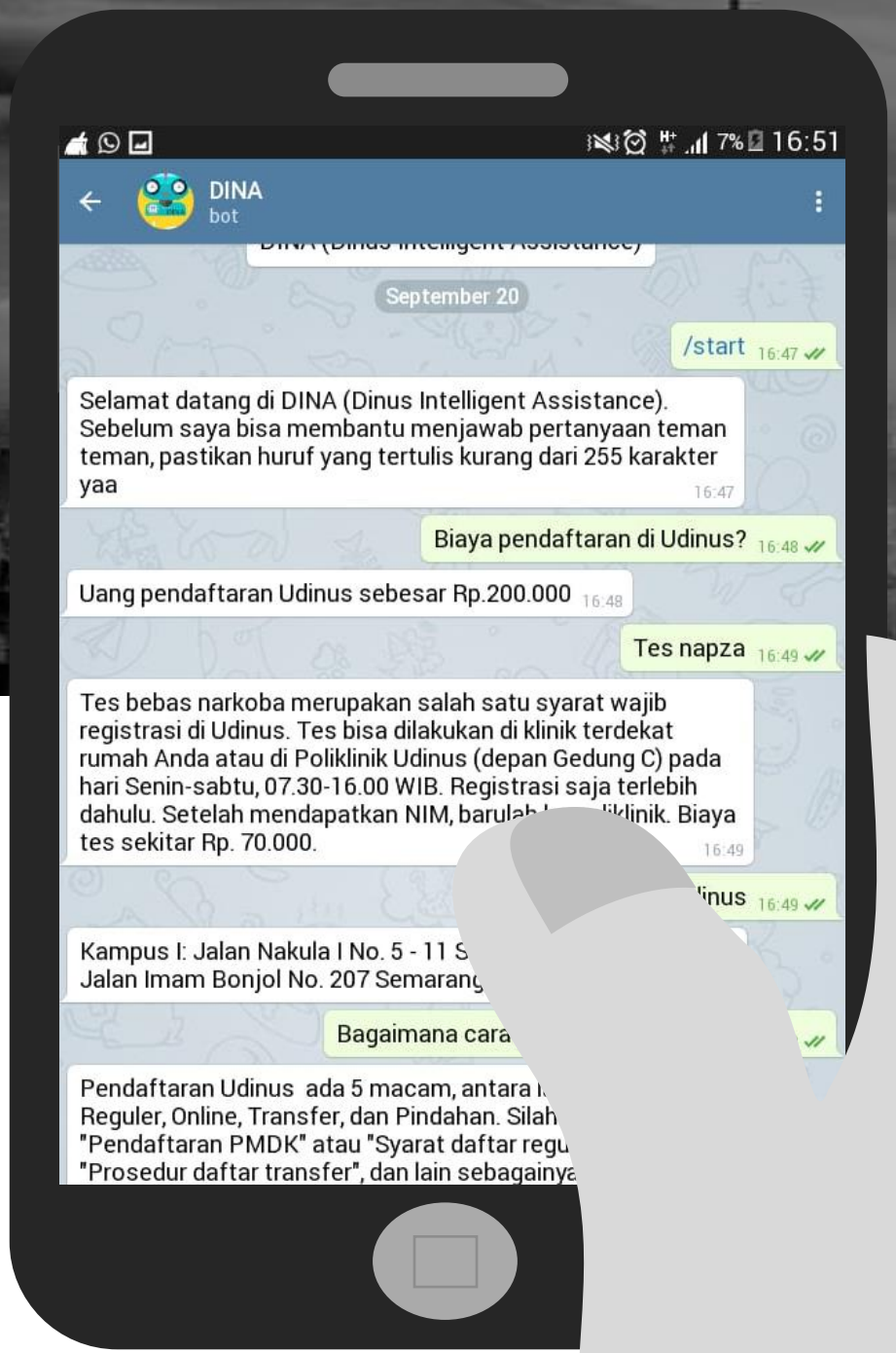
KEPUTUSAN ADALAH SPRINKLE = YES

Applications in Intelligent IoT: Case Study

Deskripsi

Laboratorium IoT merupakan bagian dari Laboratorium Sistem Cerdas tempat dosen dan mahasiswa melakukan penelitian dalam Bidang Kajian IoT dam chatbot.
Laboratorium ini dilengkapi dengan komputer, google home, sensor cahaya, suara, jarak, wajah, dan lain-lain serta micro controller Arduino dan Raspberry pi. Kegiatan penelitian pada lab ini memiliki konsep:

1. Penelitian IOT untuk memberikan solusi pada kehidupan sehari-hari, misalnya pengawasan hidroponik & face recognition
2. Penelitian tentang smart office & chatbot



Chatbot

Tujuan

Mambuat Chatbot untuk Asisten Mahasiswa Dian Nuswantoro dalam Perkuliahan

Roadmap Chatbot

2018 Architecture and Core Backbone of Application

1. Intelligent Assistant for University Admission Services (Paper published on ISEMANTIC 2018)
2. Menu-baesd and structured contents

2019-2020 Text-based chatbot

1. Intents classification using RNN Deep Learning
2. Kategori maksud percakapan pada Chatbot Cerdas dengan Deep Learning

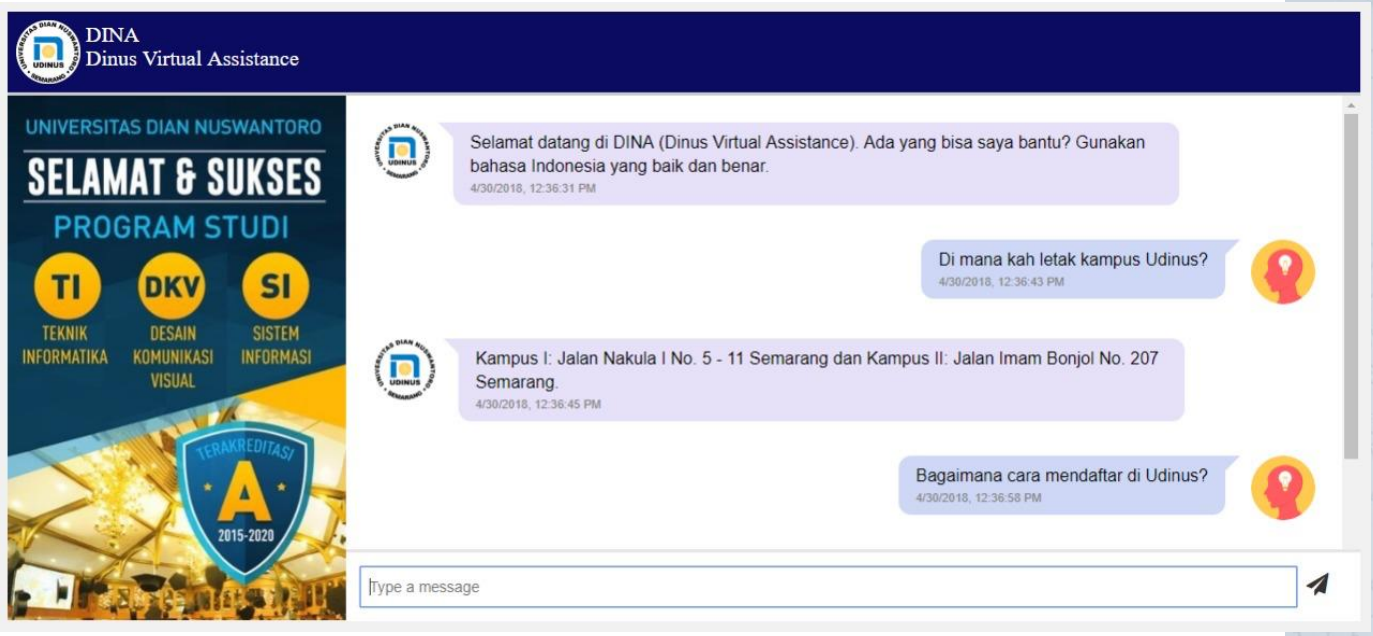
2020 – 2021 Voice-based Chatbot

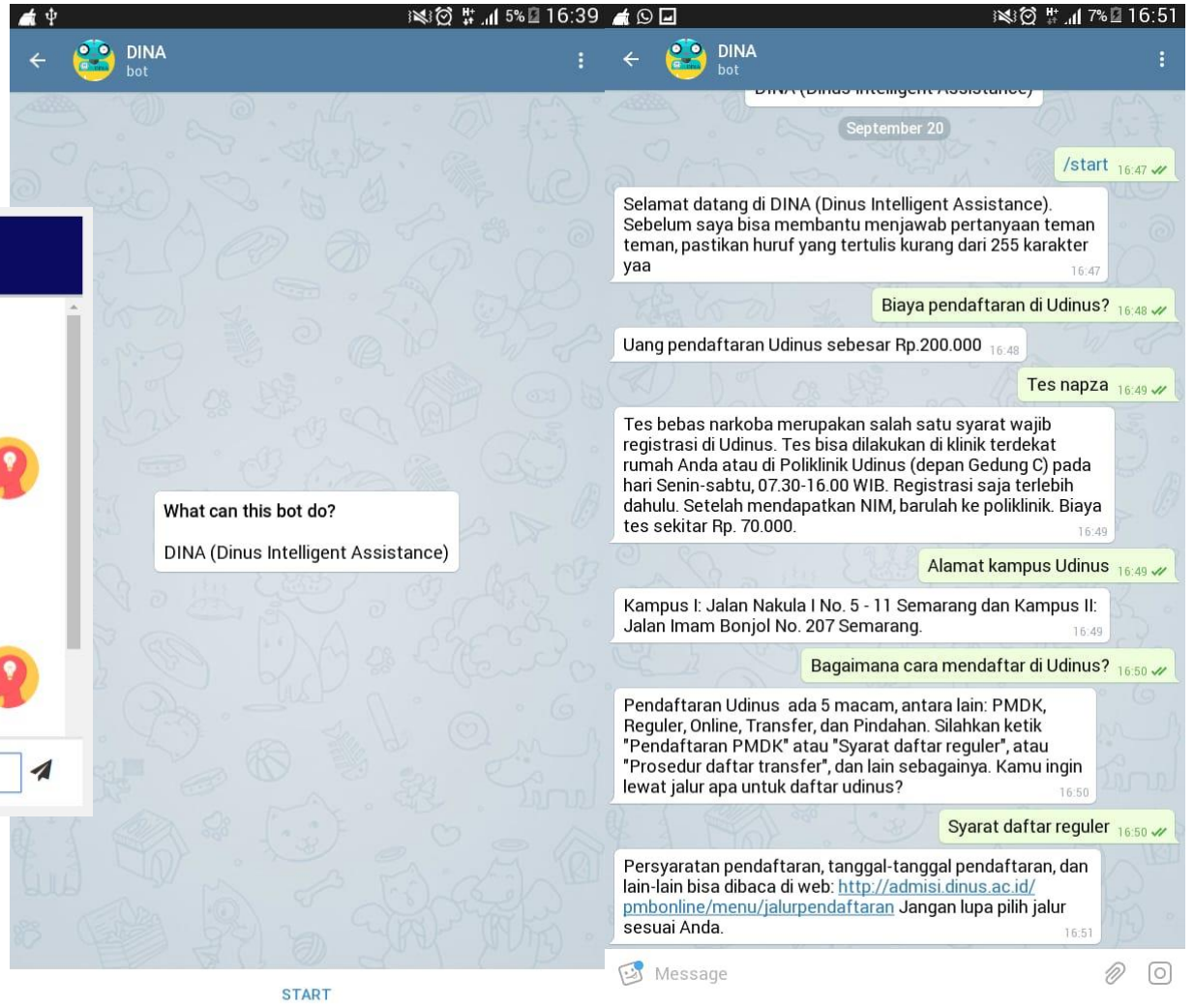
1. Voice recognition
2. Text-to-Speech System
3. Speech-to-Text System

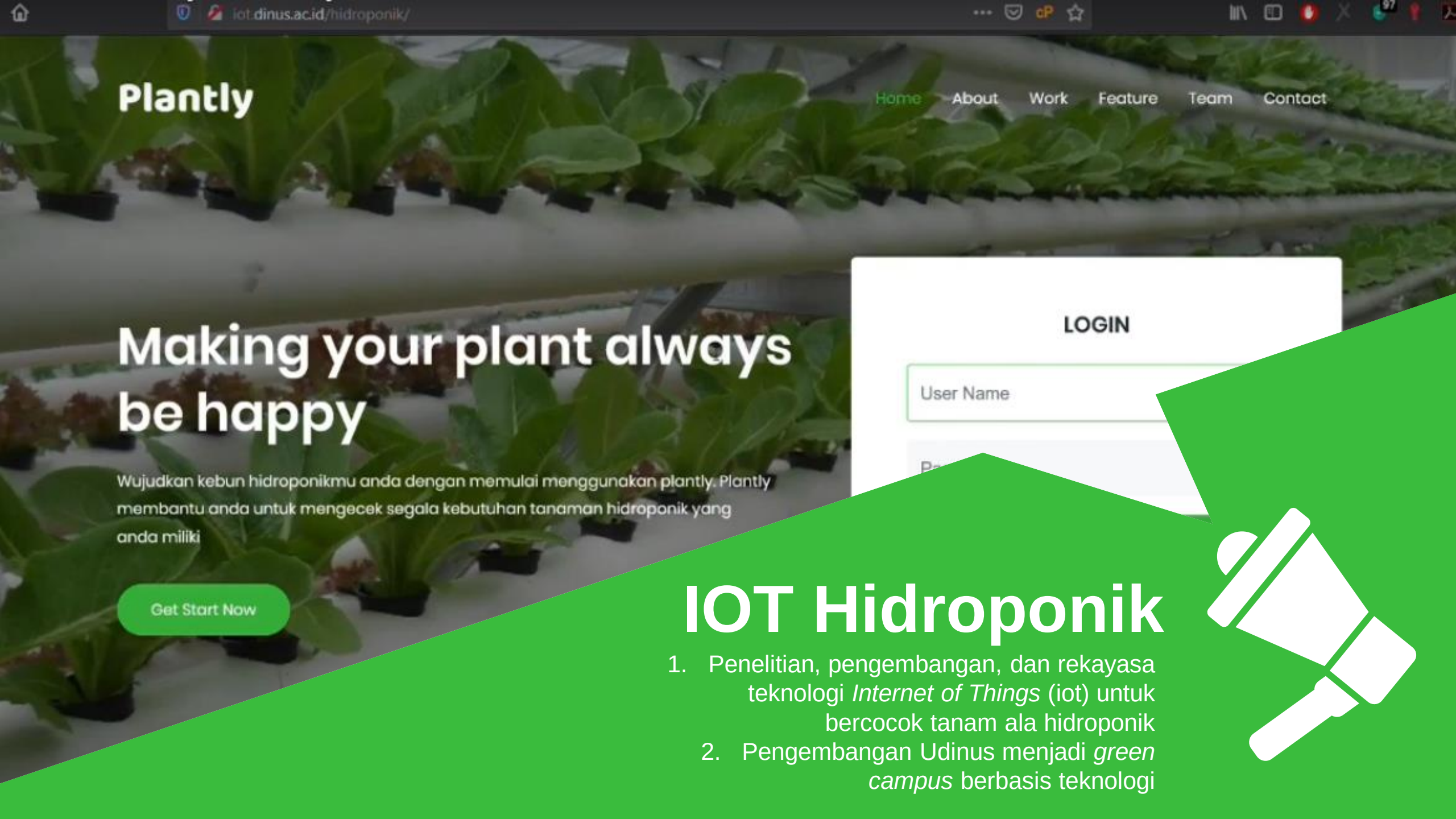
2021 – 2022 2D/ 3D Chatbot

1. Supervised/ Semi-supervised Approach
2. Unsupervised Approach
3. Augmented Reality Enhancement

Pencapaian Chatbot on Web dan Telegram



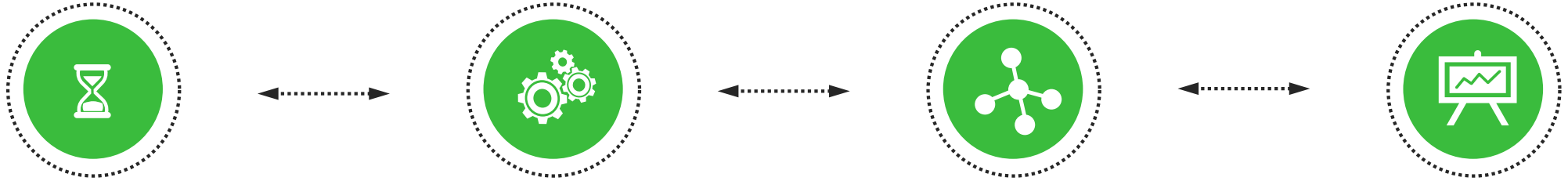




IOT Hidroponik

1. Penelitian, pengembangan, dan rekayasa teknologi *Internet of Things* (iot) untuk bercocok tanam ala hidroponik
2. Pengembangan Udinus menjadi *green campus* berbasis teknologi

Roadmap IOT Hydroponik



2018

Riset: studi lingkungan, studi literature, dan studi pakar hidropoik

2019

Percobaan kecil monitoring hidroponik

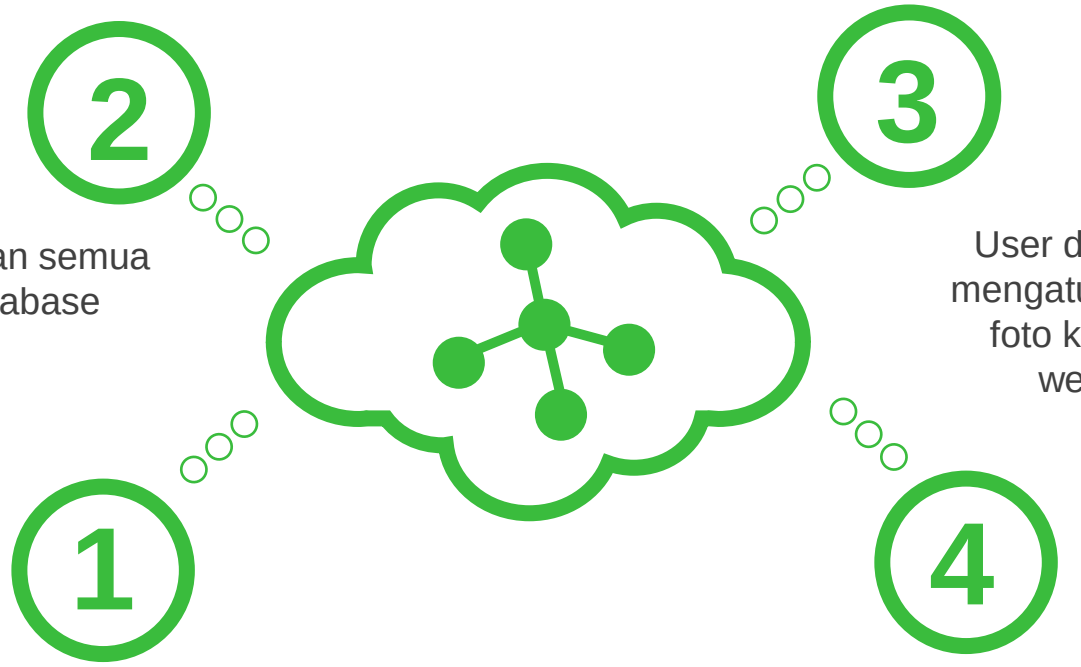
2020

Smart Hydroponic System I – Embedded system

2021

Smart Hydroponic System II Perbaikan sistem sebelumnya

Sistem Kerja Smart Hydroponic System



WIFI ESP8266 mengirimkan semua data hasil sensor ke database MySQL.

User dapat melihat hasil sensor/ mengatur sensor serta mengetahui foto keadaan tanaman melalui website maupun mobile.

Berbagai sensor yang ada di Arduino Uno membaca ketinggian, nutrisi, ph, suhu pada air.

Jika user tidak mengatur sensor, maka sensor akan memelihara tanaman menggunakan metode Fuzzy.

Survei ke Perkebunan Hidroponik

PT. Hidroponik Agrofarm Bandungan

Pencapaian I

Sensor yang dideteksi

- Ketinggian air: Ultrasonic HC-SR04
- Nutrisi: TDS meter
- PH: PH meter
- Suhu: LM35 temperature sensor
- Microcontroller: Arduino Uno
- Wifi module: ESP8266

(a) (b)

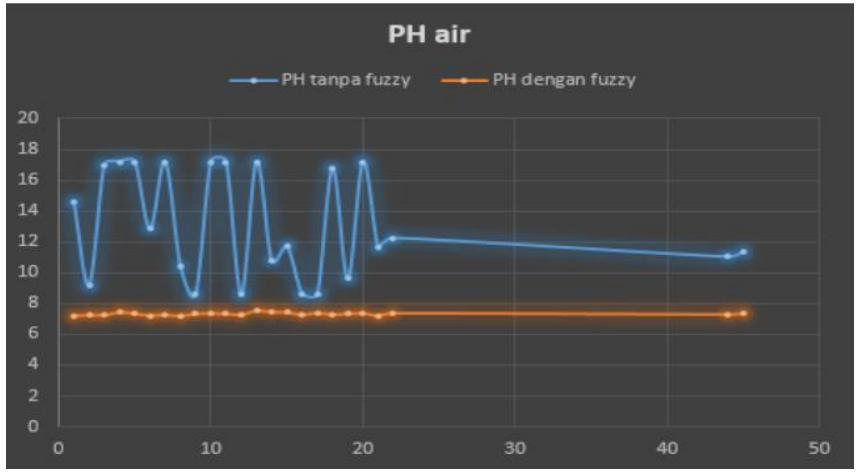
(c)

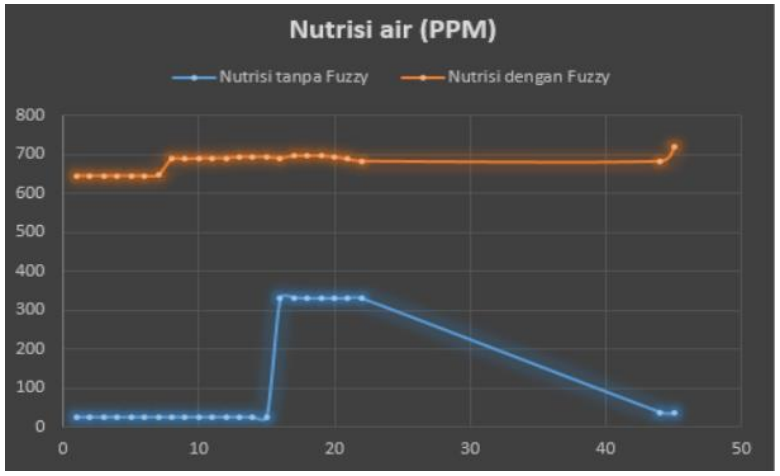
Gambar 1. Kegiatan instalasi IoT dan pemasangan hidroponik: a) pembibitan; b) setting sensor; c) pemasangan hidroponik

Pencapaian II

Nama Sayuran	Jumlah Nutrisi Standart	Nutrisi hari/minggu	Ph Standart	Ph hari/minggu
Kangkung	1050-1400	534	5.5	7.2

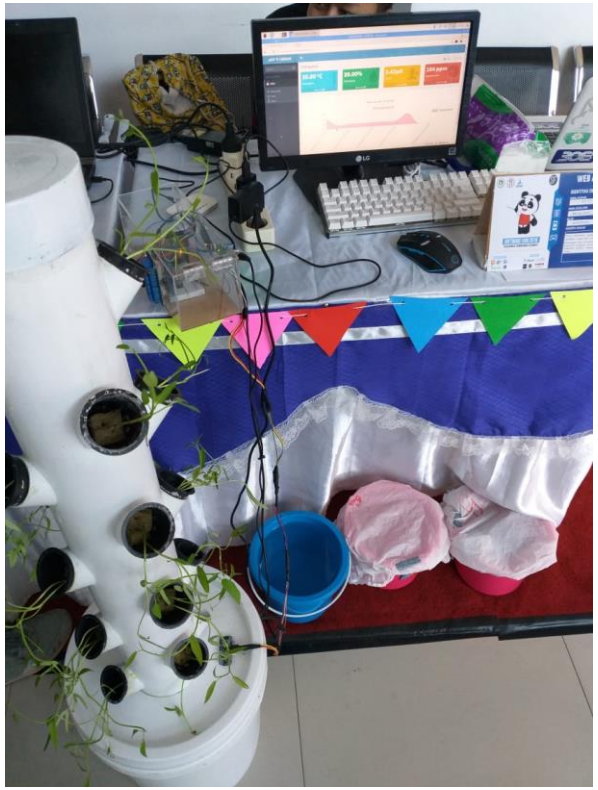
- Pengujian system dilakukan dengan cara membandingkan hasil antara pengontrolan air dan nutrisi dengan metode fuzzy dengan tanpa metode fuzzy.
- Penggunaan metode fuzzy pada tanaman hidroponik kangkung membuat grafik atau nilai dari nutrisi tanaman kangkung menjadi stabil atau terkontrol sedangkan tanpa menggunkan metode fuzzy grafik atau nilai tanaman menjadi tidak setabil dan tidak terkontrol hal ini dapat mengakibatkan tanaman kangkung kehilangan nutrisi yang diperlukan untuk berkembangdan tanaman kangkung menjadi mati.

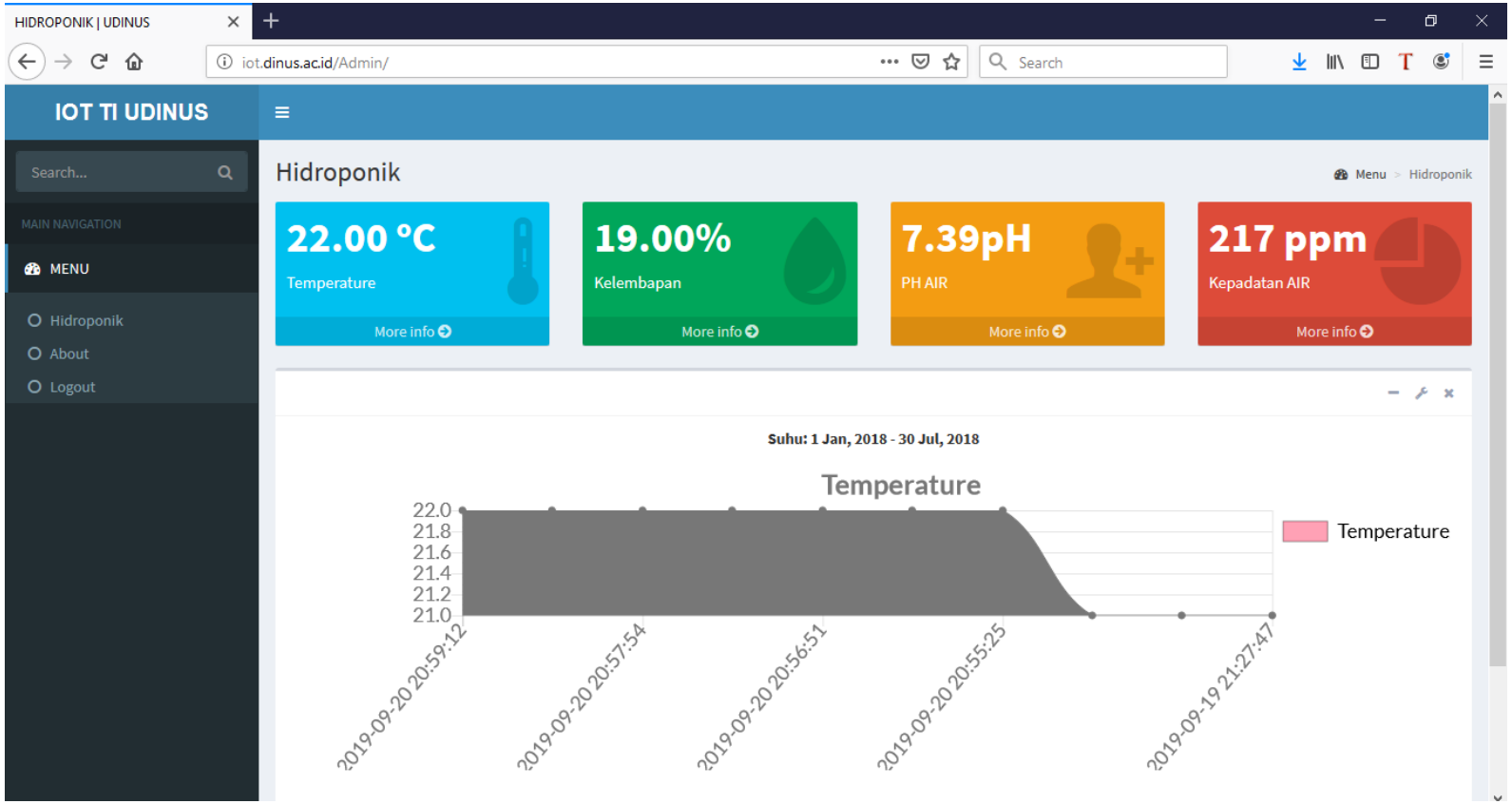




Pencapaian III

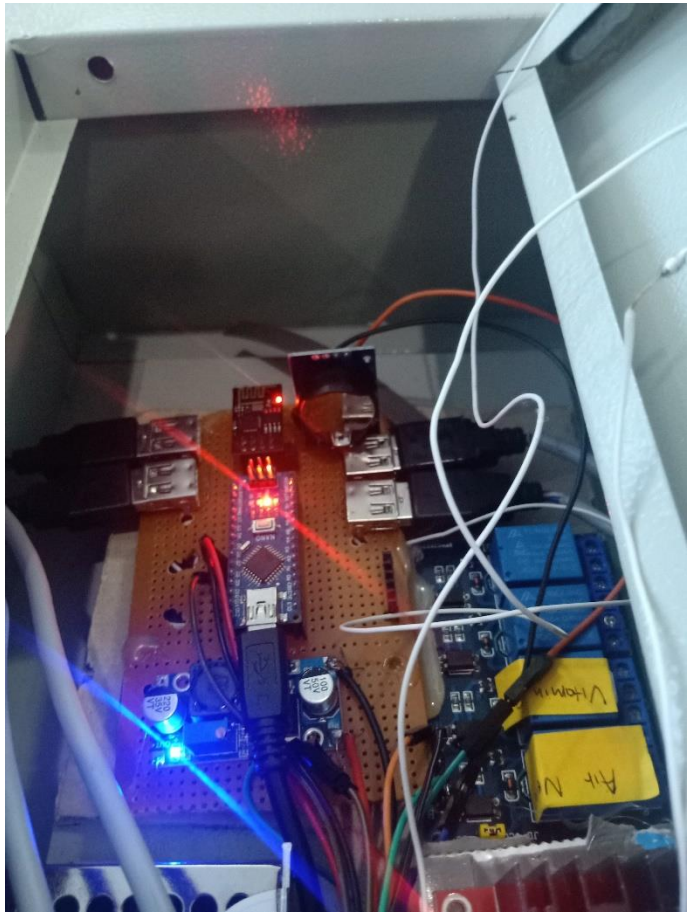
- Hasil monitoring yang ditampilkan dalam website sederhana





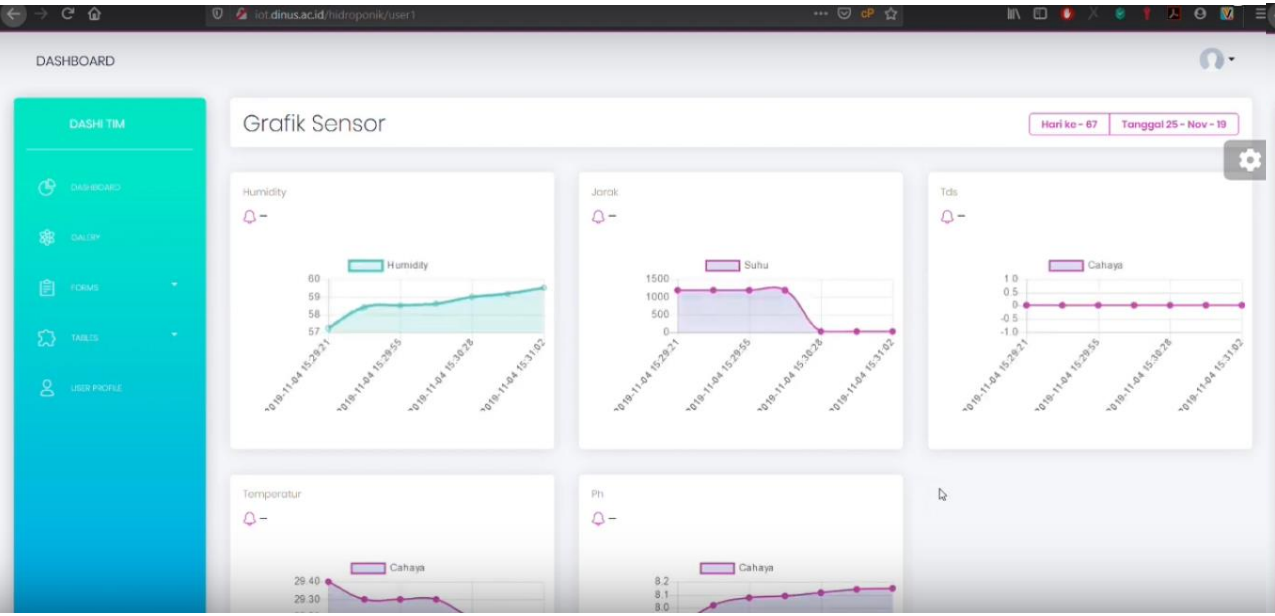
Pencapaian IV - Smart Hydroponic System I

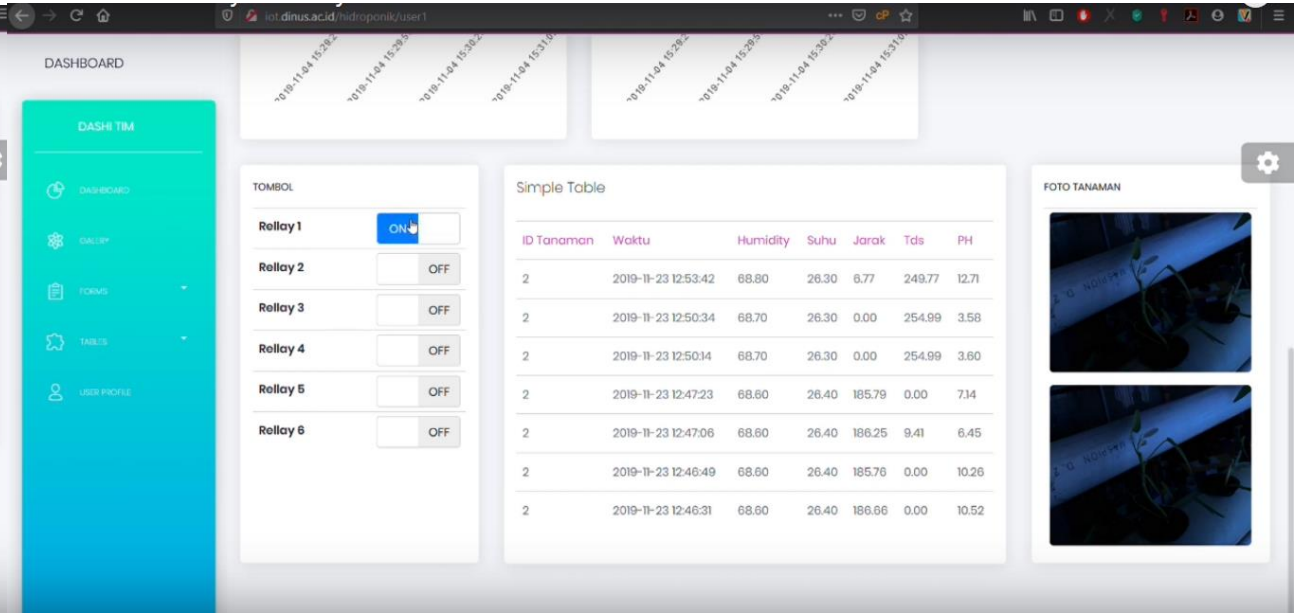
- Embedded System



Pencapaian IV - Smart Hydroponic System I

- Dashboard pemantauan hidroponik yang telah diperbarui

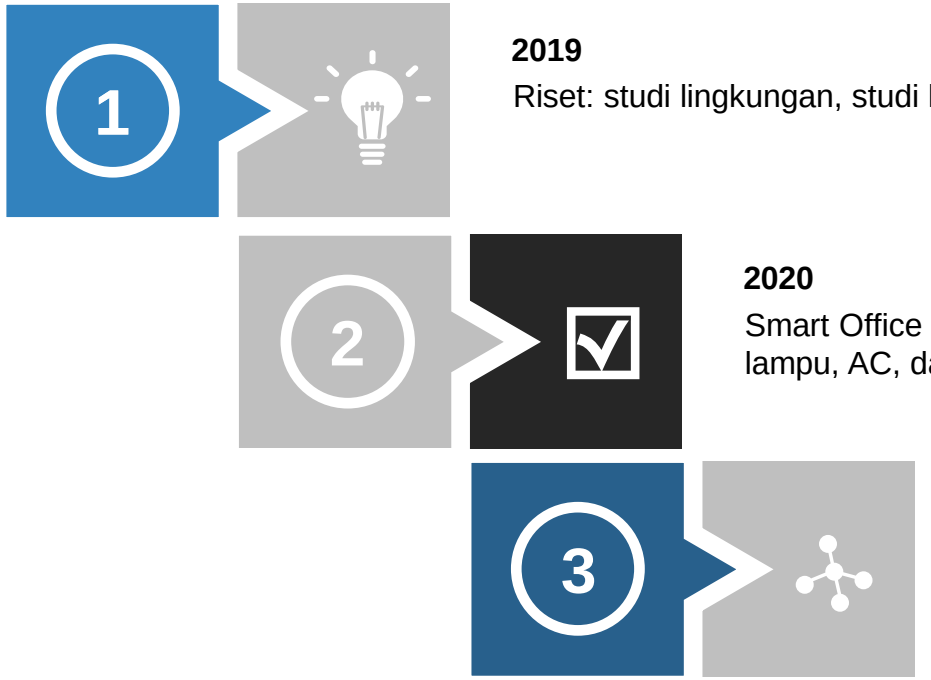




SMART OFFICE

Penelitian, pengembangan, dan rekayasa teknologi *Internet of Things* (iot) untuk kantor pintar yang dapat membuat kantor penuh inovasi dan menjadi hemat energi

Roadmap Smart Office



2019

Riset: studi lingkungan, studi literature, dan studi pakar smart office

2020

Smart Office I – absen otomatis face recognition, menyalakan lampu, AC, dan moitoring dari website

2021

Smart Office II – perbaikan dari Smart Office I dengan penambahan monitoring dari smartphone dan membuat embedded system yang lebih kecil

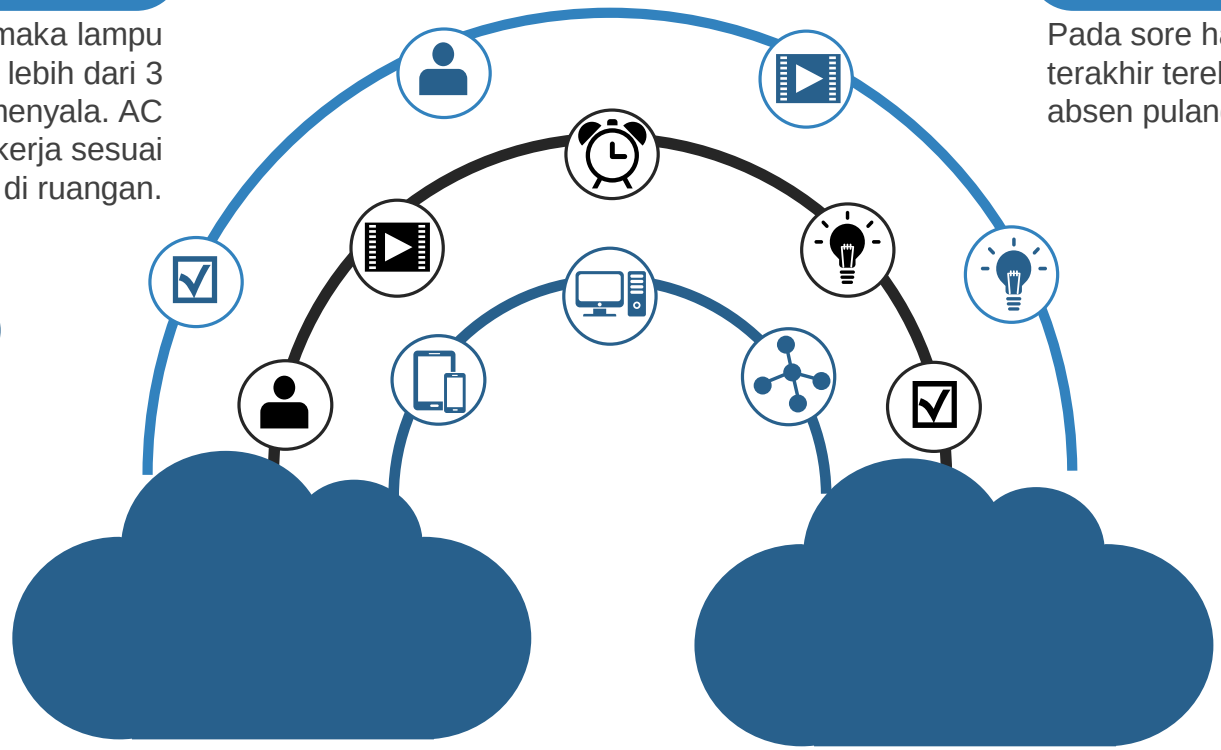
Sistem Kerja Smart Office

2

Jika ada 1 orang di ruangan, maka lampu akan menyala 1 dan jika ada lebih dari 3 orang, maka lampu ke-2 menyala. AC pun ikut menyala dan bekerja sesuai jumlah orang di ruangan.

1

Pada pagi hari, kamera mengenali wajah pegawai yang masuk. Absensi masuk otomatis akan terekam di database.



3

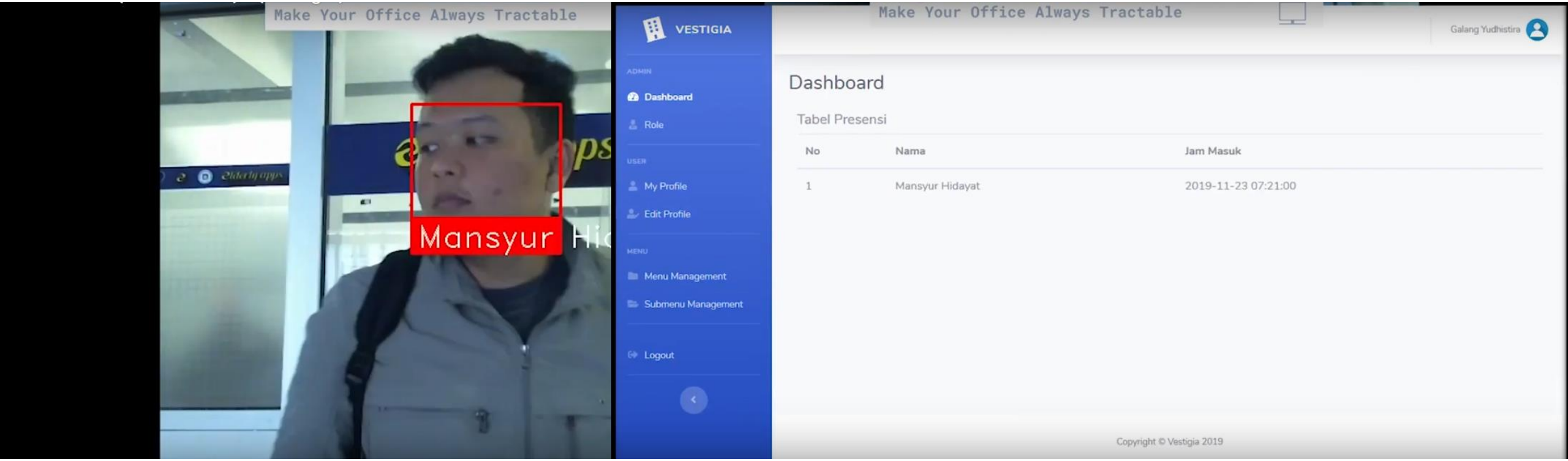
Pada sore hari, wajah pegawai yang terakhir terekam akan menjadi absen pulang.

4

Jika sudah tidak ada orang, lampu dan AC akan otomatis mati

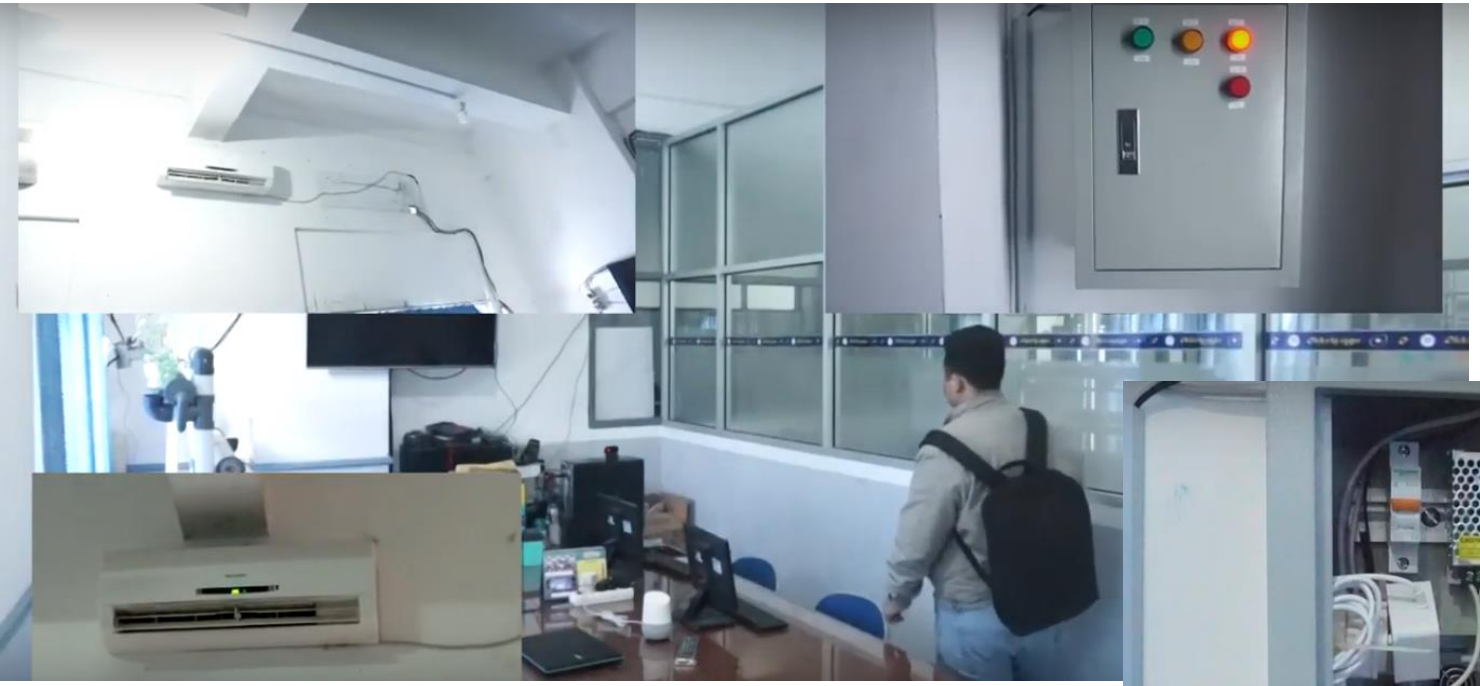
Pencapaian I

- Absen otomatis face recognition dan monitoring website

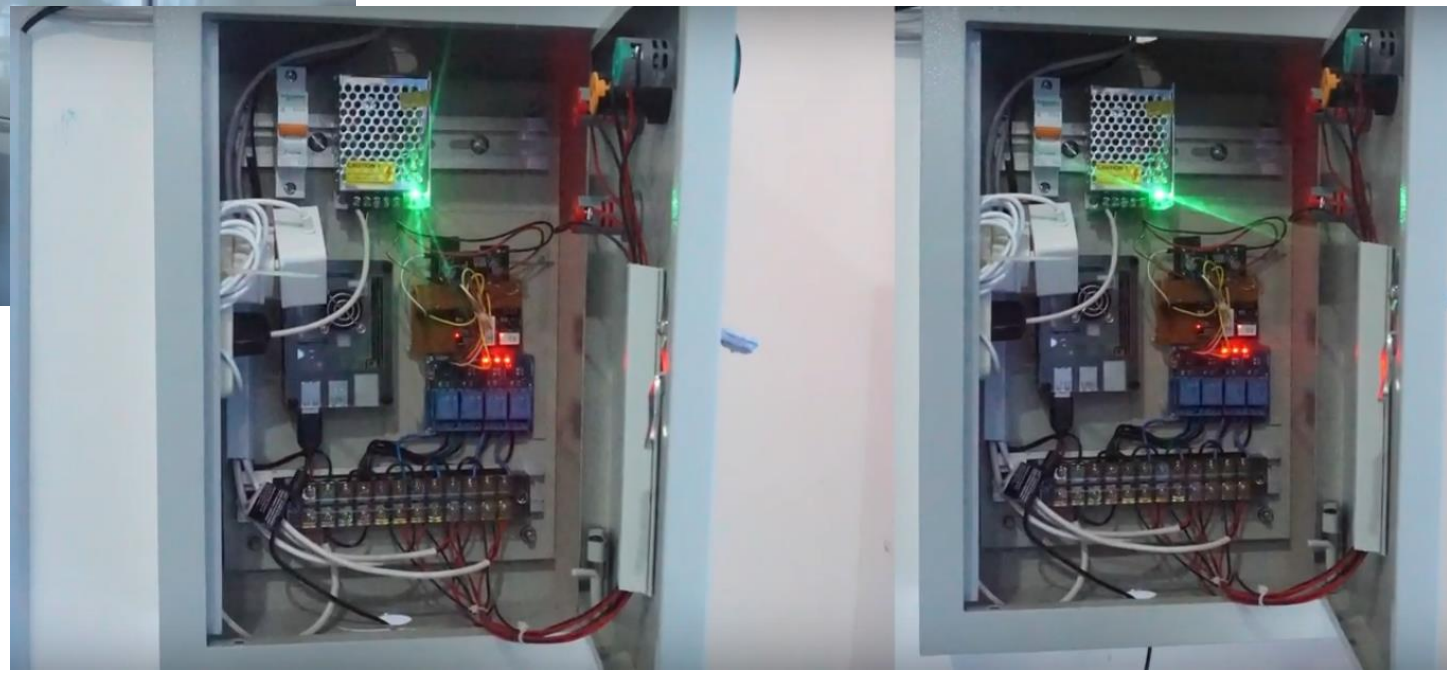


Pencapaian II

- Menyalakan/ mematikan lampu dan AC otomatis



- Embedded System



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Terima kasih