GUJARAT COUNCIL ON SCIENCE AND TECHNOLOGY
Dept. of Science and Technology, Govt. of Gujarat

Application format for the
IDEATION STAGE FOR ROBOT MAKING COMPETITION
ROBOFEST GUJARAT-5.0

Application No.:

1. Proposal submitted for Robot: (Please tick mark the category of robot proposed)

- **For Junior Level:**
  1. AI Homo-bots
  2. AI Autonomous Driving Bots
  3. Maze Solving Robot
  4. Robot Athletics

- **For Senior Level:**
  1. Aerial Robotics: Minefield Navigation Challenge
  2. Autonomous Underwater Vehicle
  3. Autonomous Maze solver
  4. Intelligent Ground Vehicle Competition
  5. Application Based Categories
     a. Robots for healthcare
     b. Robots for humanitarian propose
     c. Robot for educational/research purposes
     d. Robots for community services or community awareness
     e. Robots for tackling the climate change challenges or assisting with climate sustainability
     f. Robots for industrial applications and
     g. Robots for world peace, for example, surveillance, narcotics control etc.

2. Type of Institution : Private-Unaided

3. Name of School/Institute/Department/Organization: Parul Polytechnic Institute

4. Complete Postal Address with Pin code:

5. Name of affiliated University/Board Name: Parul University

6. Mentor/Coach/Faculty Guide Name: Dhanashree Kedare

7. Designation of Mentor/Coach/Faculty Guide: Asst. Proffesor

8. Experience of Mentor/Coach/Faculty in years: 5+ years

9. Email address of mentor:

10. Mobile Contact No of mentor:

11. Office No:

12. Proposed Team of Making robot: (Maximum four participant per team allowed)

Sr. No.	Name of Student/Research scholar	Institute Name	Department	Programme enrolled	Standard / Year	Mobile No.	E-mail address

13. Capability of the Organization / Individual specific to Robot Making:

a. Expertise available with the Mentor/Coach/Faculty Guide: (Not more than 100 words)

b. List of Participation in past in any Robot Making Competitions:

Event Name	Venue	Type of Competition (State/national/International)	Type of Robot submitted	Achievement

14. Name of the authority in whose name Cheque / Demand Draft should be drawn. (Institutional Bank account only. Do not enter mentor or student bank details)

Name of the Account Holder:

Name of the Bank:

Bank Account No:

IFSC Code:

MICR Code:

UNDERTAKING

I ______________________ (Mentor/Guide Name) on behalf of my team authorized to give undertaking that on selection of our team at Level 1 (Ideation) stage, we assure and commit to participate in the subsequent levels and to submit Level 2 (Proof of Concept) and Level 3 (Proto type) robot as per guidelines of the GUJCOST without fail, otherwise GUJCOST will take necessary action to recover the fund if disbursed for any Stage. Further, we assure that this idea is original and has not been submitted anywhere else.

Sign of Mentor/Guide ___________

Sign of Director/Principal of Host Institute ________________

Stamp of School/Institute/University

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Application No.:

TECHNICAL DETAILS FOR PROPOSED ROBOT

(Wherever necessary separate sheet/page is allowed to attach; Institute may submit extra details if find necessary)

1. Type of Robot: Autonomous Maze Solving Robot

2. Robot Assembly Design :

   Our proposed robot is a compact, two-wheeled drive with one tester build. autonomous maze solver designed for speed, precision, and reliability. The chassis will be a lightweight FR4/carbon-fiber sandwich structure to ensure stability while keeping the center of gravity low. The two rear wheels are powered by N20 600rpm metal gearmotors with encoders, while the front uses free-rolling custom designed 3D printed wheels to reduce friction during sharp turns. Our chassis will be built directly built on our end to end custom designed PCB.

   At the front and sides of the robot, five time-of-flight distance sensors (VL53L1X) are mounted inside small shrouds to provide accurate wall distance measurements in the maze. An MPU 6050 (Inertial Measurement Unit) is mounted centrally for heading correction, while wheel encoders handle odometry. Together, these sensors enable the robot to continuously estimate its position and orientation in real time.

   The electronics are organized in layers: the lowest layer houses the battery and motor drivers, the middle layer carries the microcontroller (STM32F411 Black Pill) and sensor boards, and the top layer holds the display and connectors. This modular stacking makes the robot easier to debug and repair. Power is supplied by a compact 3-cell LiPo battery regulated down to 5V for logic and sensors.

   The robot's software will be designed around a state machine with three key modes: exploration, path optimization, and high-speed run. During exploration, the robot moves cautiously while mapping walls using the flood-fill algorithm. Once the goal is discovered, the robot calculates the shortest path (using A* and path compaction). Finally, it executes a high-speed run using smooth trajectory profiles with wall-alignment corrections to minimize drift.

   The overall design emphasizes high performance without compromising reliability, ensuring the robot can adapt to different maze conditions while remaining lightweight, stable, and efficient.

3. Components to be used:

a. List of Structure components:

Chassis	Custom 2D lightweight frame (laser-cut FR4/acrylic or 3D-printed nylon/PLA) — fits size limits, low center of gravity.	Custom Designed
Wheels	3D Printed TPU wheels	Custom Designed 3D Printed
Front Support	3D Printed wheel	Custom Designed 3D Printed
Battery Mount	Custom designed as per our requirement	Custom Designed 3D Printed
Motor Mount	Custom designed as per need	Custom Designed 3D Printed

b. List of Motion Components:

Drive Motors	2× N20 DC gear motors (6V; ~600 rpm no-load)	https://robu.in/
Hubs/Couplers	Custom Designed	3D Printed

c. List of Electronics Components:.

Microcontroller	STM32F411CEU6 (ARM Cortex-M series)	https://robodo.in/products/stm32f411ceu6-minimum-system-board-microcomputer-stm32-arm-core-board?variant=43985834967240&country=IN&currency=INR&utm_medium=product_sync&utm_source=google&utm_content=sag_organic&utm_campaign=sag_organic&gad_source=1&gad_campaignid=21333132684&gbraid=0AAAADgt3fjmXLmC_BTmsxVWAeUcKU8QV&gclid=CjwKCAjw2vTFBhAuEiwAFaScwnhUZODdqT5hc1oDub12dPLnT5Xyad53B1YAHKrAj0kwZY9f398ekxoCnSwQAvD_BwE
Distance Sensors	5× VL53L1X ToF	https://robu.in/product/dfrobot-gravity-digital-adjustable-infrared-proximity-sensor/
I2C Multiplexer	TCA9548A	https://robu.in/
IMU	MPU-930C	https://robu.in/
Display	0.96" I2C OLED	https://robu.in/
LEDs	2× NeoPixel (WS2812B)	https://robu.in/

Power	3S 450 mAh LiPo (XT30)	https://robu.in/
Regulation Board	Custom 5V rails (≥3A @5V, ≥1A @3.3V)	https://robu.in/
Switches & Protection	Master switch, inline fuse / LVC module — LiPo safety.	https://robu.in/
Wiring	JST/PH connectors, jumper harnesses, USB-C for programming.	https://robu.in/

d. List of Other Accessories: Clothes, plastic eyes/ear/feeling like real all external components which are for the look.
   - Vibration damping pads, heat-shrink, zip ties, labels — robust wiring.
   - Sensor shrouds/light-guards — reduce ambient IR noise.
   - Spare jumpers & screws, small tool kit — quick field fixes.

4. The methodology of Making Robot:

The development of our maze-solving robot follows a systematic approach of design, integration, testing, and refinement.

1. Mechanical Design & Assembly

A lightweight custom chassis is designed in CAD, ensuring correct wheel spacing, low center of gravity, and optimal sensor placement for maneuvering tight corridors. Precision is achieved through laser cutting or 3D printing. N20 DC gear motors are mounted with balanced wheels for torque and speed, while front omni-wheels reduce drag during turns. The frame also houses a LiPo battery and power regulator board, providing stable 3.3V and 5V supply rails.

2. Sensor Integration

VL53L1X ToF sensors are mounted at the front and sides to detect walls in real time. Since these sensors share identical I2C addresses, a TCA9548A multiplexer ensures independent communication. An MPU-930C gyroscope placed at the robot's center tracks orientation and assists in precise turning. All sensors connect to the ESP32-S3 microcontroller, which coordinates data and control.

3. Electronics & Control System

The ESP32-S3 executes all control logic. Motor drivers receive PWM signals for speed and direction, validated through initial movement tests. An OLED screen displays live parameters such as voltage, speed, or errors, while NeoPixel LEDs provide quick visual feedback (green-ready, red-error, blue-exploring).

4. Software Development & Algorithms

The robot is programmed using ESP-IDF/Arduino frameworks, structured as a state machine with three key modes:

- Exploration – maps the maze with flood-fill algorithm while moving cautiously.
- Path Optimization – after locating the goal, computes a shortest route using A* search and simplifies trajectories.
- High-Speed Run – replays the optimized path at higher velocity using jerk-limited motion profiles, correcting drift via IMU and wall sensors.

5. Calibration & Testing

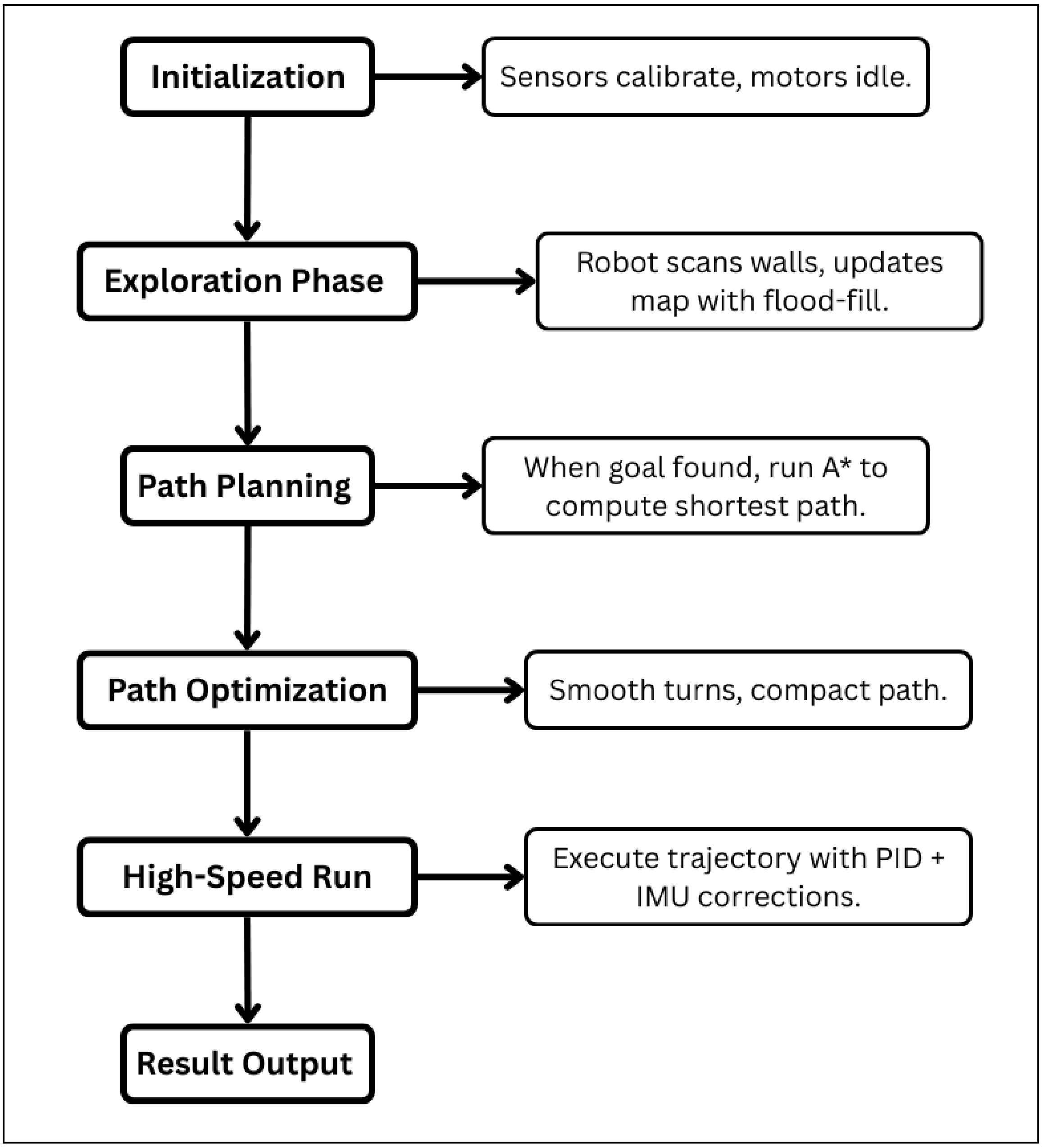
Multiple trial runs adjust PID motor gains, sensor thresholds, and motion profiles. Debugging through OLED and logged data helps refine performance, evolving from safe exploration to stable high-speed motion beyond 2 m/s.

6. Simulation & Verification

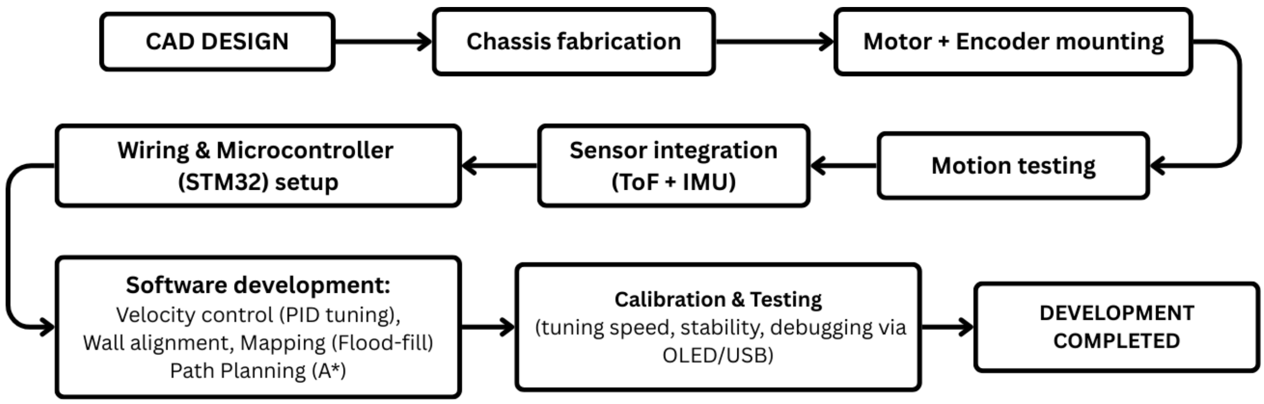
Before live testing, a Gazebo simulation model replicates hardware, sensors, and dynamics. Algorithms are validated virtually to uncover issues like sensor lag, precision errors, or control delays. This ensures that real-world trials are optimized and efficient.

Below we have shown various flowcharts and diagrams representing our workflow, methodology and working of our robot. We have also added a schematic diagram page that shows connections of various components used in our robot. Note that the diagrams made are subject to improvisations if deemed necessary as we proceed with the development of our robot.

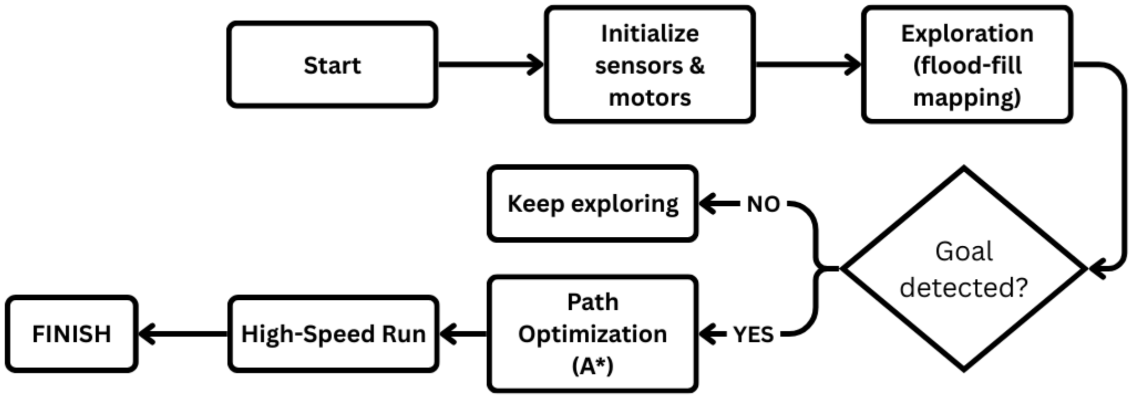
Workflow Diagram:



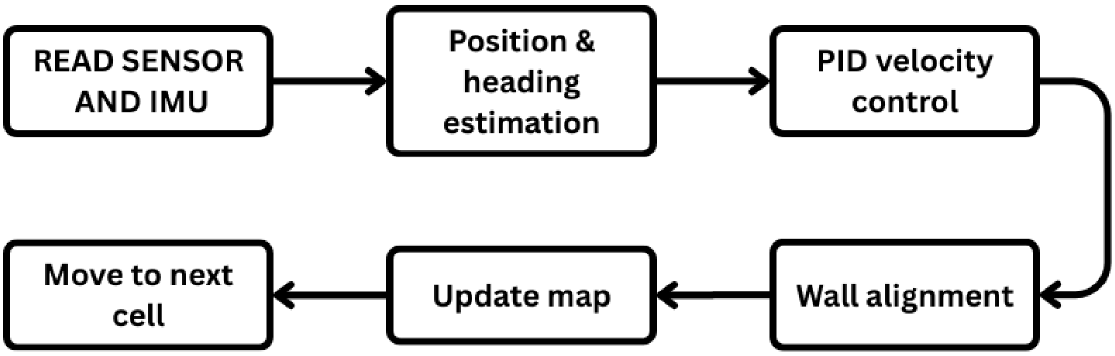
Development Methodology Diagram:



Robot Software Flowchart:



Control Loop Flowchart (for real-time motion):



5. Application of proposed Robot in a societal context: (Not more than 100 words)

   Our maze-solving robot is more than just a competition project — it's a stepping stone toward real-world autonomy. The same principles it uses to explore, map, and optimize paths are applied in self-driving cars navigating city streets, drones searching collapsed buildings during disaster rescue, warehouse robots streamlining logistics, and hospital bots delivering medicines safely. By demonstrating this with low-cost student-friendly hardware and smart algorithms, our project proves how scalable robotics can enhance mobility, safety, and community resilience — all starting from a simple maze-solving robot.

6. Size of robot proposed for Proof of concept (Small version):

a. Length in cm________ b. Width in cm __________ c. Height in cm ___________

7. Size of robot proposed as Proto type (Actual Version)

a. Length in cm________ b. Width in cm __________ c. Height in cm ___________

8. Timeline for Robot making with milestones. (Divided in activities vs. no. of days)

9. Please attach the proposed outline (photograph) for understanding of the evaluation committee.

10. ☐ I agree to file a patent of the proposed robot in ROBOFEST-GUJARAT 5.0 from the PIC Cell of GUJCOST.

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