



UNIVERSITAS  
GADJAH MADA

# Departemen Teknik Elektro dan Informatika (DTEDI)

<http://tedi.sv.ugm.ac.id>

- Riset Profil Dr. Fahmizal

<https://fahmizal.staff.ugm.ac.id/>

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- S2 Teknik Elektro National Taiwan University of Science and Technology
  - S3 Teknik Elektro Universitas Gadjah Mada

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**Riset Penelitian  
Dr. Fahmizal**

Control and Automation System

<https://otomasi.sv.ugm.ac.id/control-and-automation-system/>

Internet of Things (IoT)

<https://otomasi.sv.ugm.ac.id/internet-of-things-iot/>

Deep learning System

<https://otomasi.sv.ugm.ac.id/deep-learning/>

Robotics System

Humanoid Robot

Mobile Robot

Line Follower Robot

Omni-directional Robot

Arm Manipulator Robot

Unmanned Aerial Robot

UAV Bicopter

UAV Tricopter

UAV Quadcopter

Underwater Robot



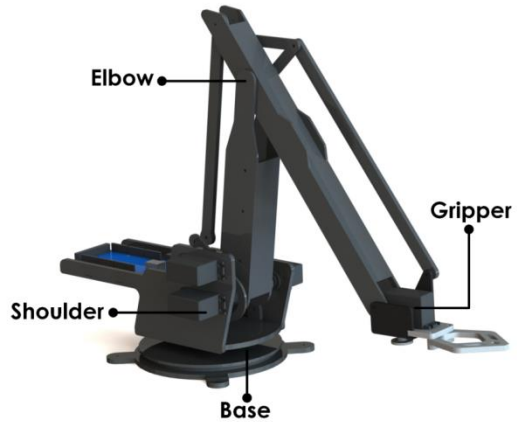
# Menara Ilmu Otomasi Sekolah Vokasi UGM [otomasi.sv.ugm.ac.id](http://otomasi.sv.ugm.ac.id)



# Penelitian Robotika dan Otomasi DTEDI SV UGM



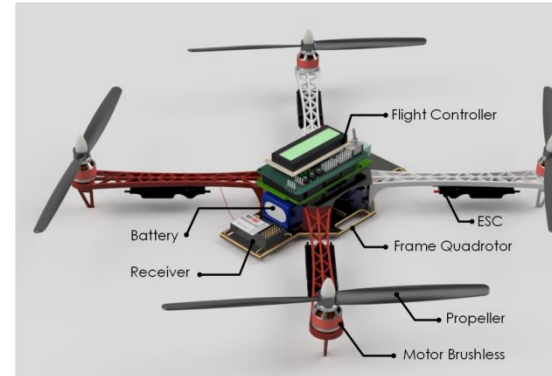
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ARM manipulator Robot



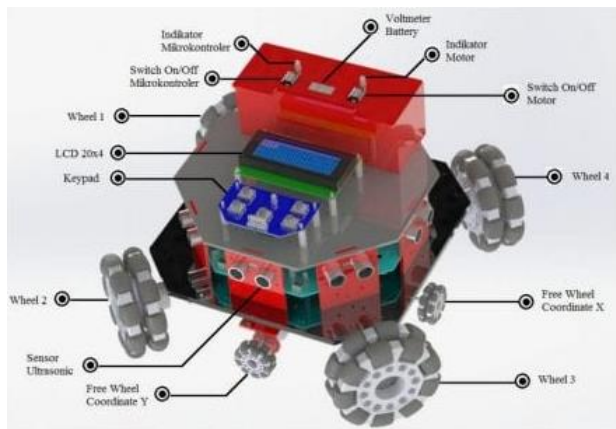
Differential Drive Mobile Robot



Aerial Copter Robot



Smarthome with IoT



Omnidirectional Robot



Remotely Operated-underwater Vehicle



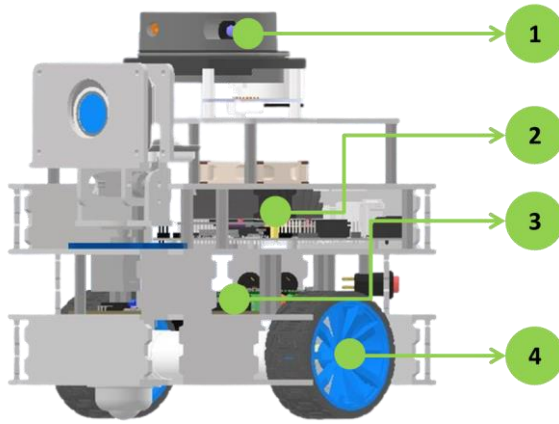
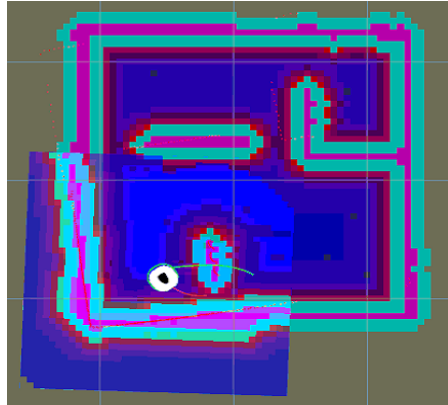
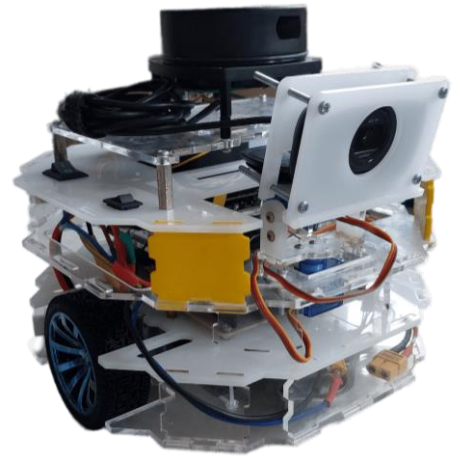
Autonomous Robotic Car



Humanoid Robot

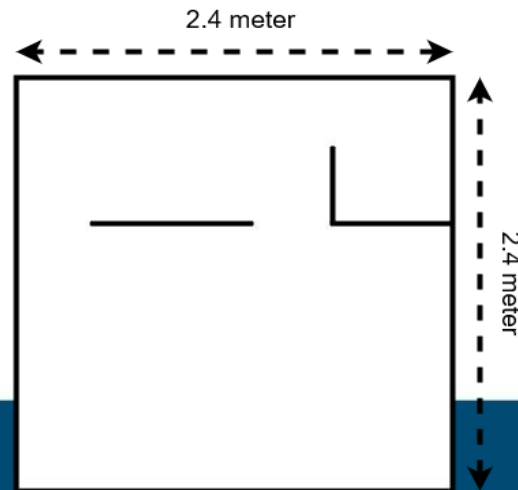
# Robotics System

- ROS (Robot Operating System)

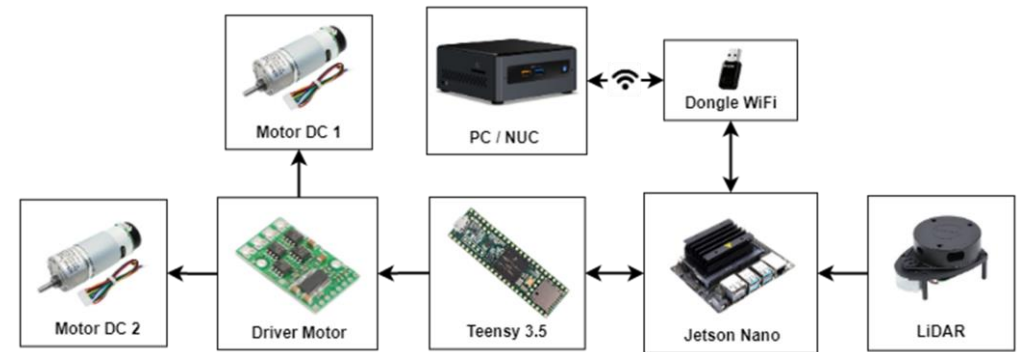


<https://youtu.be/pN8gDxHVUxY>

<https://youtu.be/Tza4qoCPIFM>



No	Perangkat	Keterangan
1	RPLiDAR A1M8	Laser Scanning 360 derajat 8000 sample data per detik Frekuensi scan = 2 - 10 Hz Jarak Pemindaian = 0.15 - 12m Komunikasi UART = 115200 bps
2	Jetson Nano 4GB	GPU = 128-core Maxwell CPU = Quad-core ARM A57 @ 1.43 GHz Memory = 4 GB 64-bit LPDDR4 25.6 GB/s Storage = microSD Connectivity = Gigabit Ethernet, M.2 Key E Display = HDMI and display port USB = 4x USB 3.0, USB 2.0 Micro-B Others = GPIO, I2C, I2S, SPI, UART
3	Kontroler	Teensy 3.5 Driver H-bridge (12 V)
4	Motor DC JGA25-370 1000RPM	Tegangan kerja = 12 V Stall Current = 1.2A Stall Torque = 1 kg.cm Gearbox = 1:9.28



LOCALLY ROOTED, GLOBALLY RESPECTED

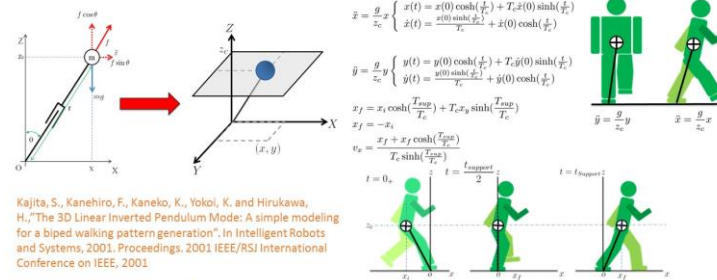
# Robotics System

- Humanoid Robot



<https://otomasi.sv.ugm.ac.id/humanoid-robot/>

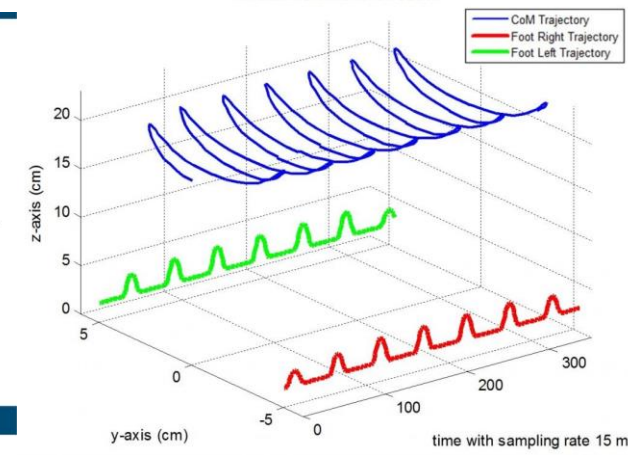
## Three Dimensional Linear Inverted Pendulum Model



Kajita, S., Kanehiro, F., Kaneko, K., Yokoi, K. and Hirukawa, H., "The 3D Linear Inverted Pendulum Mode: A simple modeling for a biped walking pattern generation". In Intelligent Robots and Systems, 2001. Proceedings. 2001 IEEE/RSJ International Conference on IEEE, 2001

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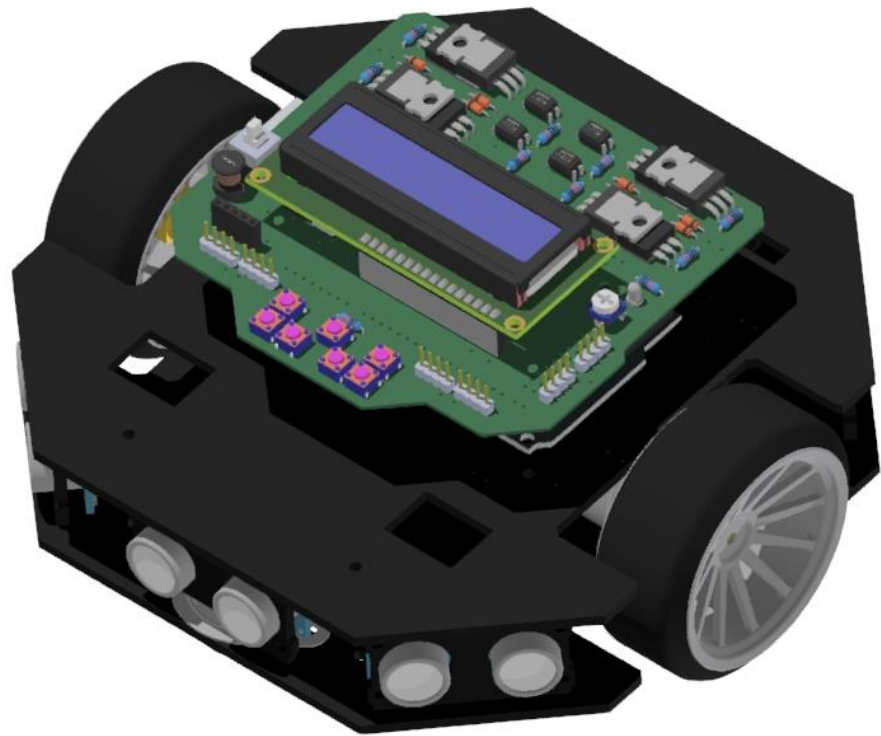
3D view Locomotion of VoBiRo



<https://ieeexplore.ieee.org/document/8534767>

# Robotics System

- Mobile Robot (Odometry)

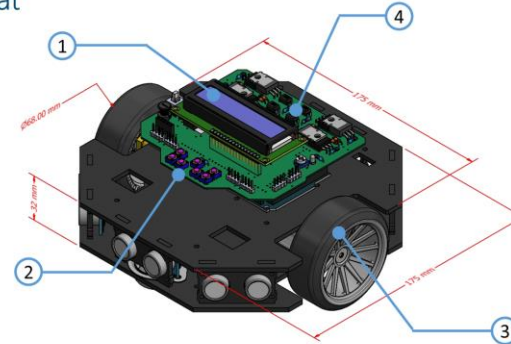


<https://youtu.be/1vndGHznzyU>



## Perancangan Alat

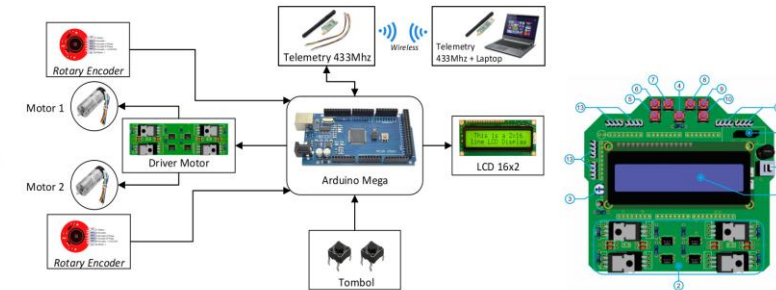
1. LCD 16x2
2. Tombol Navigasi
3. Roda 68mm
4. Driver Motor



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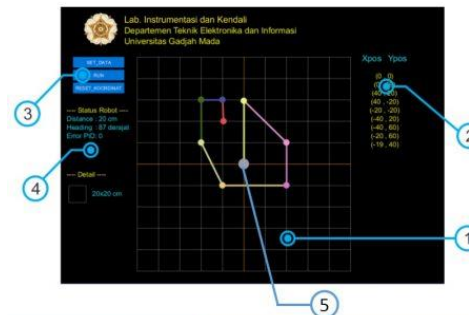
## Perancangan Elektronik



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## Trajectory Tracking use Odometry

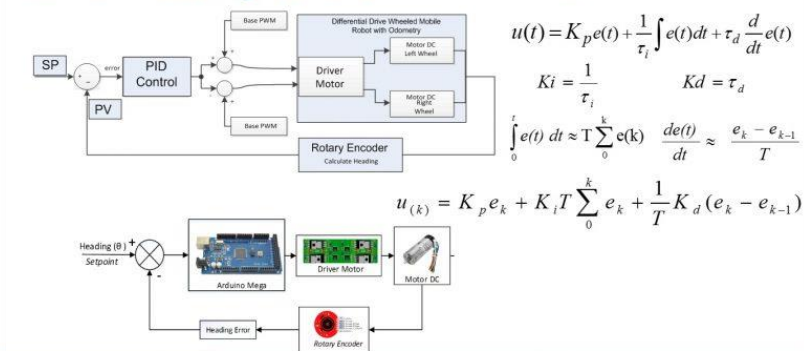


1. Odometry coordinate viewer on robots.
2. List of odometry coordinates.
3. Command buttons.
4. Robot parameters when the robot moves.
5. Initial position robots

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## PID for Heading Control



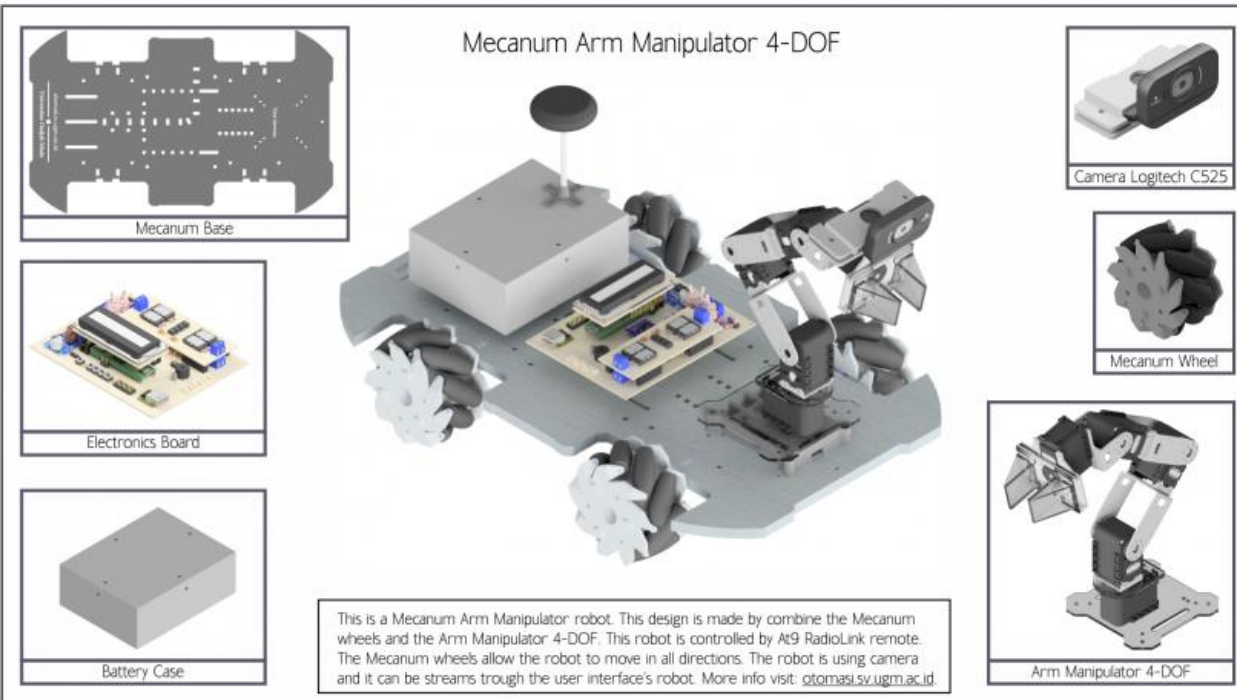
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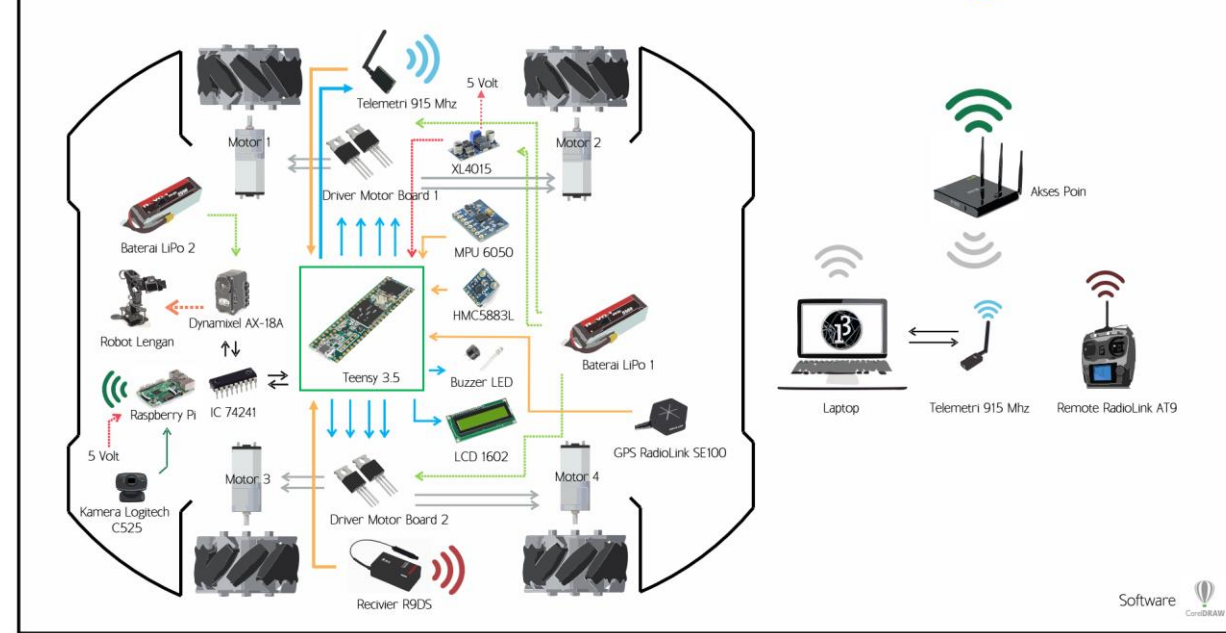
<https://ieeexplore.ieee.org/document/9223412>

# Robotics System

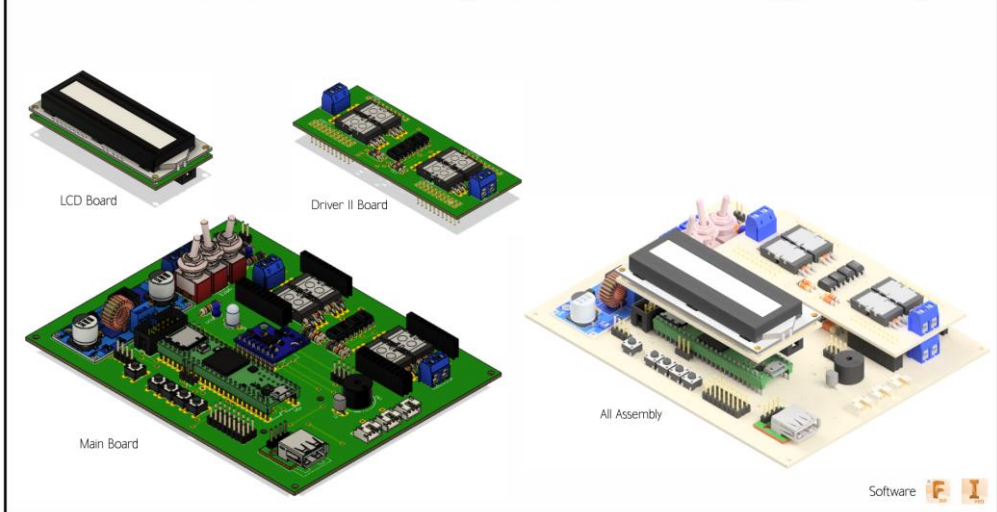
- Mobile Robot (Mecanum Wheel)



Mecanum Arm Manipulator 4-DOF - Electrical Design - Block Diagram



Mecanum Arm Manipulator 4-DOF - Electrical Design - 3D Board



<https://youtu.be/I9IMaNgYibY>

<https://youtu.be/azSCSVzKaz8>

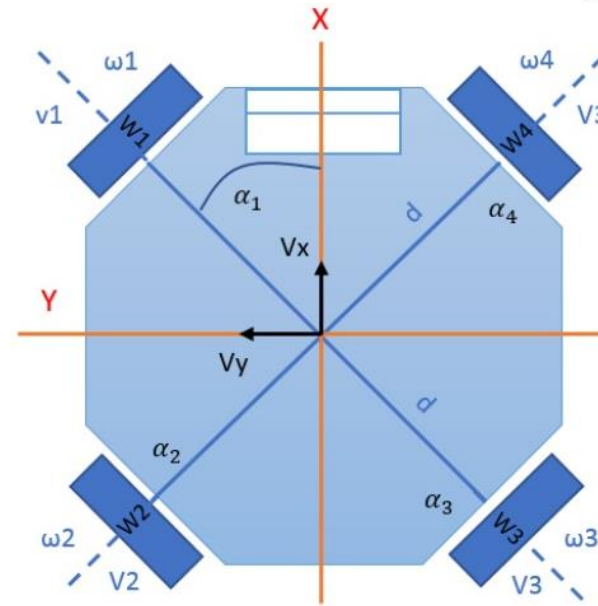
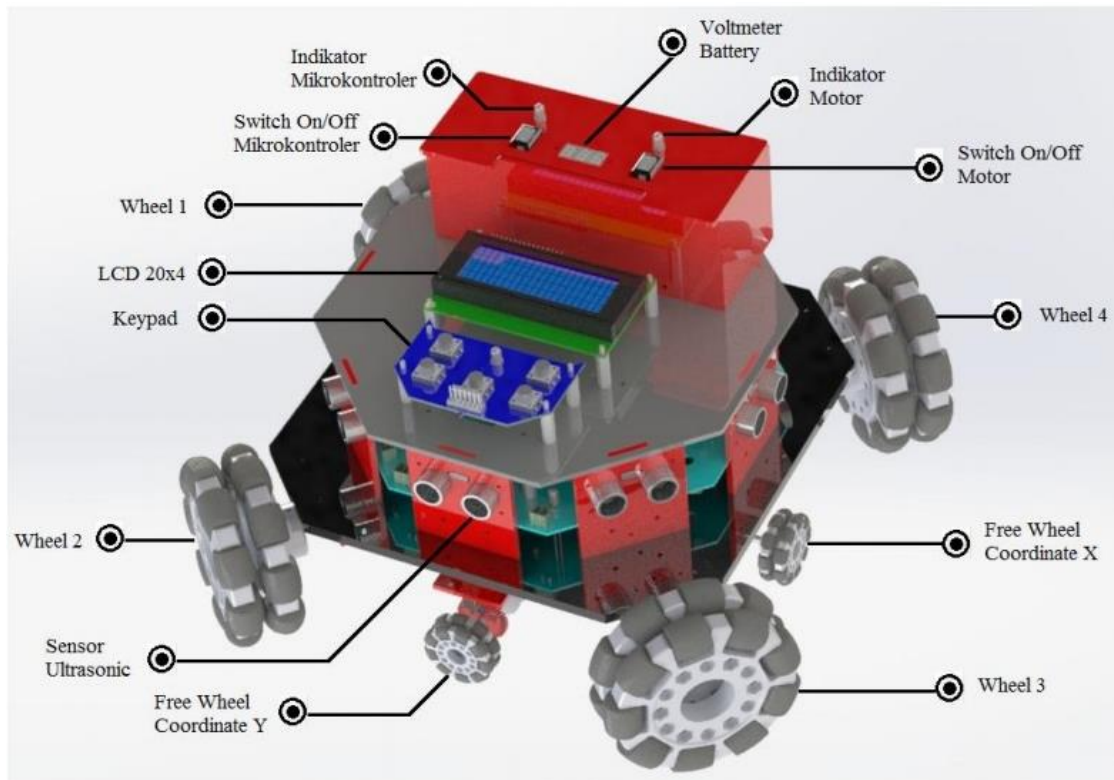
<https://jurnal.usk.ac.id/JRE/article/view/17365>



# Robotics System

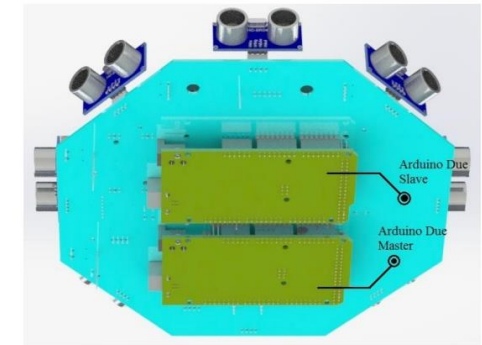
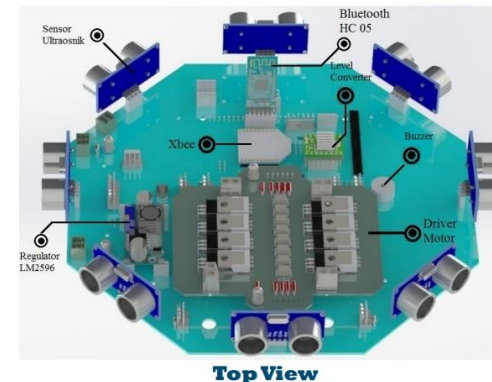


- Mobile Robot (Omni Wheel)



$$V_{w(n)} = \begin{bmatrix} -\sin\left(\theta + \frac{1\pi}{4}\right) & \cos\left(\theta + \frac{1\pi}{4}\right) & d \\ -\sin\left(\theta + \frac{3\pi}{4}\right) & \cos\left(\theta + \frac{3\pi}{4}\right) & d \\ -\sin\left(\theta + \frac{5\pi}{4}\right) & \cos\left(\theta + \frac{5\pi}{4}\right) & d \\ -\sin\left(\theta + \frac{7\pi}{4}\right) & \cos\left(\theta + \frac{7\pi}{4}\right) & d \end{bmatrix} \begin{bmatrix} V_x \\ V_y \\ \theta \end{bmatrix}$$

## Elektronik Design

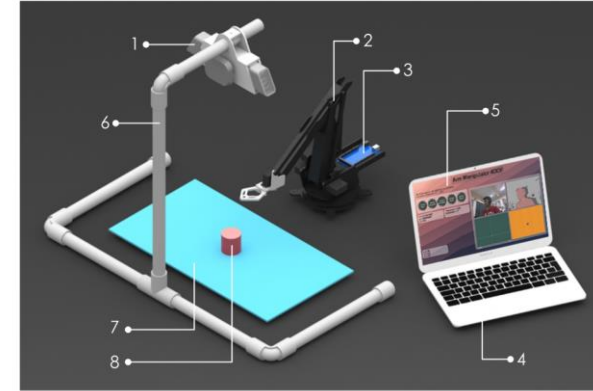


Bottom View

<https://youtu.be/7qil4OtCou4>

<https://jurnal.ugm.ac.id/v3/JNTETI/article/view/2614>

## Perancangan Sistem



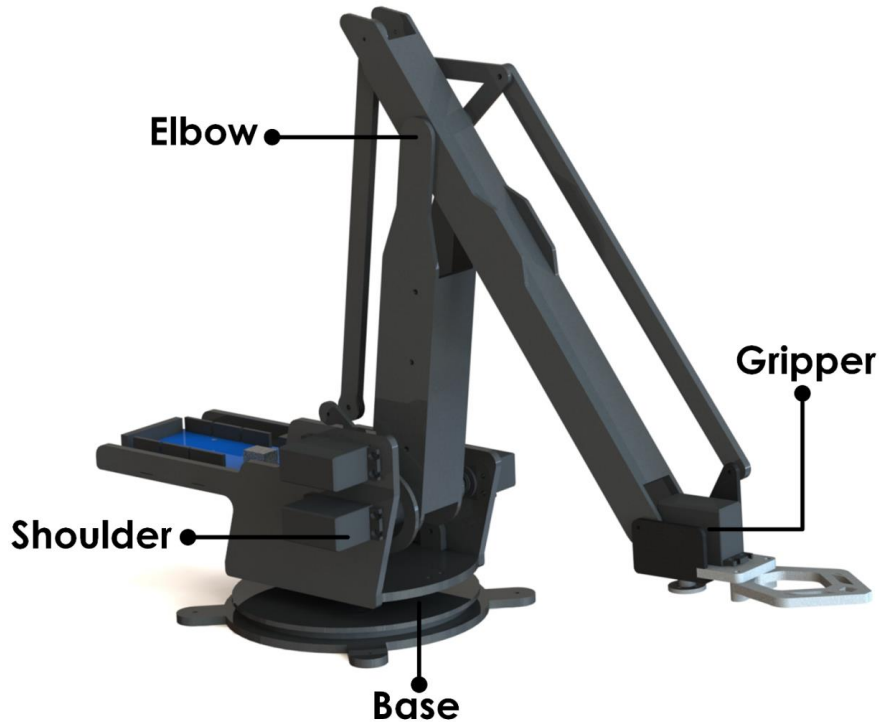
1. Kamera Kinect
2. Robot Lengan 4DOF
3. Arduino Mega 2560
4. Personal Computer
5. GUI Processing IDE
6. Mounting Kamera
7. Workspace
8. Objek

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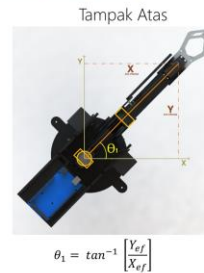
LOCALLY ROOTED, GLOBALLY RESPECTED

# Robotics System

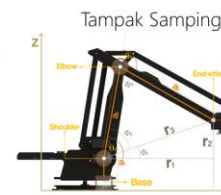
- Arm Manipulator Robot



## (Inverse Kinematics) (Kinematika Balik)



$$\theta_1 = \tan^{-1} \left[ \frac{Y_{ef}}{X_{ef}} \right]$$



$$r_1 = \sqrt{(X_{ef})^2 + (Y_{ef})^2}$$

$$r_2 = \text{Zend-effector} - a_1$$

$$r_3 = \sqrt{(r_2)^2 + (r_1)^2}$$

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## Kinematika Balik

$$\Phi_1 = \tan^{-1} \left[ \frac{r_2}{r_1} \right]$$

$$a_3^2 = (a_2)^2 + (r_3)^2 - 2a_2r_3\cos\Phi_2$$

$$\cos\Phi_2 = \frac{(a_2)^2 + (r_3)^2 - (a_3)^2}{2a_2r_3}$$

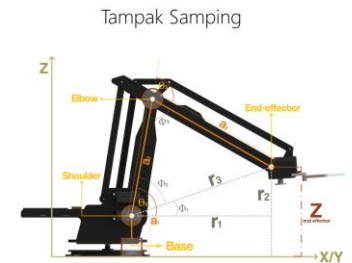
$$\Phi_2 = \cos^{-1} \left[ \frac{(a_2)^2 + (r_3)^2 - (a_3)^2}{2a_2r_3} \right]$$

$$r_3^2 = (a_2)^2 + (a_3)^2 - 2a_2a_3\cos\Phi_3$$

$$\cos\Phi_3 = \frac{(a_2)^2 + (a_3)^2 - (r_3)^2}{2a_2a_3}$$

$$\Phi_3 = \cos^{-1} \left[ \frac{(a_2)^2 + (a_3)^2 - (r_3)^2}{2a_2a_3} \right]$$

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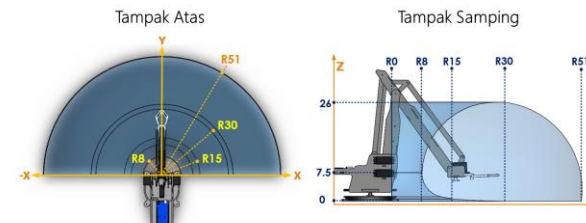


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[https://youtu.be/8y\\_Lif9SUqQ](https://youtu.be/8y_Lif9SUqQ)

<https://iopscience.iop.org/article/10.1088/1742-6596/1444/1/012030>

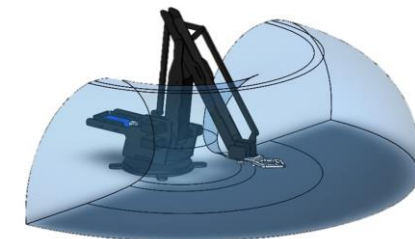
## Visualisasi Workspace



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## Visualisasi Workspace

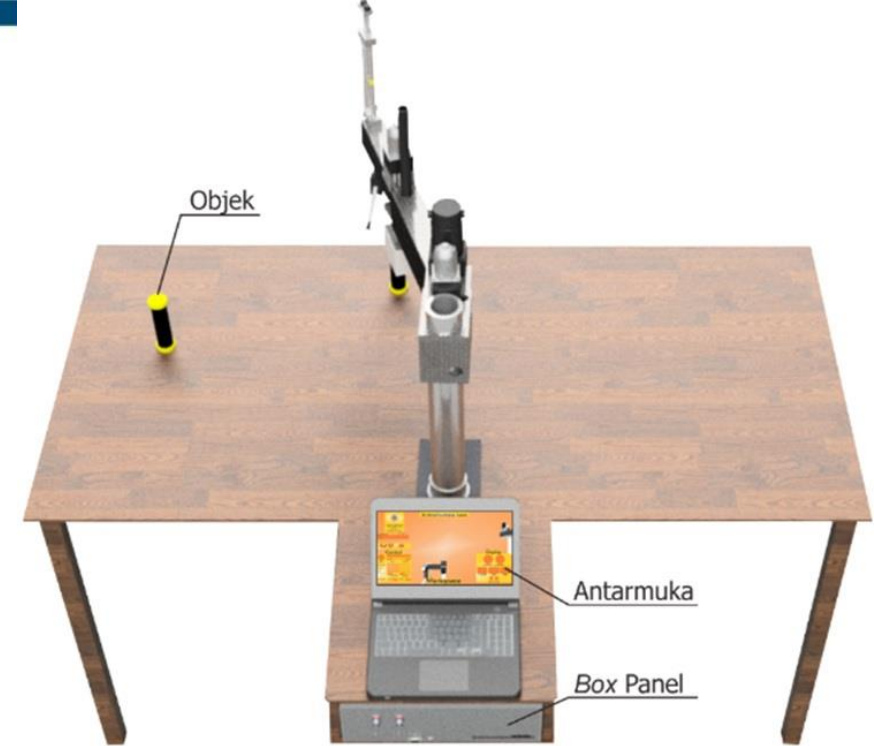
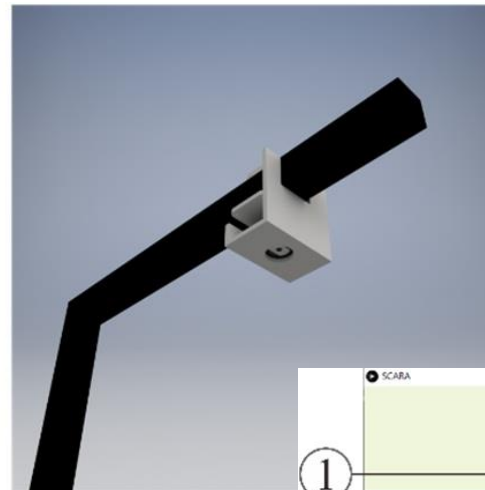
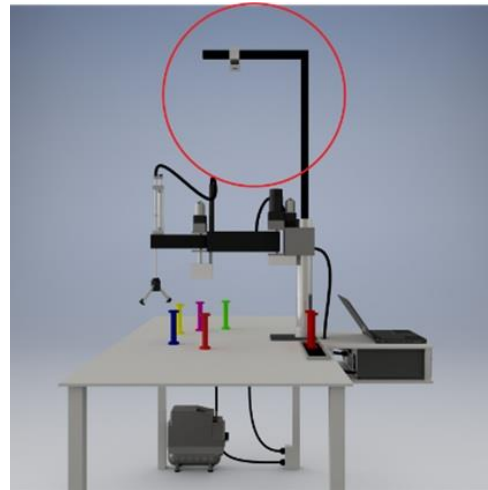


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# Robotics System

- Arm Manipulator Robot (SCARA)



<https://youtu.be/p6b-xSxJP6k>

<https://youtu.be/5FscVnYYhS8>

<https://ejournal.itenas.ac.id/index.php/elkomika/article/view/3729>

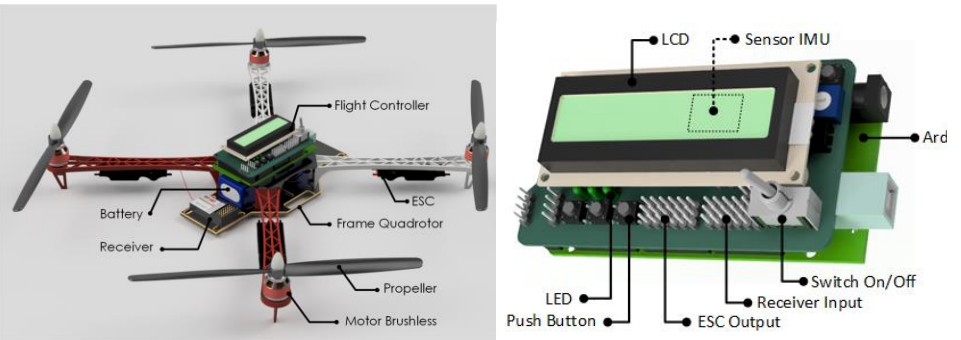
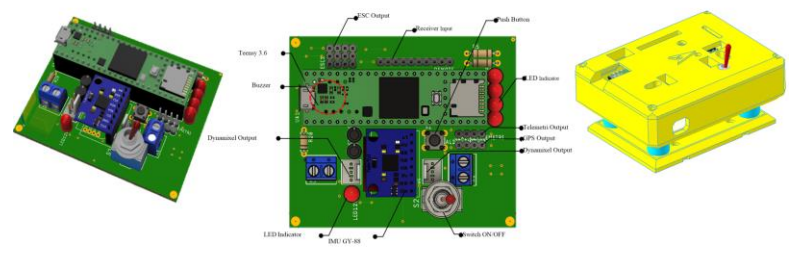


# Robotics System

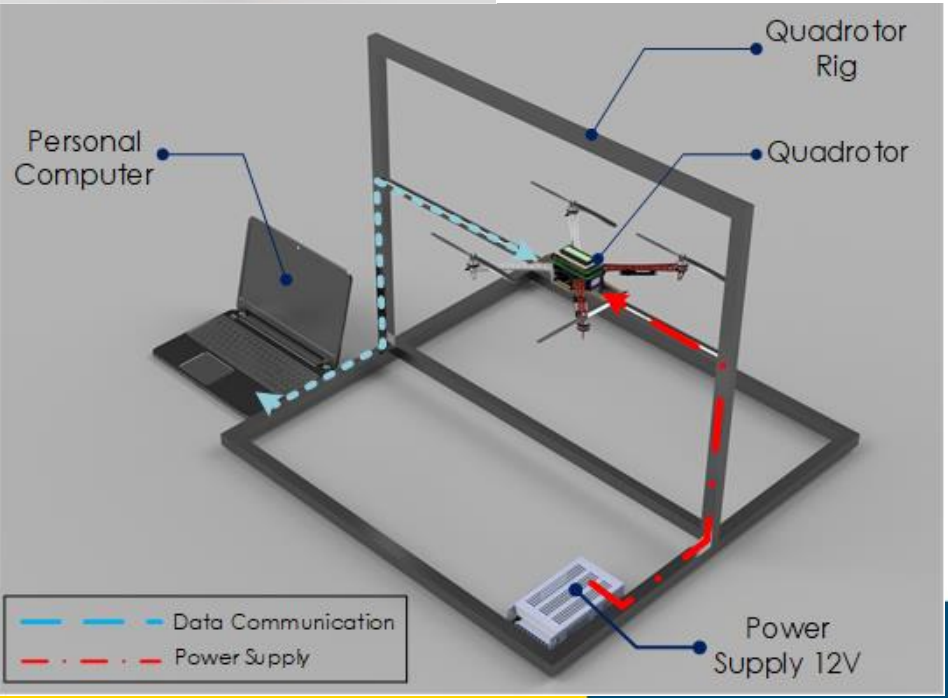
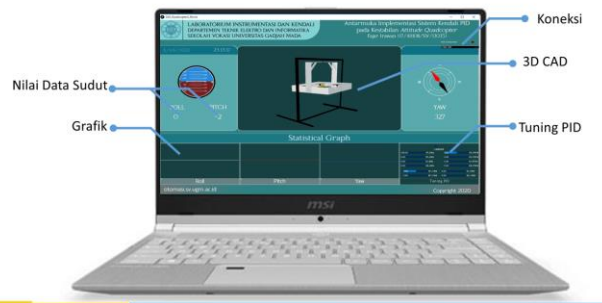
- Aerial Unmanned Robot (UAV Quadcopter)

Tahun 2018 <https://youtu.be/3YlgwXL4GBY>

Tahun 2020 <https://youtu.be/r7E7RjM0DhM>



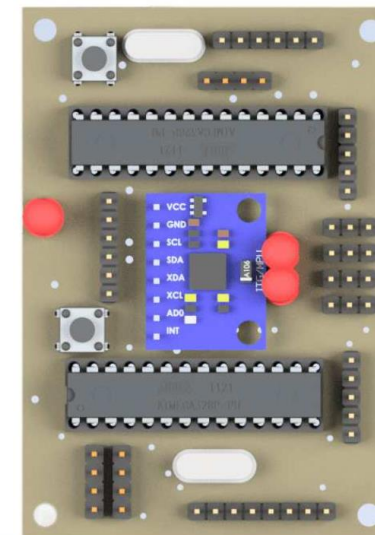
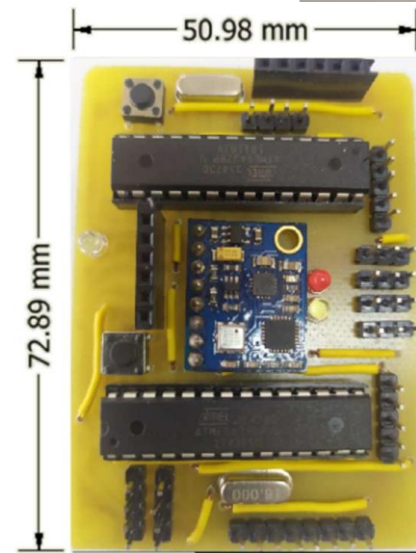
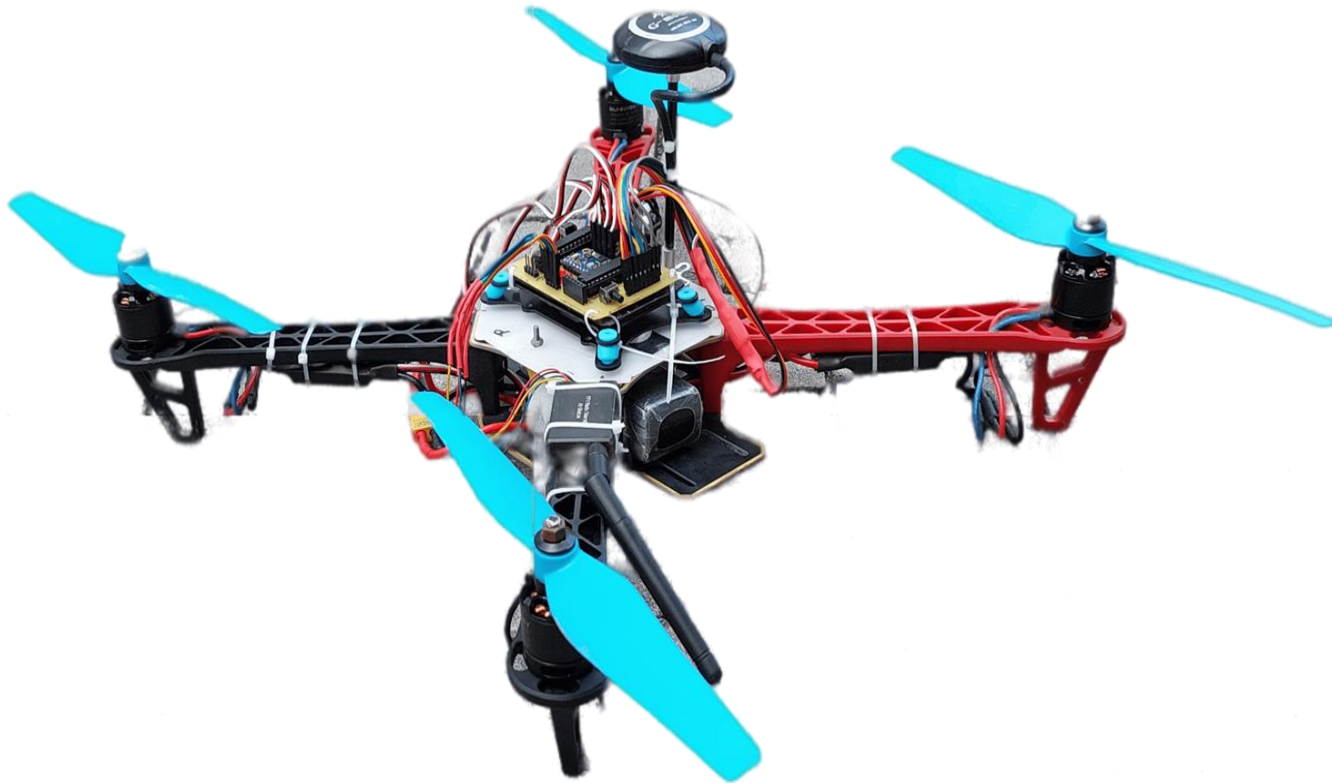
## Perancangan Antarmuka



# Robotics System



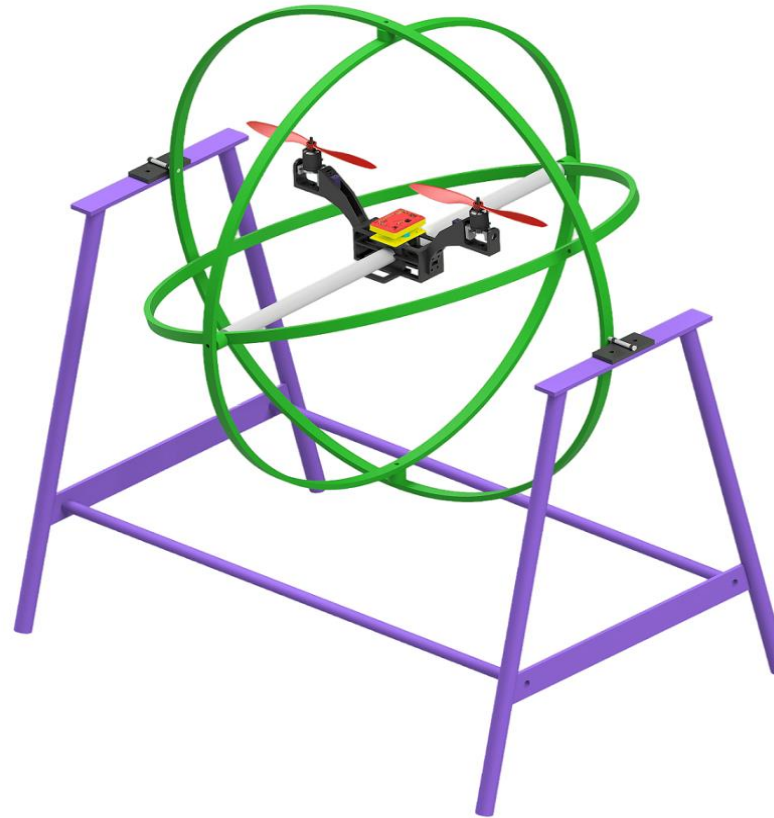
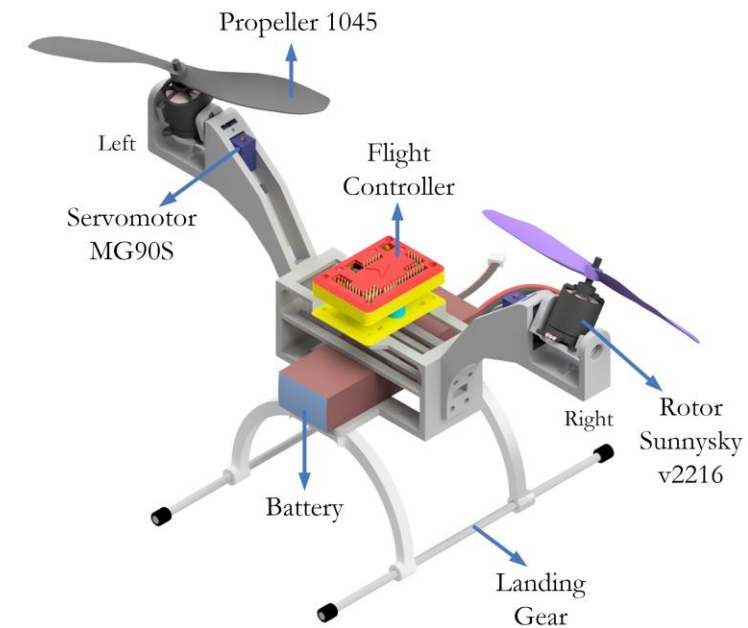
- Aerial Unmanned Robot (UAV Quadcopter)  
Tahun 2023 (Low-cost Flight Controller menggunakan Atmega328p)



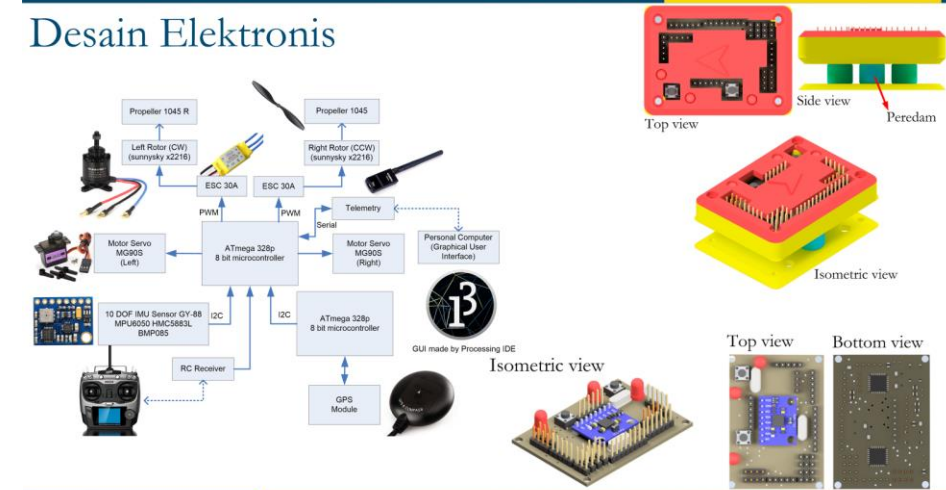
<https://youtu.be/7BaN7lz7dEw>

# Robotics System

- Aerial Unmanned Robot (UAV Bicopter)



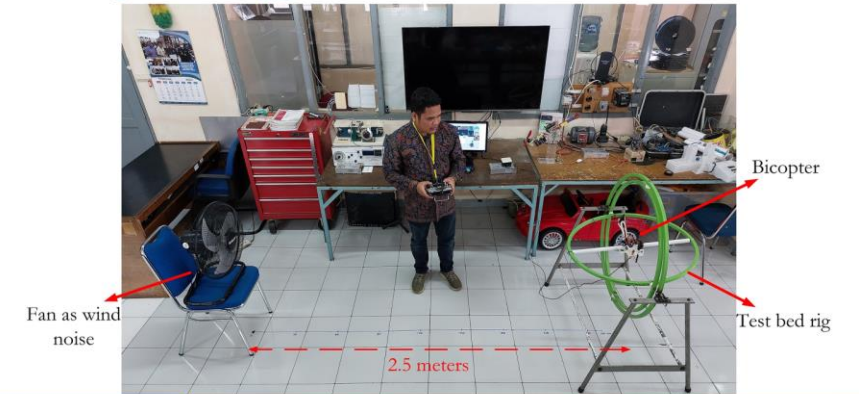
## Desain Elektronis



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## Pengujian Pengendali PID pada Attitude UAV Bicopter menggunakan Test Bed



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<https://youtu.be/2WvoN8GQrjU>

<https://youtu.be/rOh-Y5iN35g>

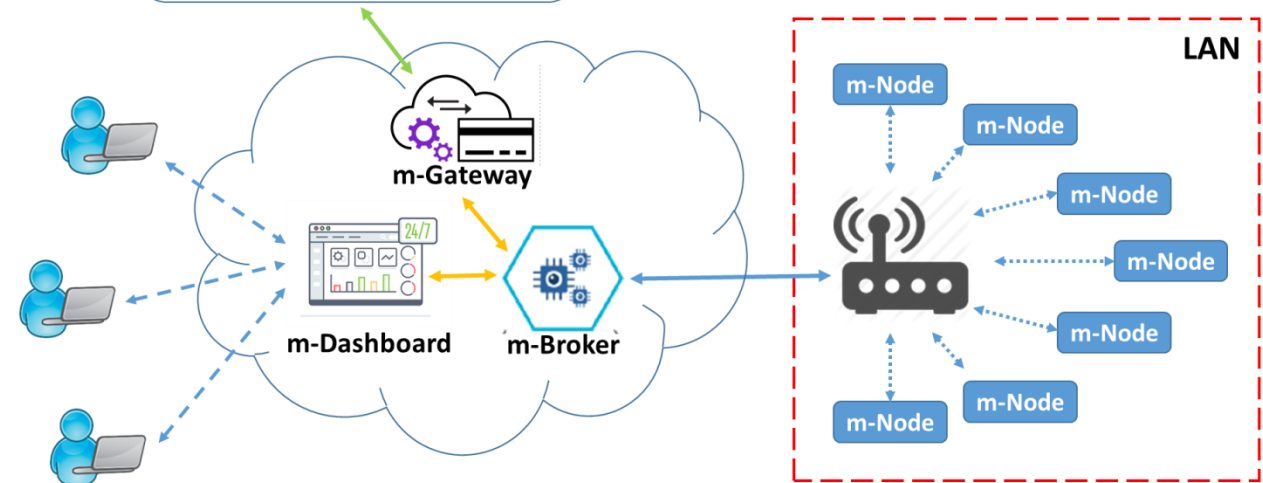
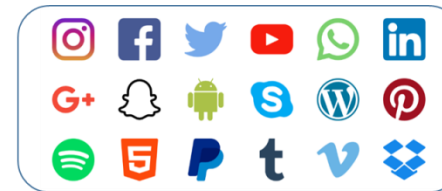


# Smarthome with IoT(Internet of Things)



Fitur Smarthome:

- Simulasi Lampu Pintar
- Simulasi AC Pintar
- Simulasi Garasi Pintar



<https://youtu.be/H624MiBg2HY>

<http://telkomnika.uad.ac.id/index.php/TELKOMNIKA/article/view/11722>

# Autonomous Robotic Car



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ROBOT MINIATUR MOBIL MERCY SLR 722 S

<https://youtu.be/kiDGoK4uaWI>

<https://journal.ugm.ac.id/juliet/article/view/59347>





# Belajar, berteman dan bermain di lab



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# Terimakasih

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  - Site: [fahmizal.staff.ugm.ac.id](http://fahmizal.staff.ugm.ac.id)
  - Lab: [otomasi.sv.ugm.ac.id](http://otomasi.sv.ugm.ac.id)