Peran Instrumentasi di Bidang Geofisika

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**PUSAT RISET SISTEM INFORMASI INDUSTRI
UNIVERSITAS DIPONEGORO**

Kerjasama :

- Lintas Fakultas
- PTN/PTS
- LEMIGAS
- Pertamina UTC
- Kemenkumham
- Kementerian Perikanan dan Kelautan
- PTN/PTS
- Pemda (Jateng, DKI)

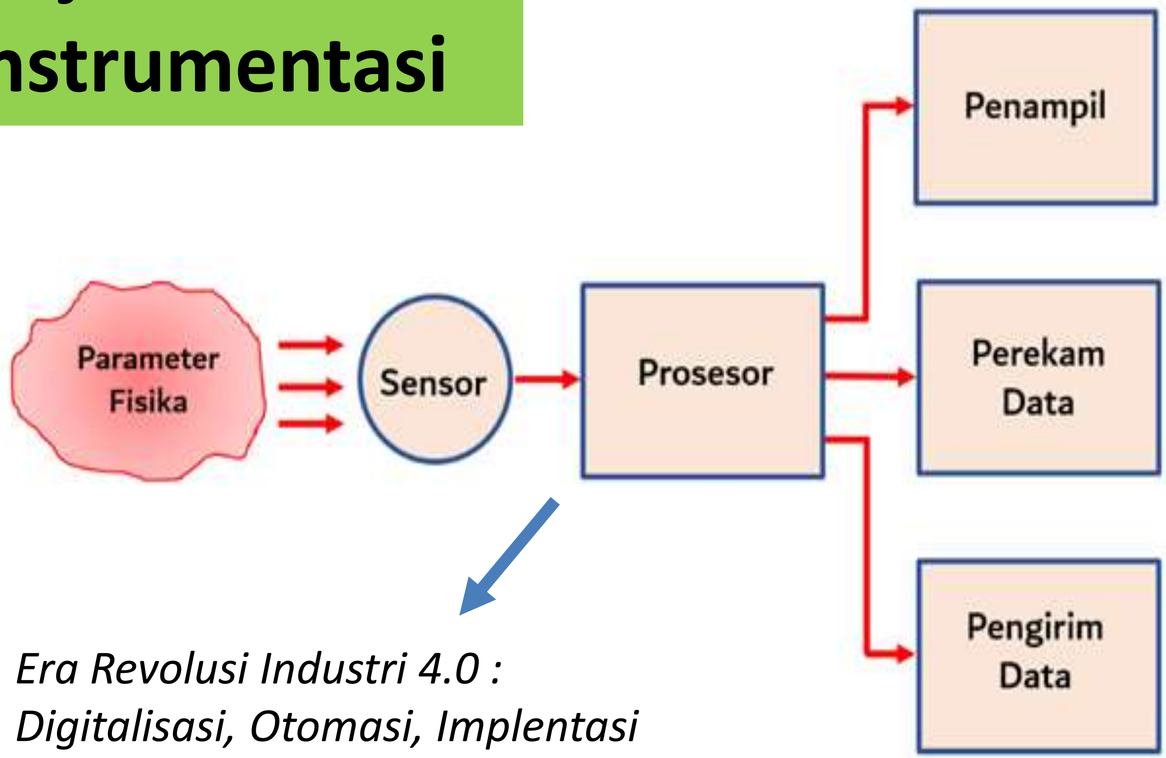
Kinerja :

- 86 Paper Scopus
- 6 Penelitian, Rp.1,285 M (2020)
- 11 HAKI
- 5 Buku

Konsep hilirisasi (alih teknologi) dari perspektif

Instrumentasi Elektronika

Aspek kajian ilmu Fisika instrumentasi



Era Revolusi Industri 4.0 : Digitalisasi, Otomasi, Implentasi ITC

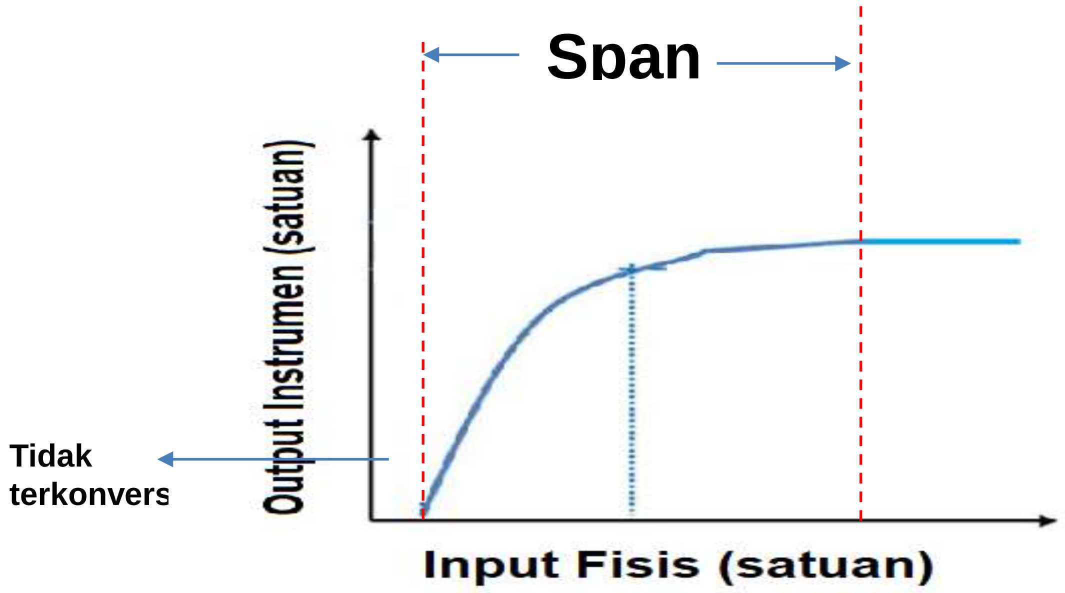
Referensi:
(Bolton,2015 : Instrumentation and Control System)

Karakteristik Instrumen

- Sensitivitas
- Span atau Rentang Dinamis
- Akurasi atau Ketidakpastian
- Histerisis
- Nonlinieritas
- Noise
- Resolusi
- Bandwidth

Span (Rentang) Dinamik Instrumen

adalah rentang masukan sinyal fisis yang dapat dikonversi menjadi sinyal listrik oleh instrument.



SENSOR

Sensor adalah perangkat yang bekerja dengan cara mengubah fenomena fisis menjadi sinyal listrik.

AKTUATOR

Aktuator adalah perangkat yang bekerja dengan mengubah energy listrik menjadi fenomena fisis.

TRANSDUSER

Satu alat yang bisa bekerja sebagai sensor dan actuator.

ELEKTRODA

Konduktor yang dapat menyalurkan listrik dari satu media ke media lain.

Besaran Fisis

Suhu
Kuat Medan magnet
Intensitas Sinar
Tekanan Bunyi
Gaya
Elastisitas
Amplitudo Getaran
Derajat Keasaman
BOD, COD
dll

Sensor

Besaran Listrik

Resistansi (R)
Beda potensial (V)
Aruslistrik (I)
Kapasitansi (C)
Waktu (t)
Frekuensi (f)

Elektroda

Besaran Listrik

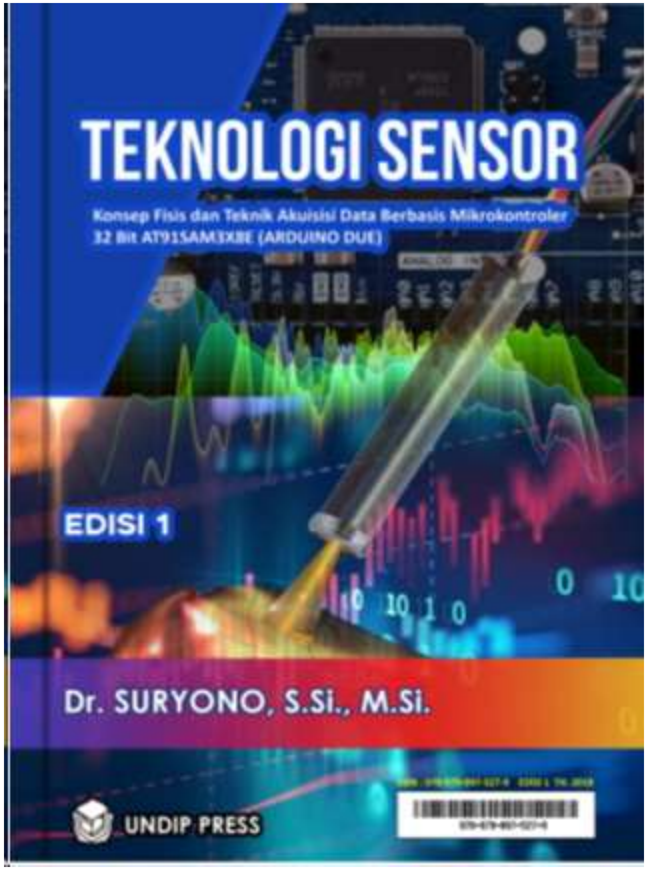
Section Cup
Floating
Micropipet
Jarum

Sensor dan Elektroda

Sensor Suhu

Elektroda EKG

Sensor mengubah besaran fisis menjadi listrik



https://drive.google.com/file/d/1yG5VoiUpxoGm43k08sk2dpXPL0x1Tp4v/view?usp=sharing

Jenis-jenis Interface Sensor

A. Sensor Analog
B. Sensor Digital
- Serial UART
- Serial I2C
- Serial TWI
- Pulsa Digital
- Time-based

American Standard Testing and Material

ASTM C957

- ✓ Berbasis ultrasonik
- ✓ Pada material padat
- ✓ Kecepatan pulsa
- ✓ Nilai rata-rata
- ✓ Numerik

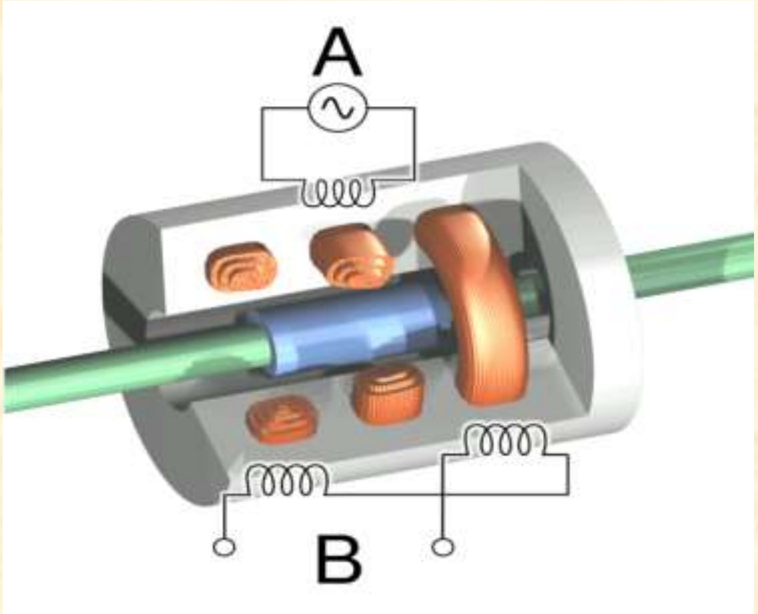
Time-based Instrumentation

SENSOR PADA INSTRUMEN

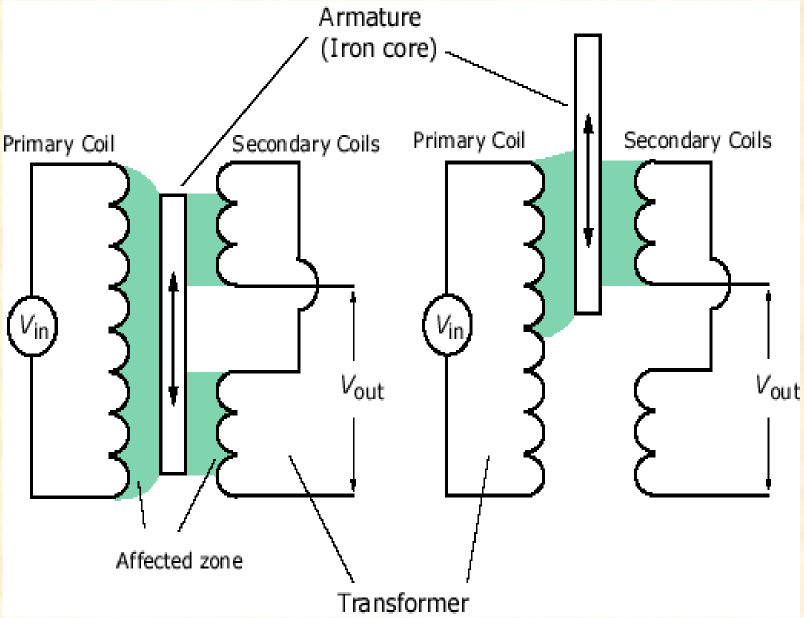
Table 1
Comparison of sensing modalities.

Sensor type	Physical information	Advantages	Shortcomings	Possible areas of application
Piezoelectric	Force	Insensitivity to electromagnetic radiation, ruggedness, excellent linearity over a wide amplitude range	Inability to differentiate between different kinds of applied force, e.g. pressure and vibration	As primary sensors mounted internally or externally of the pipeline walls to detect structural damage, vibration, displacement and for flow and pressure transient measurements
Acoustic	Sound	Low power consumption, not sensitive to precipitation, algorithms are capable of cross-correlation techniques to differentiate between different kinds of sounds	Sensitive to environmental conditions like wind, radio chatter and Doppler effects	Controllable environments like internally of the pipeline walls to detect leakages, bursts and corrosion
Ultrasonic	Radio/sound waves	Low cost, small size, ease of detection,	Sensitive to air conditions, turbulence, scattering and temperature	As secondary sensors to verify detection of leakages, bursts and pressure measurements
Thermal	Temperature	Extreme stability and linearity even at excessive temperatures	Difficulty in adapting to rapid and random temperature fluctuations	Measurement of operating temperature, as secondary sensors for structural integrity monitoring, e.g. fire detection
Optical	Light/ radiation	Fast response, small size, algorithms are capable of light intensity classification and cross-correlation techniques	Sensitive to effects of sun glint, changing light intensities, and absorption due to water concentration in fog, rain and snow, can also be obscured by smoke and dust	Controllable environments where rapid fluctuations in light intensity or shadowing cannot constitute a problem, as secondary sensors to detect structural damage
Chemical	Chemical composition	Also capable of operating as biological sensors	Sensitivity may drop after long term use and the sensing element may thus require cleansing	To monitor chemical composition of pipeline oil and gas materials and in hazardous environments to detect safe areas of operation
Magnetic	Magnetic flux	Small size, low cost, fast response, good sensitivity, low power consumption, easily integrated	Sensitive to magnetic fluctuation, requires close proximity for accurate detection	As secondary sensors to detect corrosion and thinning defects

Contoh ➔ SENSOR Analog GETARAN



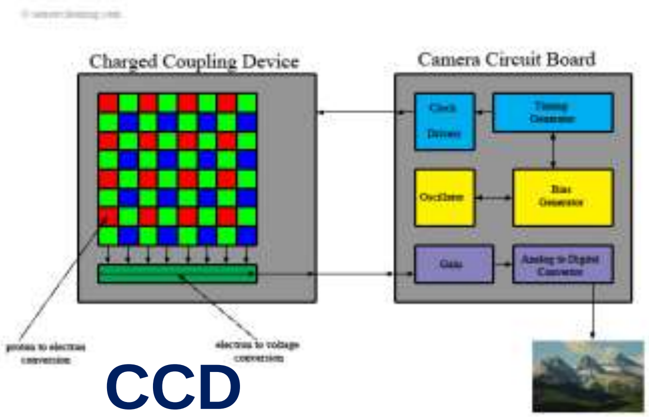
Konstruksi LVDT



Rangk. Ekivalen LVDT

Sensor Digita ➔ Mengarah ke Teknologi Embedded Sensor

Magnet



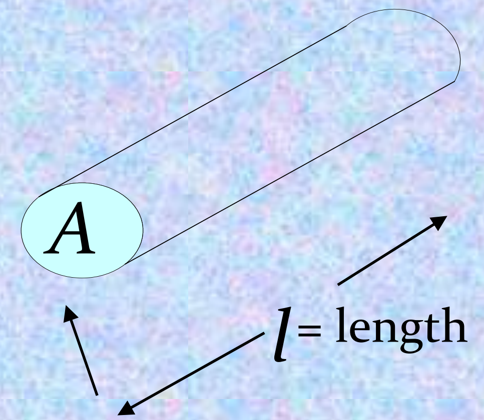
CCD

Ultrasonik

Temperatur dan Kelembaban

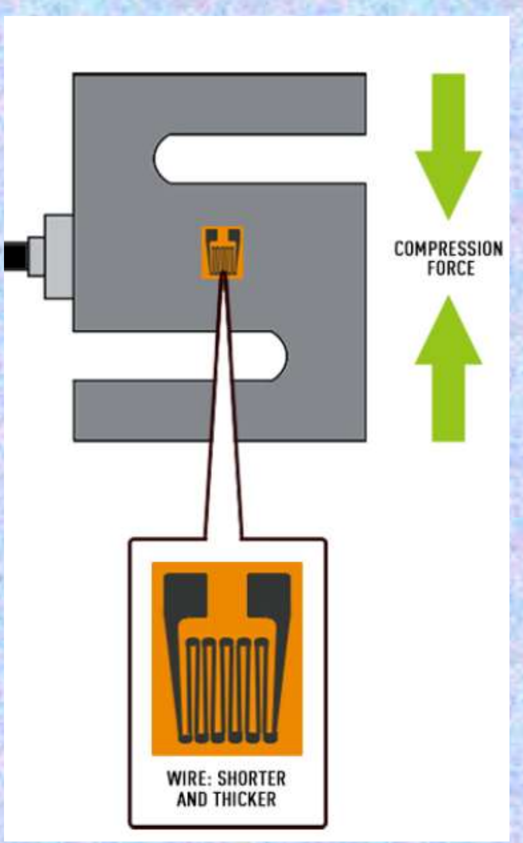
Sensor dengan Pengkondisian Sinyal

Strain Gauge (sensor dengan perubana hambatan karena gaya tekan.



Resistance

$$R = \rho l / A$$

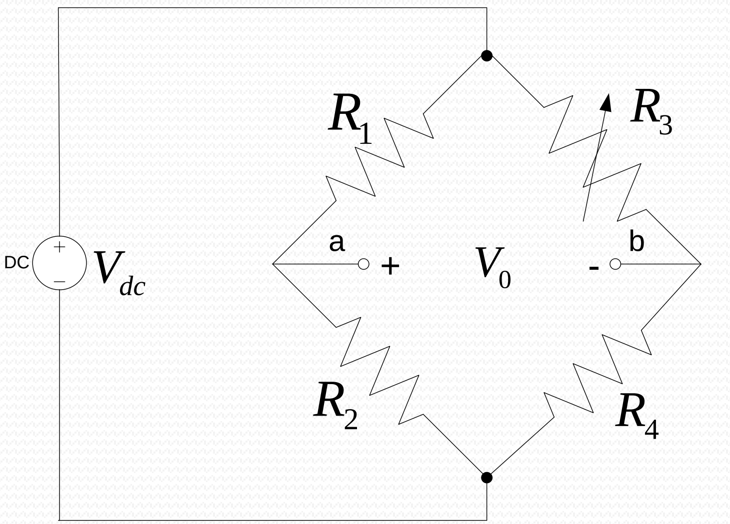


Pengukuran Hambatan

$$V_0 = V_{dc}\left[\frac{R_2}{R_1+R_2}-\frac{R_4}{R_3+R_4}\right]$$

$$\frac{V_0}{V_{dc}} = \frac{R_2}{R_1+R_2}-\frac{R_4}{R_3+R_4}$$

$$\left(R_3+R_4\right)\left(\frac{V_0}{V_{dc}}-\frac{R_2}{R_1+R_2}\right) = -R_4$$

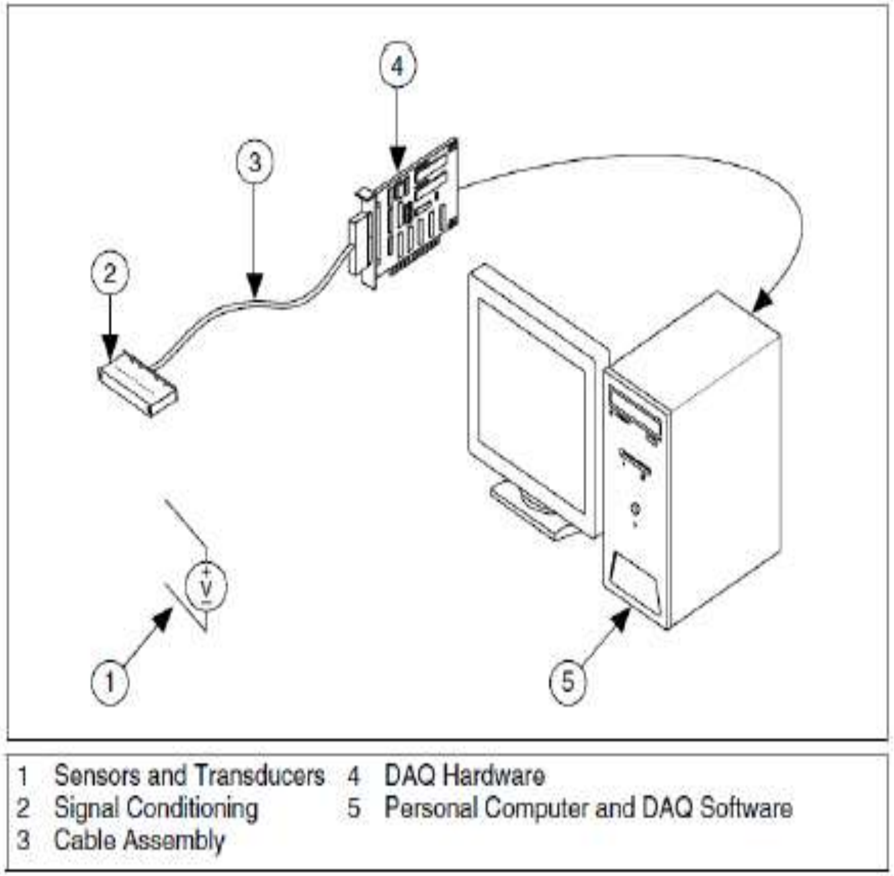


$$R_3 = R_4\left[\frac{1}{\left(\frac{R_2}{R_1+R_2}-\frac{V_0}{V_{dc}}\right)}-1\right]$$

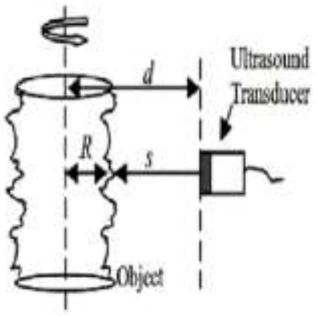
Sistem Akusisi Data Sensor ke dalam komputer

A DAQ system consists of:

- Sensors (transducers)
- Signal Conditioning
- Cables
- DAQ hardware
- Drivers
- Software



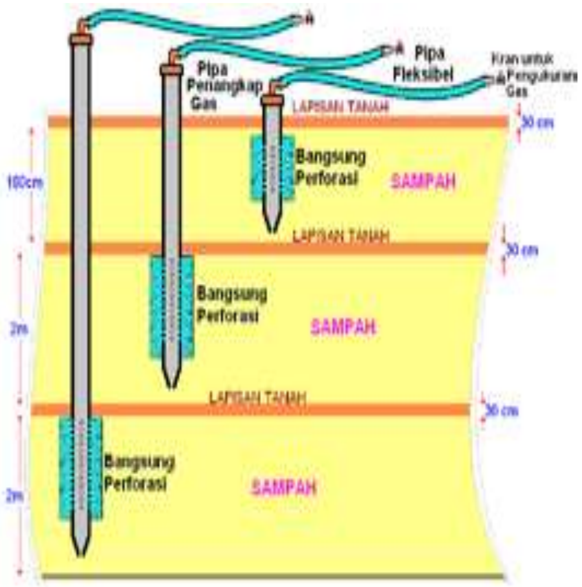
Sensor untuk Mendeteksi Lubang Perporasi pada Eksplorasi Minyak Bumi



$$s = \left(\frac{t_{of} \cdot c \cdot \cos\theta}{2} \right)$$

Kerjasama UNDIP - LEMIGAS

Instrumen untuk Mendeksi Sumbatan Lubang Perporasi Menggunakan Immersion Ultrasound Transducer



- Membuat alat pendeteksi lupang perporasi dengan sensor ultrasonic ➔ bisa mengukur kekasaran permukaan yang keci dan bisa tercelup dalam cairan.

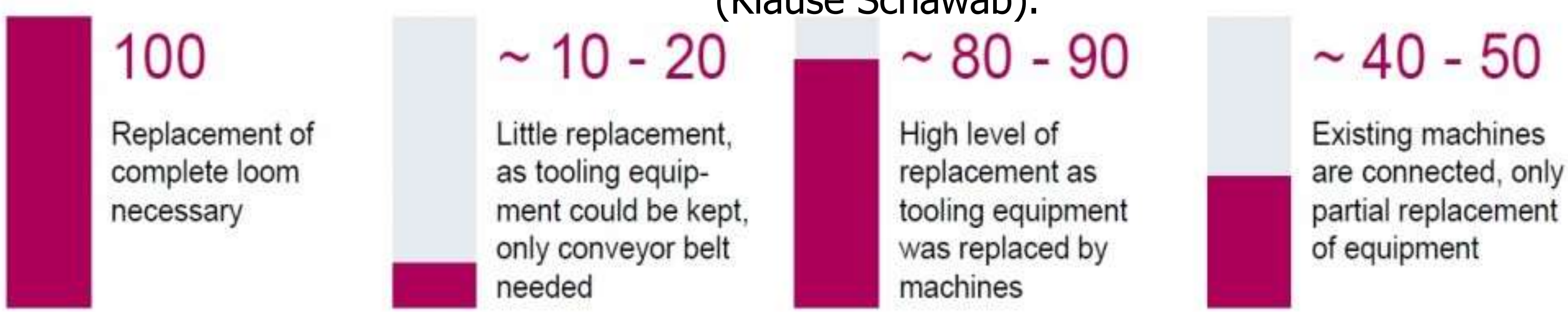
Industrial Revolutions

1st revolution	2nd revolution	3rd revolution	4th revolution
Water/Steam	Electricity	Automation	Cyberphysical systems

The 4th revolution is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres (Klause Schawab).

Replacement of equipment

Percent of installed base



Source: WEF

The 25 Biggest Technology Trend

(Bernard Marr, Tech Trends in Practice: The 25 Technologies that are Driving the 4th Industrial Revolution, 2020)

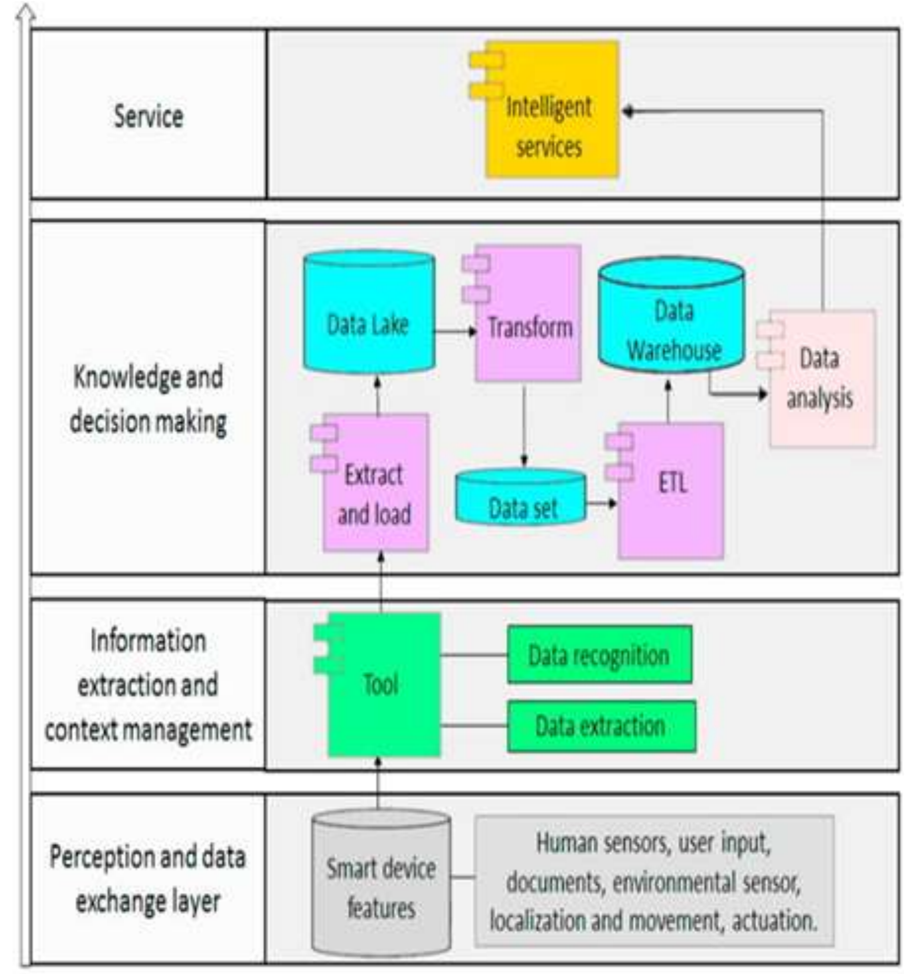
1. AI & Machine Learning
2. Internet of things
3. Wearable Technology
4. BIG DATA
5. Intelligent Spaces
6. Blockchain Tech
7. Cloud and Edge Computing
8. Extended Reality
9. Digital Twins
10. Natural Language Processing (NLP)
11. Voice Interfaces & Chat Bots
12. Computer Vision & Facial Recognition
13. Robots & CoBots
14. Autonomous Vehicles
15. 5G
16. Genomics and Gene Editing
17. Machine Creativity & Augmented Design
18. Digital Platforms
19. Drones
20. Cyber Security
21. Quantum Computing
22. Robotic Process Automation
23. Mass Personalisation
24. 3D Printing
25. Nano Tech & Material Science

Internet of Things (IoT)

Kosep transfer data sensor dan actuator melalui jaringan nirkabel dan terkoneksi ke jaringan internet untuk melakukan suatu proses tanpa melibatkan peran dominan manusia (Alex Grizhnevich, 2019)

Arsitektur IoT

Instrumentasi Fisika di era revolusi industry 4.0 mengarah ke Teknologi ***Internet of Things (IoT)***

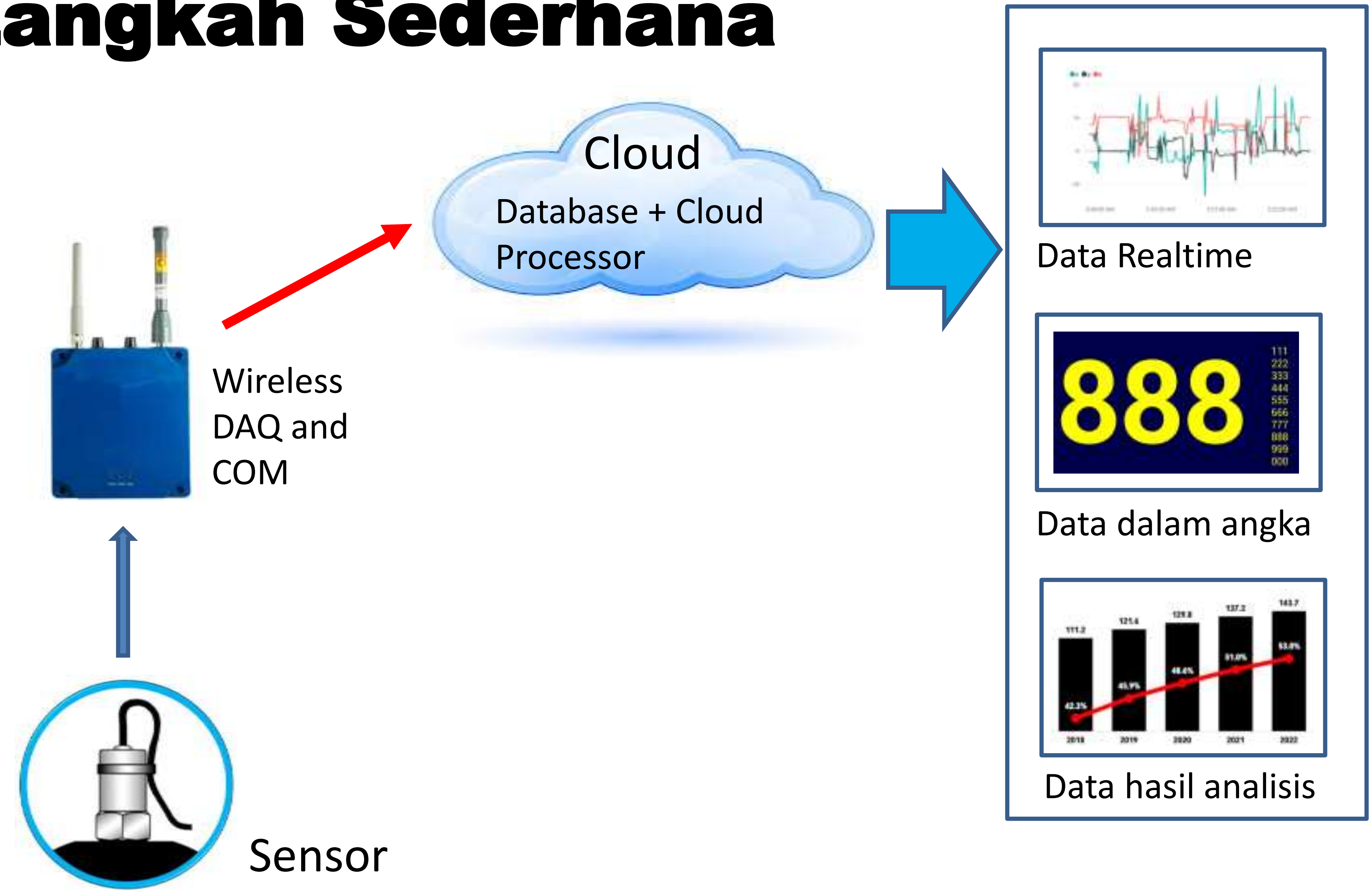


RIRN 2017 - 2014

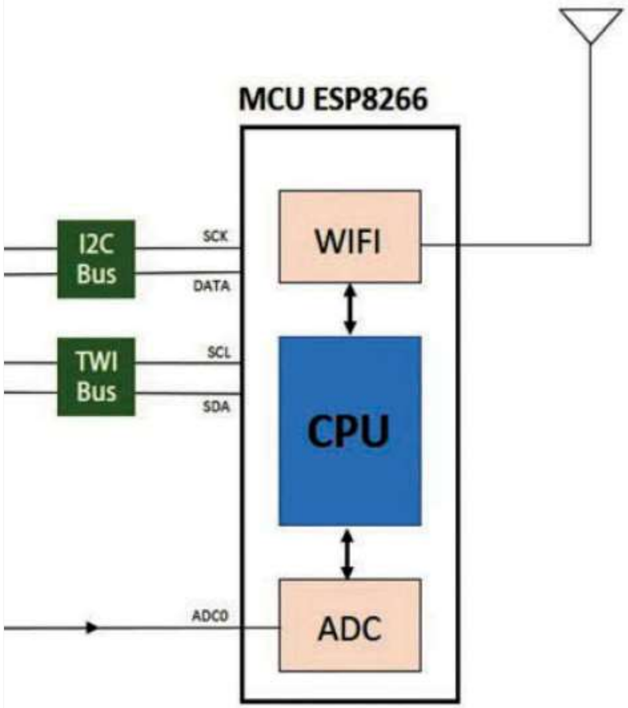
Big data, Data mining, Data science, Artificial intelligent, Machine learning & Deep learning, Block chain, dan Robotic system

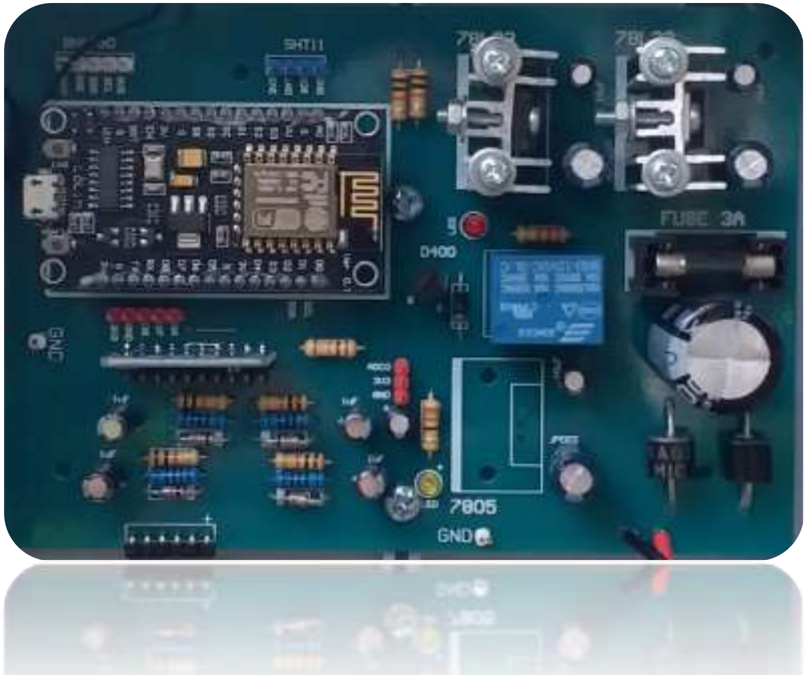
Referensi:
(Sassi et.al., 2020 : A New Architecture for Cognitive Internet of Things and Big Data)

Membangun IoT dari Langkah Sederhana



SOC Wifi Microcontroller

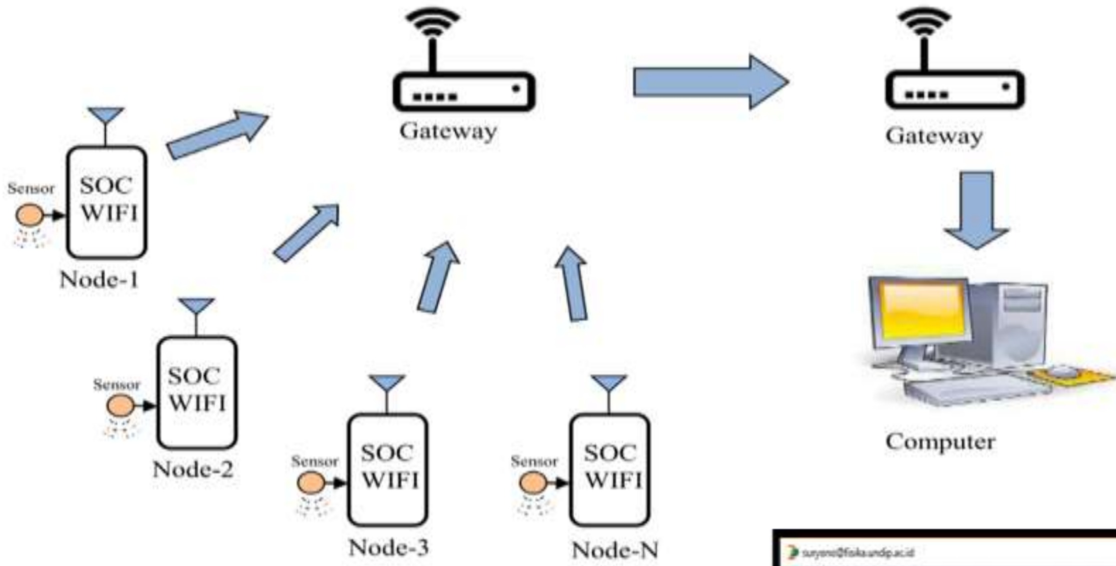




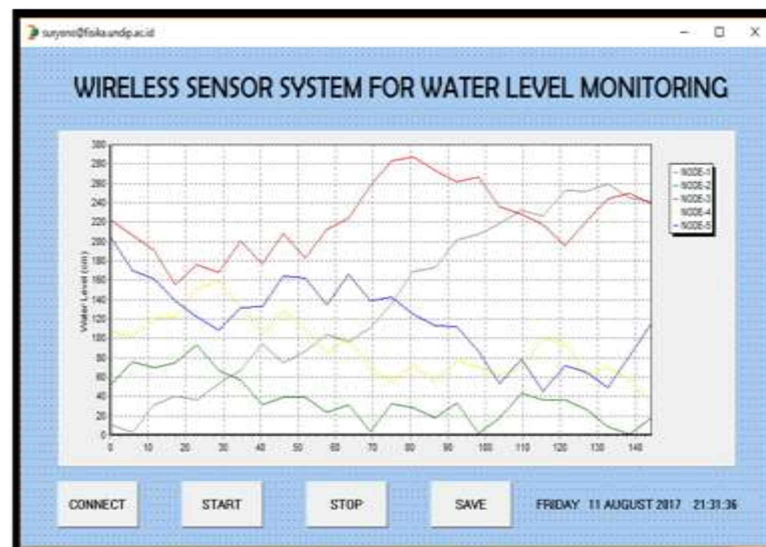
Pengembangan Wireless Sensor

Pengembangan produk System on Chip (SoC) WIFI-Microcontroller (open source) untuk menghubungkan berbagai sensor ke komputer melalui jaringan nirkabel WIFI.

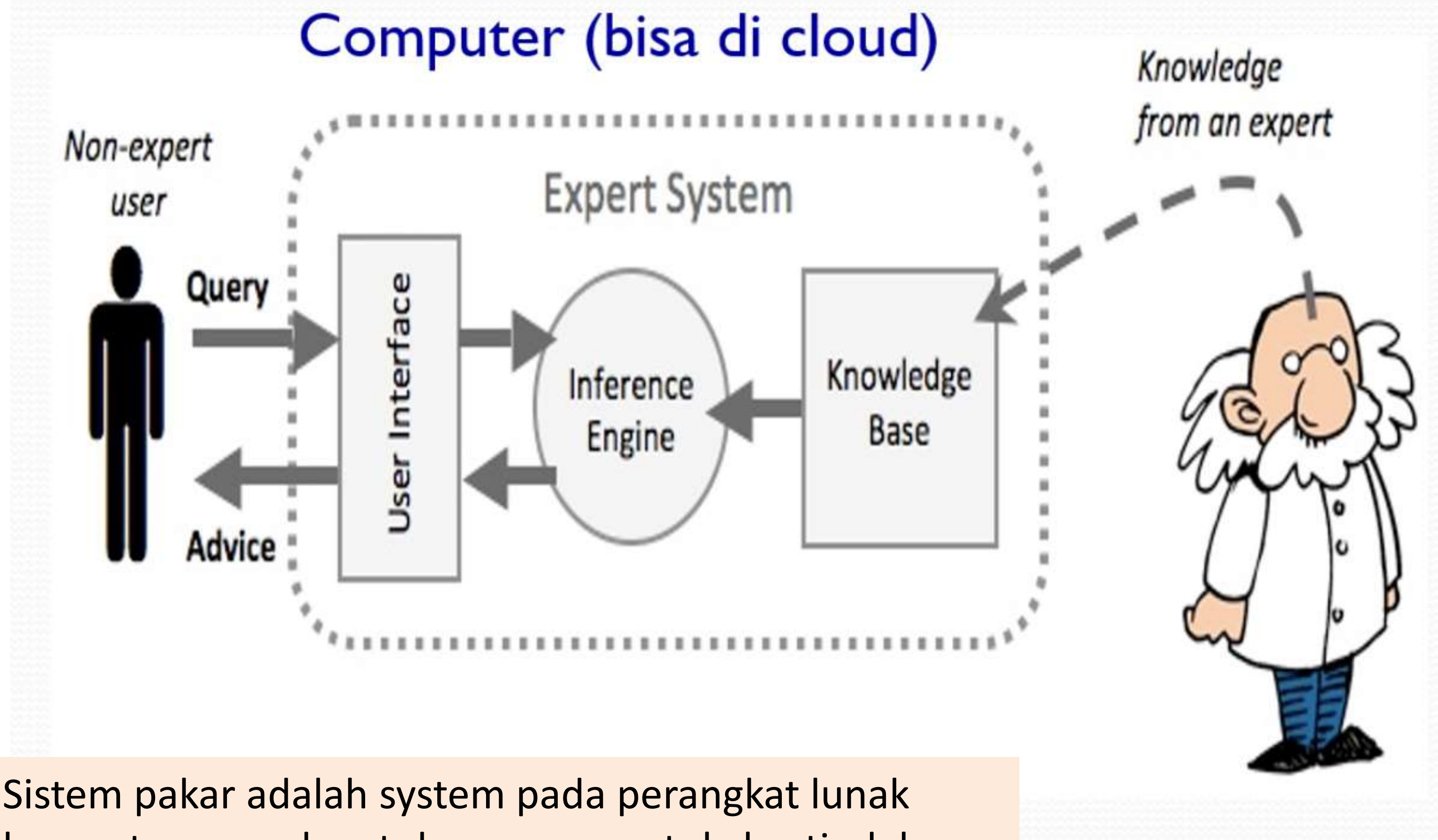
Membangun Sistem Wireless Sensor System multistasion menggunakan jaringan lokal



- Tanpa biaya internet
- Survive daerah bebas sinyal
- Kecepatan tinggi
- Biaya murah



Contoh AI – Expert System (Sistem Pakar)



Sistem pakar adalah system pada perangkat lunak komputer yang dapat deprogram untuk bertindak seperti seorang pakar.

WSS untuk Pengontrolan dan monitoring pada Produksi Coalbed Methane (Pertamina Hulu Energi– Tanjung Tabalong Kalimantan Selatan)


Thank You!