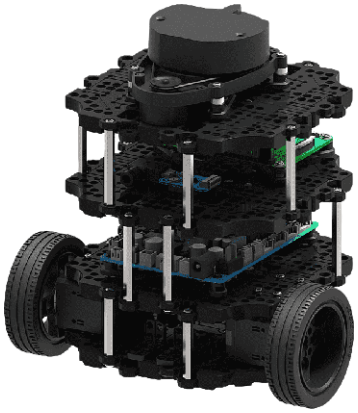
RTH 236 Mobile Manipulator System

RTH 236 Mobile Manipulator System is a Package Consists of the following:

- Raspberry Pi500
- TurtleBot Burger
- Humanoid Robot
- Mobile Robot with controller
- GPU
- GPS
- Camera Depth Sensor
- IMU
- RP Lidar
- 6DOF Robotic Arm with 2 finger grippers



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Sr. No.	Feature	Specifications of Features
1	Raspberry Pi 500	
1.1	**Processor**	2.4GHz quad-core 64-bit Arm Cortex-A76 CPU, with cryptography extensions, 512KB per-core L2 caches and a 2MB shared L3 cache
1.2	**Memory**	8GB LPDDR4X-4267 SDRAM
1.3	**Connectivity**	Dual-band (2.4GHz and 5.0GHz) IEEE 802.11b/g/n/ac Wi-Fi®, Bluetooth 5.0, BLE, Gigabit Ethernet, 2 × USB 3.0 ports and 1 × USB 2.0 port
1.4	**GPIO**	Horizontal 40-pin GPIO header
1.5	**Video & sound**	2 × micro-HDMI ports (supports up to 4Kp60)
1.6	**Multimedia**	H.265 (4Kp60 decode); OpenGL ES 3.0 graphics
1.7	**SD card support**	MicroSD card slot for operating system and data storage
1.8	**Keyboard**	78-, 79- or 83-key compact keyboard (depending on regional variant)
1.9	**Power**	5V DC via USB connector
1.10	**Operating temperature**	0°C to +50°C

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1.11	**Dimensions**	286 mm × 122 mm × 23 mm (maximum)
2	**Indoor mobile robot should have following specifications:**	
2.1	**Maximum translational velocity**	0.22 m/s
2.2	**Maximum rotational velocity**	2.84 rad/s (162.72 deg/s)
2.3	**Maximum payload**	15kg
2.4	**Size (L x W x H)**	138mm x 178mm x 192mm
2.5	**Weight (+ SBC + Battery + Sensors)**	1kg
2.6	**Max. traversable step**	10 mm or lower
2.7	**Operating time**	2h 30m
2.8	**Charge time**	2h 30m
2.9	**PC connection**	USB
2.10	**LiDAR LDS**	**02**
2.11	**IMU**	gyroscope 3 axis, accelerometer 3 axis, magnetometer 3 axis
2.12	**Power connectors**	3.3V / 800mA 5V / 4A 12V / 1A
2.13	**Expansion pins**	GPIO 18 pins Arduino 32 pin
2.14	**Programmable LEDs**	User LED x 4
2.15	**Board status**	LED x 1
2.16	**Battery status**	LED x 1
2.17	**Arduino**	LED x 1
2.18	**Battery**	Lithium polymer battery 11.1V 1800 mAh / 19.98 Wh 5C
2.19	**Firmware upgrade**	via USB / JTAG
2.20	Input	100-240V, AC 50/60Hz, 1.5A @max
2.21	Output	12V DC, 5A
3	**Humanoid Robot or better should have following specifications:**	
3.1	**Size**	373*186*106mm (14.69x7.32x4.17inches)
3.2	**Weight**	About 1800g

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3.3	**Camera pixel**	480P
3.4	**Battery**	11.1V 2000mAh 10C lithium battery
3.5	**Working Hour**	About 60mins
3.6	**Head**	2 DOF
3.7	**Shoulder**	2 DOF
3.8	**Arm**	2 DOF (each)
3.9	**Leg**	2 DOF (each)
3.10	**Foot**	1 DOF (each)
3.11	**Hardware**	Raspberry Pi 4B/5 and Raspberry Pi 4B/5 expansion board
3.12	**Software**	APP+PC software
3.13	**Communication**	Wi-Fi and ethernet
3.14	**Servo**	LX-824HV bus servo/ LFD-01M avoid blocking servo
3.15	**Shipping size**	45*43*17cm
3.16	**Shipping weight**	About 3.9kg
	If Better option available	3.1 Size 70cmx31cmx40cm 3.2 Weight 15Kg (including battery) 3.3 Payload 7Kg (limit~ 10Kg) 3.4 Speed 0~2.5m/s 3.5 Maximum climbing height 15cm 3.6 Maximum climbing slope angle 30° 3.7 Large joint movement space body: -48~48°; thigh: -200~90°; calf: -156~-48 3.8 Bluetooth 5.2/4.2/2.1 3.9 Battery type Standard battery (8000mAh) Battery life 1-2h; Standard charging charger (33.6V 3.5A) 3.10 Material Aluminum alloy + High strength engineering plastic 3.11 Voltage 28V~33.6V 3.12 Peaking Capacity About 3000W 3.13 Aluminum Knee joint motor 12Set 3.14 Smart Battery Standard (8000mAh) 3.15 Battery life About 1-2h 3.16 Charger Standard (33.6V 3.5A)
4	**Customized Mobile Manipulator Robot Consisting of:**	
4.A	**Mobile Robot (Outdoor) should have following specifications:**	
4A.1	**Dimensions** **L x W x H**	508 x 430 x 250 mm 20 x 17 x 10 in
4A.2	**Weight**	17 kg (37 lb)
4A.3	**Payload**	All terrain: 10 kg / 22 lb Maximum: 20 kg / 44 lb

4A.5	**Clearance**	65 mm (2.6 in)
4A.6	**Operating Time**	2 hrs maximum, 8 hrs typical
4A.7	**Drive Power**	500 W
4A.8	**Battery**	270-Watt hours, Lithium Ion
4A.9	**Encoders**	78,000 pulses/m Quadature
4A.10	**User Power**	5V at 5A, 12V at 10A, 24V at 20A
4A.11	**Communication**	Ethernet, USB 3.0, RS232. IEEE 1394 available
4A.12	**Drivers / APIs**	Packaged with ROS Kinetic
4A.13	**Control Modes**	Open-loop Wheel Velocity Kinematic Commands
4A.14	**Feedback**	Battery and motor current Wheel velocity and travel Integrated GPS Integrated gyroscope and accelerometer
4.B	**GPU integrated in mobile robot should have following specifications:**	
4B.1	**GPU Memory**	4 GB GDDR6
4B.2	**Memory Interface**	128-bit
4B.3	**Memory Bandwidth**	Up to 160 GB/s
4B.4	**NVIDIA CUDA Cores**	896
4B.5	**Single-Precision Performance**	Up to 2.5 TFLOPs3
4B.6	**System Interface**	PCI Express 3.0 x 16
4B.7	**Max Power Consumption**	50 W
4B.8	**Thermal Solution**	Active
4B.9	**Form Factor**	2.713 inches H x 6.137 inches L, single slot
4B.10	**Display Connectors**	4 x mDP 1.4 with latching mechanism
4B.11	**Max Simultaneous Displays**	4x 3840 x 2160 @ 120Hz 4x 5120 x 2880 @ 60Hz 2x 7680 x 4320 @ 60Hz
4B.12	**Graphics APIs**	DirectX 12.074, Shader Model 5.174, OpenGL 4.685, Vulkan 1.25
4B.13	**Compute APIs**	CUDA, Direct Compute, OpenCL™
4A.4	**Maximum Speed**	2.0 m/s (6.6 ft/s)

4.C	GPS integrated in mobile robot should have following specifications:	
4C.1	**GNSS Solution**	MTK MT3333a
4C.2	**Frequency**	GPS L1, 1575.42MHz GLONASS L1, 1598.0625~1605.375MHz
4C.3	**Sensitivity (GPS portion)**	Acquisition: -148dBm, cold start Reacquisition: -163dBm, Hot start Tracking: -165dBm
4C.4	**Position Accuracy**	Without aid:3m (50% CEP) DGPS (SBAS (WAAS, EGNOS, MSAS, GAGAN b)):2.5m (50% CEP)
4C.5	**Velocity Accuracy**	Without aid: 0.1m/s DGPS (SBAS (WAAS, EGNOS, MSAS, GAGAN b)):0.05m/s
4C.6	**Timing Accuracy (1PPS Output)**	Default: ±20ns RMS within 100ms in one pulse (pulse width/duration can be customized)
4C.7	**Altitude**	10,000m maximum (Normal mode: car/pedestrian/ aviation) 80,000m maximum (Balloon mode)
4C.8	**Velocity**	Maximum 515m/s (1000 knots) c
4C.9	**Acceleration**	Maximum 4G
4C.10	**Update Rate**	1Hz (default), maximum 10Hz
4C.11	**Baud Rate**	9600 bps (default)
4C.12	**DGPS**	SBAS (default) [WAAS, EGNOS, MSAS, GAGAN b
4C.13	**Power Supply**	VCC: 3V to 4.3V; VBACKUP: 2.0V to 4.3V
4C.14	**Current Consumption @ 3.3V,1Hz Update Rate**	GPS+GLONASS Acquisition: 24mA/ 27mA /30mA (min / typical / max) Full Power Tracking: 21mA / 23mA / 28mA (min / typical / max) GLP (GNSS Low-power) Tracking: 7mA / 16mA / 32mA (min / typical / max)
4C.15	**Backup Power Consumption@ 3V**	15uA (TYP)
4C.16	**Power Saving (Periodic)**	Backup mode: 1.2mA (TYP) d Standby mode: 1.5mA (TYP) d
4C.17	**NRESET Current @ 3.3V**	8mA (TYP)
4C.18	**Working Temperature**	-40 °C to +85 °C
4C.19	**Dimension**	12.5x12.5 x 6.8 mm, SMD
4C.20	**Weight**	4g
4.D	Camera Depth Sensor integrated in mobile robot should have following specifications:	
4D.1	**Use environment**	Indoor/Outdoor

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4D.2	**Ideal range**	.3 m to 3 m
4D.3	**Depth technology**	Stereoscopic
4D.4	**Depth Field of View (FOV)**	87° × 58°
4D.5	**Minimum depth distance (Min-Z) at max resolution**	~28 cm
4D.6	**Depth output resolution**	Up to 1280 × 720
4D.7	**Depth Accuracy**	<2% at 2 m1
4D.8	**Image sensor technology**	Global Shutter
4D.9	**RGB frame resolution**	1920 × 1080
4D.10	**RGB sensor FOV (H × V)**	69° × 42°
4D.11	**RGB frame rate**	30 fps
4D.12	**RGB sensor resolution**	2 MP
4D.13	**RGB sensor technology**	Rolling Shutter
	Major Components	
4D.14	**Camera module**	Intel RealSense Module D430 + RGB Camera
4D.15	**Vision processor board**	Intel RealSense Vision Processor D4
4D.16	**Form factor**	Camera Peripheral
4D.17	**Connectors**	USB-C* 3.1 Gen 1*
4D.18	**Length × Depth × Height**	90 mm × 25 mm × 25 mm
4D.19	**Mounting mechanism**	- One 1/4-20 UNC thread mounting point. - Two M3 thread mounting points.
4.E	**IMU (Inertia Measurement Unit) Sensor integrated in mobile robot should have following specifications:**	
4E.1	**Features**	Gyroscope: Digital-output X-, Y-, and Z-Axis angular rate sensors (gyroscopes) with a user- programmable full-scale range of ±250, ±500, ±1000, and ±2000°/sec and integrated 16-bit ADCs Digitally-programmable low-pass filter Gyroscope operating current: 3.2mA Sleep mode current: 8µA Factory calibrated sensitivity scale factor Self-test

		Accelerometer: Digital-output triple-axis accelerometer with a programmable full-scale range of ±2g, ±4g, ±8g and ±16g and integrated 16- bit ADCs Accelerometer normal operating current: 450µA Low power accelerometer mode current: 8.4µA at 0.98Hz, 19.8µA at 31.25Hz Sleep mode current: 8µA User-programmable interrupts Wake-on-motion interrupt for low power operation of applications processor Self-test Magnetometer: 3-axis silicon monolithic Hall-effect magnetic sensor with magnetic concentrator Wide dynamic measurement range and high resolution with lower current consumption. Output data resolution of 14 bit (0.6µT/LSB) Full scale measurement range is ±4800µT Magnetometer normal operating current: 280µA at 8Hz repetition rate Self-test function with internal magnetic source to confirm magnetic sensor operation on end products
4E.2	**Operating Range**	Max. 85°C
4E.3	**Supply Voltage**	2.4 – 3.6 V
4E.4	**Environment of use**	Indoor
4E.5	**Emitting Property**	Infrared Laser
4E.6	**Laser class**	CLASS 1
4E.7	**Emitting property Wavelength band**	905nm
4E.8	**Emitting property Max. pulse output power**	6W
4E.9	**Beam conversion angle**	9.5 mrad
4E.10	**Scanning frequency**	15 Hz
4E.11	**Response time**	Typ.67ms
4E.12	**Monitoring zone**	0.05 ~ 10 m
4E.13	**Min. size of the scanning target**	At detection distance of 8m: ≈ 121 mm
4E.14	**Angular resolution**	0.33°

4E.15	**Aperture angle**	270°
4E.16	**Object reflectivity**	Min. 4 %
4E.17	**Weight**	≈ 228 g (314 g)
4E.18	**Power supply**	9-28VDC
4E.19	**Power consumption**	< 4W
4E.20	**Input**	4 Photocoupler inputs - H: ≥ 9-28 VDC, L: ≤ 3 VDC
4E.21	**Output signal**	NPN-PNP open collector output setting (software)
4E.22	**Insulation resistance**	≥ 5 MΩ (500 VDC megger)
4E.23	**Dielectric strength**	500VAC 50/60Hz for 1 minute
4E.24	**Vibration**	10 sweep cycles in each X, Y, Z axes at sine wave, 10 to 500 Hz, acceleration 5 G
4E.25	**Environment Ambient illumination**	≤ 80,000 lx
4E.26	**Environment Ambient temperature**	-10 to 50 ℃, storage: -30 to 70 ℃ (no freezing or condensation)
4E.27	**Environment Ambient humidity**	0 to 95 %RH, storage: 0 to 95 %RH (no freezing or condensation)
4E.28	**Protection structure**	IP67(IEC standard)
4E.29	**Connector type**	Power I / O: M12 12-pin, Ethernet: M12 8-pin
4E.30	**Material**	Case: AL, Window: PC
4E.31	**Communication interface**	Ethernet
4F	**RP LIDAR Sensor integrated in mobile robot should have following specifications:**	
4F.1	**Product**	S2
4F.2	**Models**	S2M1-Rx
4F.3	Distance Range	0.05-30m（90% reflection）
		0.05-10m（10% reflection）
4F.4	**Blind Range**	0.05m
4F.5	**Sample Rate**	32000 times per second
4F.6	**Scan Rate**	10 Hz
4F.7	**Angular Resolution**	0.1125°
4F.8	**Scan Field Flatness**	±1.5°

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4F.9	**Accuracy**	±30mm
4F.10	**Distance Resolution**	13mm
4F.11	**Communication Interface**	13mm
4F.12	**System Voltage**	5V
4F.13	**Power Consumption**	> 2W
4F.14	**Proof Level**	IP65
4F.15	**Temperature Range**	-10℃-50℃
4G	**6DOF (Degree of Freedom) Robotic Arm with 2 Finger Gripper Specifications**	
4G.1	**Weight (including weight of Robot controller)**	Less than 6 Kg
4G.2	**Payload**	400 to 600 grams
4G.3	**Maximum reach**	700 to 800 mm
4G.4	**Maximum Cartesian translation speed**	20 to 30 cm/s
4G.5	**Degrees of Freedom**	6 DoF
4G.6	**Capacitive wrist interaction buttons**	Quantity: 2 (programmable)
4G.7	**Power supply voltage**	18 to 30 VDC, 24 VDC nominal
4G.8	**Robot power**	15 to 30W (average)
4G.9	**Materials**	Aluminum Polycarbonate, reinforced nylon
4G.10	**Internal communications and control**	Ethernet (100 Mbps)
4G.11	**Operating temperature**	0 to 40 degree C
4G.12	**Robot Ingress Protection**	IP22
	TECHNICAL SPECIFICATIONS - SOFTWARE AND CONTROL	
4G.13	**Low-level control**	position, velocity, current
4G.14	**High-level control**	Cartesian twist (linear & angular velocity), joint speed
4G.15	**High-level control features (mode dependent)**	protection zones - rectangular, spheric, cylindrical handling
4G.16	**Serving modes**	High level, low-level
4G.17	**Interfaces**	USB-A, micro-USB, Ethernet, Wi-Fi

4G.18	**Supported ROS distribution**	Kinetic Kame
4G.19	**Boot time**	30 seconds or lesser
4G.20	**Internal communication frequency**	1 kHz or better
4G.21	**Regarding API (Application Programming Interface)**	Using API, following sensor values of the actuators should be accessible to programmer: Position: angular position of the actuator in ° Velocity angular velocity of the actuator in ° / s Torque: approximate equivalent torque derived from motor Current in n·m Current: Motor Current in Ampere Voltage: main board voltage in Volts Temperature motor: actuator motor temperature in °c (one of three 3 Phases) Temperature core: microcontroller temperature in °C" **Wrist readings required through API:** imu_acceleration_x IMU Measured acceleration (X-axis) of the gripper. (m / s2) imu_acceleration_y IMU Measured acceleration (Y-axis) of the gripper. (m / s2) imu_acceleration_z IMU Measured acceleration (Z-axis) of the gripper. (m / s2) imu_angular_velocity_x IMU Measured angular velocity (X-Axis) of the gripper. (° / s) imu_angular_velocity_y IMU Measured angular velocity (Y-Axis) of the gripper. (° / s) imu_angular_velocity_z IMU Measured angular velocity(Z-Axis) of the gripper. (° / s) Base readings available through API: **Base readings available through API Field name Description** arm_voltage arm voltage in V temperature_cpu CPU temperature in °C temperature_ambient ambient temperature in °C imu_acceleration_x IMU measured

		acceleration (X-Axis) of base in m / s2 imu_acceleration_y IMU measured acceleration (Y-Axis) of base in m / s2 imu_acceleration_z IMU measured acceleration (Z-Axis) of base in m / s2 imu_angular_velocity_x: IMU measured angular velocity(X-Axis) of base in ° / s imu_angular_velocity_y IMU measured angular velocity(Y-Axis) of base in ° / s imu_angular_velocity_z: IMU measured angular velocity(Z-Axis) of base in ° / s
4G.22	**Actuators in the Robotic Arm should have these features:**	The robot should contain actuators which power the rotational movement at the robot joints. The robot contains three sizes of actuators with distinct performance capabilities. The actuators contain sensors. The rotational motion at each of the joints of the robot is powered by rotary actuators. There is one actuator for each joint. There are three types of actuators: • small • medium • large Each actuator should be equipped with the following: • current sensing • temperature sensing (motor) • temperature sensing (CPU) • relative position and velocity sensing • absolute position sensing Wrist joints (joints 4 to 6) use small actuators. Medium actuators are used for joints 1 and 3. A single large actuators is used for the shoulder joint (joint 2). Actuators use either high-efficiency planetary gearboxes (small and medium actuators) or low backlash strain wave gearing (large actuator). The actuators are connected to each other using a series of internal cables. These cables convey: • power • Ethernet data transmission

4G.23	**2 finger Gripper of the Robotic Arm**	The robot should incorporate a two- finger gripper. The finger body is composed of two different materials. The finger structure be made of a hard, but flexible plastic for structural integrity and strength, and a soft, rubber-like plastic for the grip. The gripper fingers should be actuated by a linear actuator inside the robot wrist and should open and close to accommodate a variety of grip types.
4G.24	**Sensors Required in the robot**	The robot should contain a number of different sensors in the base, actuators, and wrist and gripper. The robot components should contain the following sensors: **Base sensors** • voltage • current • temperature • 6-axis accelerometer / gyroscope **Actuator sensors** • motor current • motor temperature • CPU temperature • Angular Hall sensors • magnetic angular sensor • 24 V monitor **Wrist and gripper sensors** • capacitive sensors (qty. 2) • microcontroller temperature • microcontroller board voltage • 6-axis accelerometer / gyroscope • gripper motor current • gripper motor temperature • gripper motor voltage • gripper finger position and velocity (from gripper motor)
4G.25	**Joystick**	Joystick should also be provided to control the movement of Robotic Arm.
4G.26	**Graphical User Interface (GUI) as a Web Interface**	Creating trajectories for the robot should also be possible using a GUI over a web interface over an IP address. We should able to monitor the robot's different sensors and values over the web app. We should also be able to control the robot over the GUI and access sensor data.

		The Web App to be made available on desktop computers, tablets, and smartphones. Should support Chrome or any other browser.
4G.27	**Protection zones required and Control modes required**	Protection zone to be provided for robotic arm: A protection zone should define a three-dimensional region with respect to the robot base where the end effector or arm is either prevented from entering or where its speed is limited. Protection zones to be used for enabling obstacle avoidance. For the robot, protection zones should be definable of one of three shapes (or combination thereof): • cylinder • rectangular prism • sphere. Control Modes Required: Angular Mode for Independent joint control, whereby each axis of the manipulator is controlled separately. Cartesian Mode as a Mode used to control the velocities (translation and orientation) of the tool in Cartesian space. Trajectory Mode as a Mode allowing user to specify an endpoint (in joint space or Cartesian space) that the robot should reach.
4G.28	**Safety Requirements**	Following safety related features should be considered in the robot arm: Safety items, and their associated warning and error thresholds should be active on the robot and should be viewable within the Safeties page of the Web App. Safeties required are: • Base (arm) safeties: related to maximum core temperature, minimum and maximum voltage. • Actuators safeties: related to its maximum velocity, position, maximum and minimum voltage, maximum current • Gripper safeties: related to maximum and minimum voltage, maximum motor current.