

TECHNICAL SPECIFICATIONS AND OTHER ALLIED REQUIREMENTS

Sl No.	Description of items	Quantity
PUR/326/DM&SE/AP/E/2021-22/RET		
1	DEVELOPMENT & MANUFACTURING OF CONTROL CIRCUITS, HARDWARE FOR MCU, ACTUATOR DRIVERS, OPERATOR PANEL AND INTERFACING SYSTEM OF MCU WITH PROXIMITY SENSORS, IMU/GNSS, MOTOR DRIVERS, ACTUATOR DRIVERS, CAMERAS FOR THE EXISTING 6x6 UGV PLATFORM FOR REMOTE CONTROL (WIRELESS) (DETAILED SPECIFICATIONS & DRAWING AS PER ANNEXURE – I)	1 SET

1. DELIVERY, INSTALLATION & COMMISSIONING:

The ordered goods are to be delivered, installed & commissioned at CSIR-CMERI, Durgapur within 180 days of receipt of Purchase Order. Installation should be carried out only by expert engineers of Supplier / Manufacturer.

2. PERFORMANCE SECURITY:

Performance Security@3% of Invoice value will be provided by the supplier within 21 days after awarded of Purchase Order value valid till 2 months beyond the warranty period.

3. PAYMENT TERMS:

The payment shall be made in Indian Rupees, as follows:

- Milestone (1) :30% Payment shall be made against submission of design documents; BOM, drawings, Gerber files etc. and acceptance thereafter.
- Milestone (2) :50% Payment will be made against supply of necessary components, circuitries, driver, hardware, MCUs, sensors, IMU/GNSS etc. and sub-system testing at CSIR-CMERI, Durgapur, inspection/testing and acceptance of the ordered materials.
- Balance 20% payment shall be paid within 30 days after satisfactory installation, interfacing, integration, inspection/testing, modifications (if any) and final acceptance.

4. BID SECURING DECLARATION:

Bid Securing Declaration is to be submitted by the Bidder as per the format prescribed in the tender document.

5. WARRANTY:

01 year warranty should be provided by the supplier from the date of satisfactory installation & commissioning.

ANNEXURE – I

- A. Introduction**
- B. Tender**
- C. Detailed Specifications of MCU, Driver, Proximity Sensor, INS/ GNSS and other accessories**
- D. Scope of the Work**
- E. Final Deliverables**
- F. Eligibility Criteria of Vendors**
- G. Terms & Conditions**
- H. Acceptance & Test procedures**

A. Introduction:

This tender document is for the development & manufacturing of Control Circuits, Hardware for MCU, Actuator Drivers, Operator Panel and interfacing MCU with proximity sensors, IMU/GNSS, motor drivers, actuator Drivers, cameras and other accessories for the existing 6X6 UGV platform for remote control (Wireless only).

The robotic platform (Unmanned Ground Vehicle or UGV) have 6X6 configurations and will carry a payload of 100 kg with its net weight as 700kg. The average speed is 20 km/hr (maximum speed may be up to 40k/hr) and the maximum inclination is be 20°. The UGV is electrically powered from an onboard 72V DC battery bank. The 6X6 vehicle is fitted with six In-wheel Hub motors along with brakes and encoders. These independent wheels are mounted on a retractable, telescopic arm equipped with passive shock absorbers and a 24VDC linear actuator. Angle sensor will be used to measure the change of relative angles of the retractable, telescopic arm. However, these motors do not have any separate steering mechanism rather it uses skid-steering mechanism as shown in Figure - 1 below. The turnings of the UGV are achieved through differences in speeds of the left and right wheels.

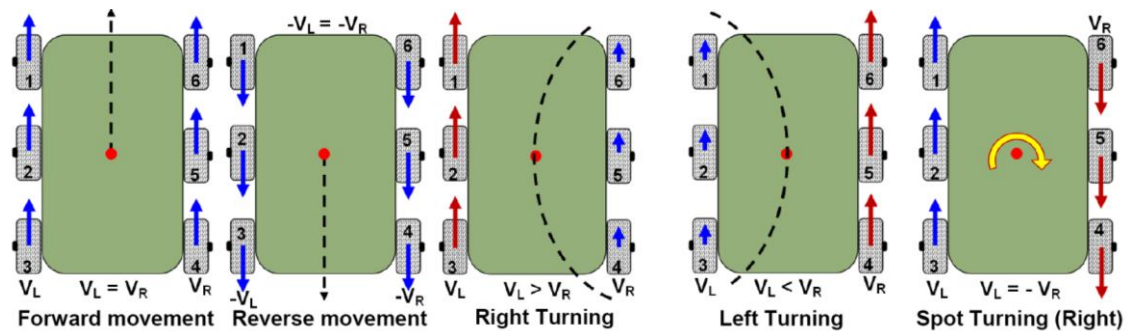


Figure – 1: Straight-line movements and turnings of the UGV to be achieved

As each of the wheels is driven by individual motors and drivers, the speed of each of the wheels can be different. But for the simplicity of control, the speeds of all the three wheels on the left side (V_L) as well as the right side (V_R) can be equal or very close to each other. The UGV will move in straight line (forward or reverse) if $|V_L| = |V_R|$ or take right turning, if $|V_L| > |V_R|$ or left turning, if $|V_L| < |V_R|$. The vehicle can also take spot or in-place turning right through right side or left side, if $V_L = -V_R$ or $-V_L = V_R$ respectively.

The present scheme of controlling the UGV will be initially through a wired Joystick (later through wireless) for various movements of the vehicle using all the six (06) drive motors and tilting of the platform using six 24V DC linear actuators. The platform may need to be raised or rolled on right-side or left-side based upon the obstacles as shown in Fig 2.

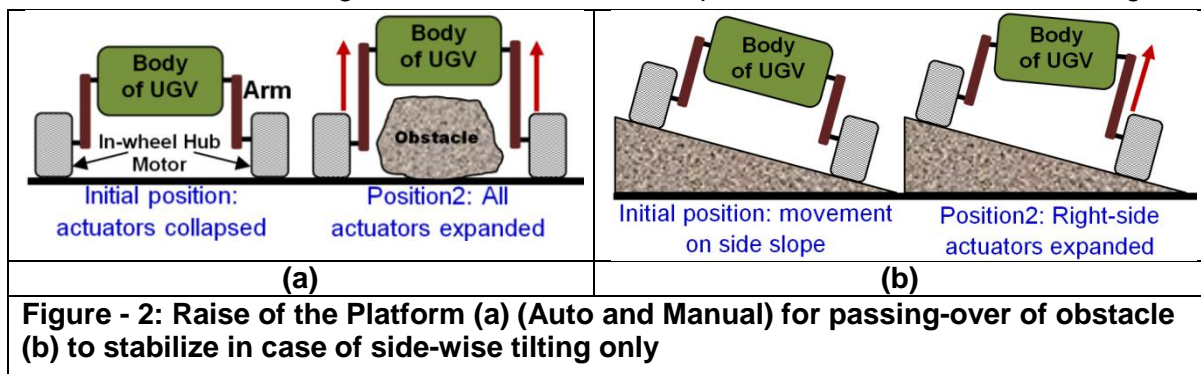


Figure - 2: Raise of the Platform (a) (Auto and Manual) for passing-over of obstacle (b) to stabilize in case of side-wise tilting only

UGV will have a central controller, called Main Control Unit (MCU) which will receive control signal from the operator either through tether or wirelessly. Separate motor drivers/ controllers will be used to drive the In-Wheel Hub motors and the linear actuators. Necessary commands will be then sent to these drivers from the MCU for their movements. The proximity sensors will be mounted at the front, rear and side of UGV for obstacle detection. Bottom sensor will be used to detect ditch or obstacles to be overridden. INS/ GNSS sensor will be used for platform stabilization in case of tilt of the platform in sidewise direction only. Camera will be installed for visual feedback or surveillance around the vehicle. So, followings are the broad operations which will be performed by the Control System to demonstrate the performance of the UGV:

- Forward and reverse movements on plain land
- Left, right and spot turning on plain land
- Change of speed during (at least) forward movement
- Slope climbing on an inclined plane of minimum 20°
- Detection of obstacles in the front and thereafter automatic raise of the platform at static condition of the vehicle
- Manual raising of the platform during manual operations at static condition of the vehicle
- Stabilization of the platform automatically within certain limit in case of side-wise tilting only

All these development will be carried out in phase wise manners. UGV will carry its on-board battery, control system, relevant sensors and other payloads.

Phase – I: The operator will ride on the UGV and carry out the desired functions using a wired joystick through the operator panel

Phase – II: Later this wired joystick will be converted to a wireless joystick for remote operations of the above mentioned functions of the UGV

The basic design and parameters for the control circuits, hardware, MCU, driver, operator panel along with different sensors are presented in this document. The vendor has to follow similar principles and prepare their own design and comply to the requirements and specifications with that of CSIR-CMERI, Durgapur. After, confirmation from CSIR-CMERI, the original circuitries and hardware have to be developed, installed and tested. Only the motor driver may be provided during the development. Integration of the hardware including harnessing, installations of drivers/ software etc. have to be carried out on the prototype of UGV at CSIR-CMERI Durgapur.

B. Tender

Title: Development & Manufacturing of Control Circuits, Hardware for MCU, Actuator Drivers, Operator Panel and Interfacing MCU with Proximity Sensors, IMU/GNSS, Motor drivers, Actuator Drivers, Cameras and other accessories for the existing 6X6 UGV platform for remote control (Wireless only)

Responsible Organization: CSIR - CMERI, Durgapur

Time frame for the Tender: **1 Month**

Time frame for the Job after placement of PO: **06 Months**

C. Detailed Specifications of MCU, Driver, Proximity Sensor, INS/ GNSS and other accessories:

The following paragraphs present the items to be used/ supplied for the development of the hardware system for driving/ controlling the UGV. The integration, harnessing, installations of all these items have to be done on the UGV prototype. Finally the complete system has to be tested as per the laid-down test procedure. The concept block diagram has been presented below.

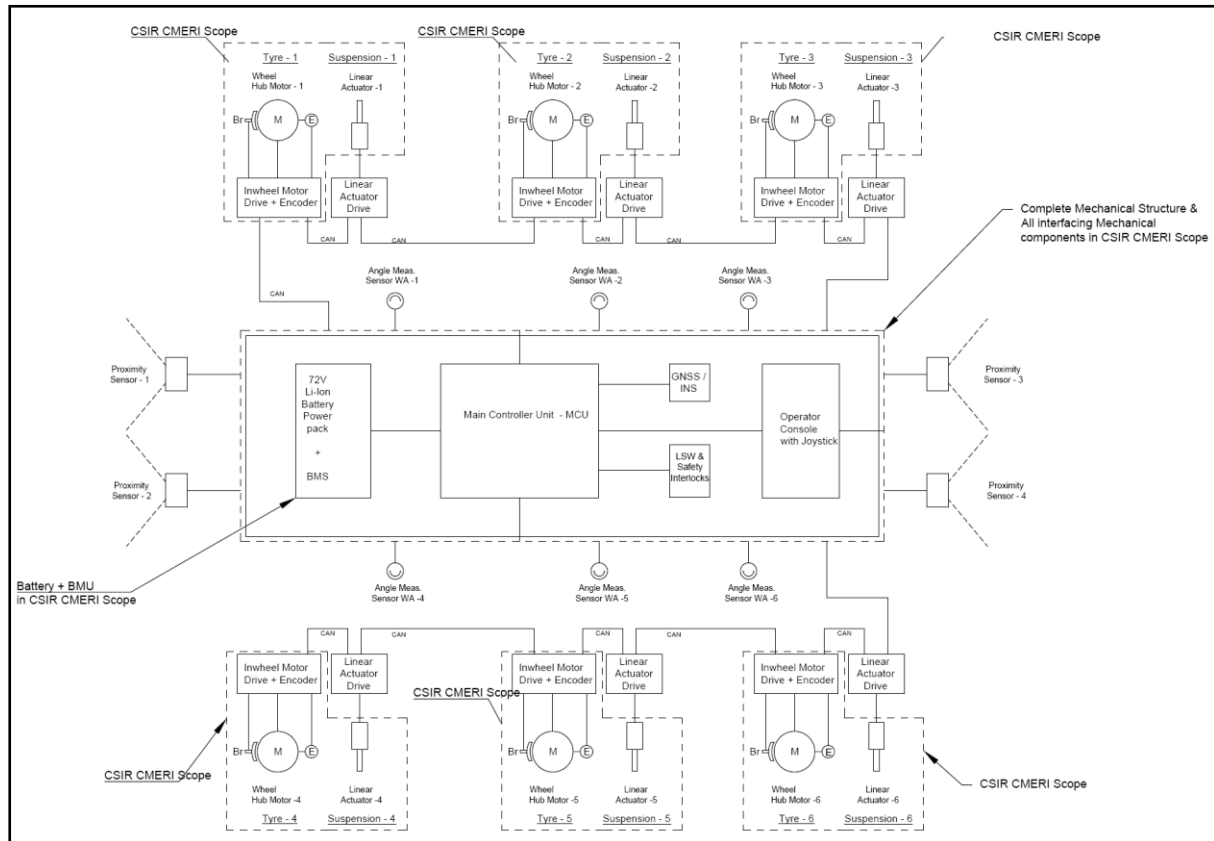


Figure - 3: Block Diagram for 6X6 UGV Platform

(i) Main Controller Unit (MCU) for Controlling & Monitoring of UGV Operations/ Motions through Local Operator console in Phase – I - 01 Set

Specifications/ Features of MCU:

- Low Power 32 Bit processor with on-board Memory
- Ethernet, USB Port for Interface & programming
- Serial interface for Peripheral equipment's
- CAN Interface for In-wheel Hub Motor drives & Linear Actuator drive Control, Battery Management
- Digital I/O for Digital sensor signal interface as per design requirements
- Analog I/O for wheel arm angle measurement
- HMI – 7" colour touch screen Display for local Operations, Diagnosis & Monitoring.
- Driver dashboard & Joystick interface for running of UGV
- Linear actuator Drive for 24 V DC actuator motor - 7 nos.
- DC- DC converter for 24 V Dc operated devices, max 900 watts – 1 no.
- Alarm Indication & annunciations as per design requirement - 1 no.

(ii) Proximity Sensors in for Obstacle detection in Front, Rear, Bottom, side of UGV - 8 Nos.

Specifications/ Features of Proximity Sensor:

- Type: Useful for outdoor applications
- Supply voltage: 5/12/24 V DC
- Range (Digital type): 0 – 5 m

(iii) Global Navigation Satellite System/ Inertial Navigation System (GNSS/INS) sensor for navigation & control - 1 Set

Specifications/ Features of GNSS/INS:

- Mechanical:
 - Weight: <1Kg including accessories
 - IP: IP68 enclosure
- Electrical:
 - Input: 12/24 VDC
 - Power: < 5 W
- Performances:
 - Roll & Pitch: < 1° RMS
 - Yaw/ Heading: < 1° RMS
 - Position: < 1m Circular Error Probability
- Gyroscope:
 - Standard full range: <2000°/s
- Accelerometer:
 - Standard full range: 10g
- GNSS Receiver: External on the UGV
- Magnetometer: Available
- Interfaces:
 - Interfaces: UART, CAN, RS232
 - Protocols: CAN or Xbus or equivalent
- Software Suite:
 - GUI (Windows/ Linux), SDK (C++, C#, python. Matlab or eq.), Drivers (LabView, RoS or eq.) & Support to be provided

(iv) Angle sensors for wheel Arm Position measurement & control – 8 sets

Specifications/ Features of Proximity Sensor:

- Input: 5/ 12/ 24 V DC
- Range: 0 – 90° or as suitable with the design
- Interface: Analog

(v) Driver dashboard with Joystick & Push Buttons for UGV operations – 01 Set

Features:

- Main Power ON-OFF switch
- Voltage – Ampere display
- Necessary safety fuses/isolators/MCBs wherever essential
- Necessary indication through Indicators/LEDs/ LCDs/Segmental display
- Wired Joystick(s) for Forward-Reverse, Change of speed, and Left-Right (including spot) turning of the UGV
- Push-button/ switch for the raise of platform
- On-board 7 Inch or larger Display unit

(vi) Internal wiring harness – 01 Set

Features:

- Suitable size of silver plated copper conductor cable with PTFE insulation to be used for wiring
- Overall tin plated copper braiding should be designed & installed on UGV as per final interface drawing.
- Industrial grade MS connectors for the wiring interface termination as per mating connector requirement

(vii) Drawing of the Complete Electrical & Electronics system on UGV with its wiring harness & layout – 01 Set (soft copy)

(viii) Design, Development Operation & control Software UGV – 01 Set

A. During Phase – I, design and control software will be developed with the following basic functionalities:

- Software Algorithm to Run UGV with Local Joystick & feedback from control sensors
- Acceleration / deceleration & brake control through Joystick input (Driver dashboard)
- Synchronous control of all wheel motors as per motion requirement in velocity control mode
- Steering Control Software algorithm – based on skid steering control concept designed by CSIR-CMERI, Steering command through Joystick (Driver dashboard)
- Obstacle overriding control Algorithm to control & overcome obstacle while running in manual & auto Mode. Manual control command through Joystick (Driver dashboard)

(ix) Integration of UGV for Trials & Testing – 01 Set

(x) Trials & Testing of complete UGV on plane Track with Payload for Forward & Reverse Movements with Left & Right turning – 01 Set

- Maximum Velocity: 20Kmph
- Spot turning trials

A. Provisions/ facility to Upgrade UGV in Phase- II with the following capability

- Up-gradation of UGV incorporating the feed-backs during Phase-I
- Interface of Vision camera – Front & Rear side for Object Monitoring & Motion control
- Remote Operation in Semiautonomous mode through wireless
- Remote Monitoring

D. Scope of Work:

- (i) Complete design, calculations, necessary standards and specifications, other critical/ essential components, if any (on returnable basis) will be made available to the vendor/ bidder by CSIR-CMERI
- (ii) Development, manufacturing of the Control Circuits, Hardware for MCU, Actuator Drivers, Operator Panel in accordance with the design concept given by CSIR-CMERI
- (iii) Interfacing MCU with proximity sensors, IMU/GNSS, motor drivers, actuator Drivers, cameras (Phase-II only) and other accessories for the existing 6X6 UGV platform for remote control i.e. both through wire and wirelessly
- (iv) Integration of the Control Circuits, Hardware for MCU, Motor & Actuator Drivers, Operator Panel, Proximity Sensors, IMU/GNSS etc. with the existing 6X6 UGV platform through wire and wirelessly
- (v) Supply of Control Circuits, MCU, Actuator Drivers, Operator Panel with Display-Switch(es)-Safety Fuse(s), Proximity Sensors, IMU/GNSS, wires/cables, connectors as per the quantities mentioned above in Sl. (C)
- (vi) All components used will be Industrial grade suitable for the existing 6X6 UGV
- (vii) Integration drawings along with BOM and Interface schematic drawings should be submitted to CSIR-CMERI for approval from CSIR-CMERI before manufacturing
- (viii) In case of any suggestions/ changes in design or concept implementation, vendor/ supplier/ bidder may communicate to CSIR-CMERI and present the requirement to adopt the changes
- (ix) Any changes should be implemented with confirmation from CSIR-CMERI before the manufacturing
- (x) Any major change, if required after starting of manufacturing process, which has financial implication after approval will be treated as extra work and the same will be paid as extra
- (xi) Final installations, interfacing, integration and trials/ testing for both phases will be done at CSIR-CMERI, Durgapur
- (xii) Assistance for minimal mechanical works and tooling at CSIR-CMERI during the installations, interfacing, integration will be provided by CSIR-CMERI

E. Final Deliverables:

- (i) Electrical & Electronics Control System along with the driver, hardware, circuits, MCU, sensors, IMU/ GNSS, cables, connectors, switches, fuses/ MCBs, joysticks, push buttons as mentioned in the scope of supply - 1 Set
- (ii) Soft copy of Installation, Integration Drawing, Circuit Drawings with BOM & list of Spares - 1 Set
- (iii) Soft copy of Operation & Maintenance Manual - 1 Set

F. Eligibility Criteria of Vendor:

The vendor or the bidder should pose the following criteria for participation in the current tender.

- (i) Firms registered and supplier to the reputed Indian R&D organizations only (CSIR, DRDO, ISRO etc.)

- (ii) Working experience of minimum 3 years with the reputed Indian R&D organizations only (CSIR, DRDO, ISRO etc.)
- (iii) Documental evidence of Purchase Orders for similar items from any of the reputed Indian R&D organizations (CSIR, DRDO, ISRO etc.) in last 5 years
- (iv) The Directors of the Company/ Firm should be of Indian origin with Service Centre at India and Trained Service Engineer
- (v) Adequate Lab Test Set-up (installations & Instruments) for Testing of Control System as per ATP mentioned in this tender document

G. Terms & conditions:

(i) Price: FOR CSIR-CMERI Durgapur

(ii) Payment:

- Milestone 1: Against submission of design documents, BOM, drawings etc. for Phase - I and acceptance thereafter – 20% of the total amount after acceptance
- Milestone 2: Against supply of necessary components, circuitries, driver, hardware, MCUs, sensors, IMU/GNSS etc. and sub-system testing at CSIR-CMERI Durgapur - 30% within 30 days after inspection/ testing and acceptance
- Milestone 3: Against submission of updated design documents, BOM, drawings etc. and supply of necessary components, circuitries, driver, hardware etc. for Phase - II and acceptance thereafter – 30% of the total amount after acceptance
- Milestone 4: Against final installations, interfacing, integration, inspection/ testing, modifications (if any) and acceptance - 20% of the total amount within 30 days after acceptance

(iii) Delivery: 24 weeks from the date of P.O.

(iv) Warranty: Till One year from the date of supply only against any manufacturing defects

H. ATP: Acceptance test procedure:

- (i) Physical verification: Items supplied will be inspected at CSIR-CMERI for physical verifications before installations
- (ii) Sub-system Testing: Items (sub-system wise) will be tested individually against suitable power and control signals at CSIR-CMERI before installations
- (iii) Integrated test: All the items will be installed, interfaced, integrated to the UGV and UGV should demonstrate the following capabilities:
 - (a) Forward and reverse movements at a Maximum speed of 20 KM/Hr and 10 KM/Hr respectively on plain land
 - (b) Movement on a gradient of minimum 20° with a slower speed
 - (c) Movements over gravels, loose soils, sandy terrain with a slower speed
 - (d) Left, right and spot turning with a slower speed
 - (e) Movement of the platform by 100 mm from its normal/ initial position to pass-over obstacle (in auto-mode as well as manually)
