

SYSTEM

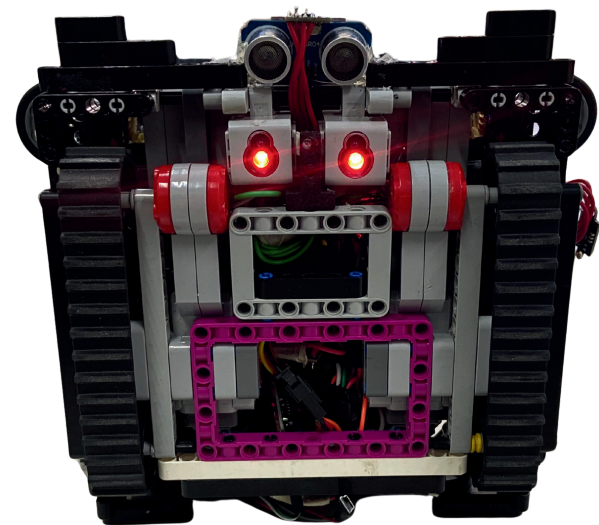
OVERRIDE

HARDWARE

SOFTWARE

CHASSIS

DURING THIS COMPETITION, WE FOCUSED ON REFINING OUR ROBOT'S DESIGN TO OVERCOME CHALLENGES CAUSED BY EXCESS SIZE AND WEIGHT. THE CHASSIS IS BUILT USING LEGO PARTS, WITH THE EV3 MOTORS INTEGRATED DIRECTLY INTO THE FRAME TO SERVE AS BOTH FUNCTIONAL AND STRUCTURAL COMPONENTS. SINCE THE EV3 BRICK HAS ALWAYS LIMITED SIZE REDUCTION, WE MODIFIED IT TO MINIMISE ITS VOLUME. ADDITIONALLY, WE ADDED A HANDLE TO ENHANCE THE ROBOT'S USABILITY AND PORTABILITY.



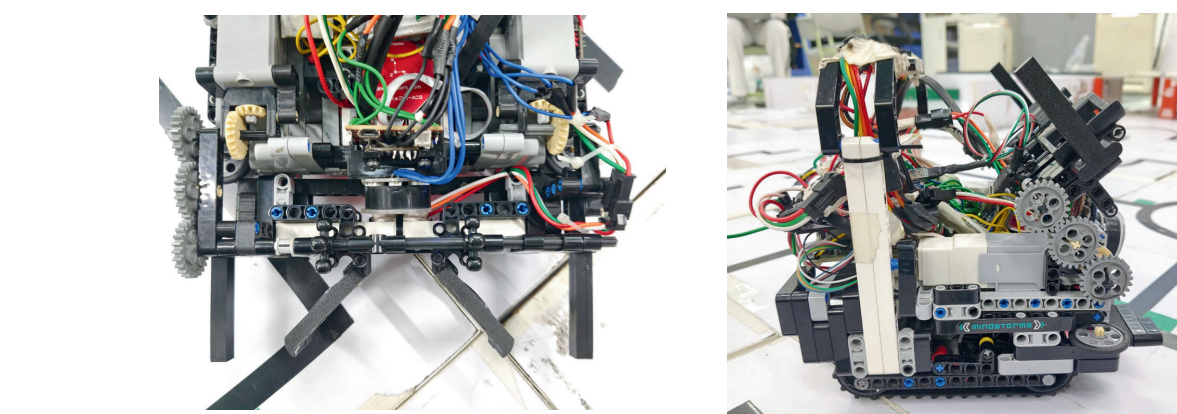
OPEN BRICK AND BUTTONS PCB

IN PREVIOUS COMPETITIONS, OUR ROBOT STRUGGLED TO CLIMB RAMPS AND OCCASIONALLY GOT STUCK WHILE ENTERING THE EVACUATION ZONE. TO ADDRESS THIS, WE MODIFIED THE EV3 BRICK BY SOLDERING EXTERNAL BUTTONS ONTO THE BUTTON PCB, WHICH ARE MOUNTED ON THE HANDLE FOR EASIER ACCESS. WE ALSO REMOVED UNNECESSARY EV3 COMPONENTS, INCLUDING THE BATTERY PACK CASING AND EV3 BRICK CASE, TO REDUCE BOTH WEIGHT AND OVERALL SIZE.



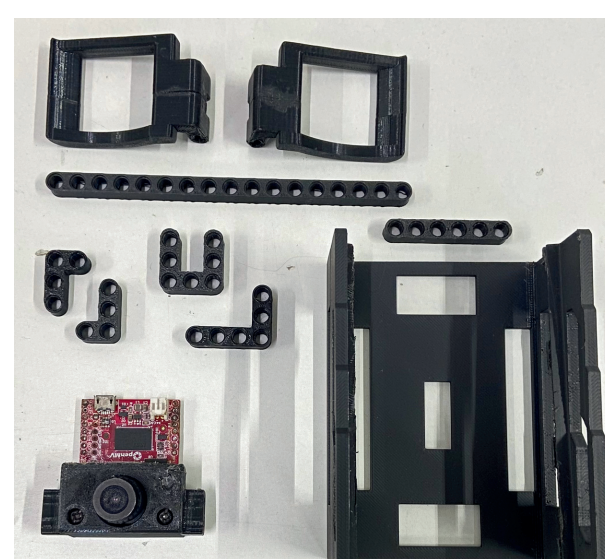
ARM

THE ARM AND CLAW ASSEMBLY IS A REMOVABLE MODULE DESIGNED FOR EASY MAINTENANCE AND UPGRADES, WHICH IS EQUIPPED WITH FOUR KNOB GEARS FOR CLAW OPERATION AND A COMBINATION OF BEVEL AND SPHERE GEARS FOR ARM MOVEMENT. IN TOTAL, THE ARM HAS 11 GEARS. UTILISING EV3 BEAMS AND 3D-PRINTED PARTS, THIS LIGHTWEIGHT AND STURDY GRABBER SYSTEM IS CAD-DESIGNED AND REFINED THROUGH AI SIMULATIONS, ENABLING THE ROBOT TO EFFECTIVELY REACH AND LIFT VICTIMS FROM A DISTANCE.

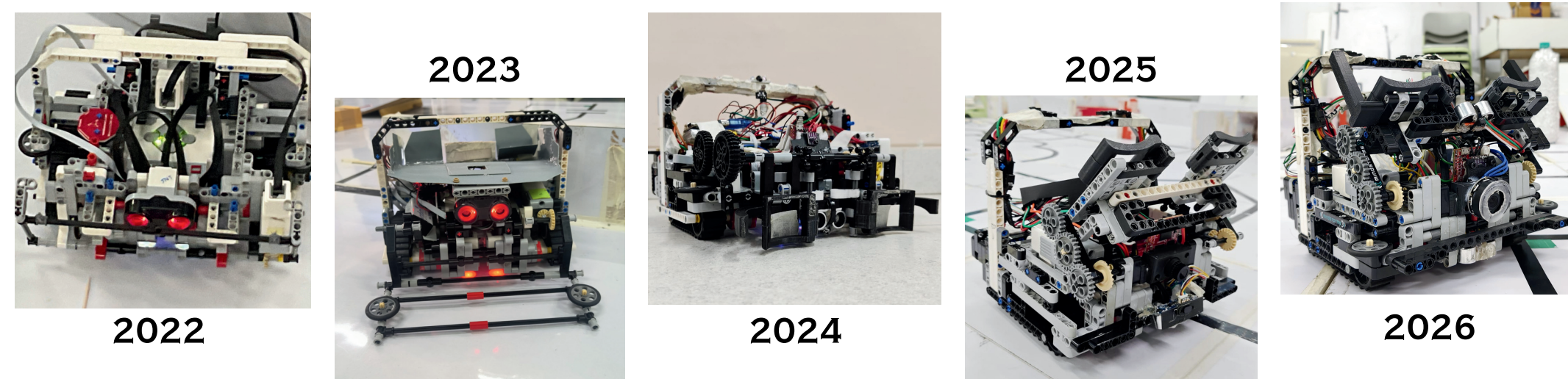


3D PRINTED PARTS

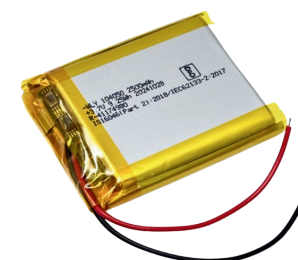
THE EV3 COMPONENTS HAVE LIMITED FLEXIBILITY. TO ADDRESS THIS ISSUE, WE UTILISED OUR 3D PRINTER TO CREATE CUSTOM PARTS THAT ARE COMPATIBLE WITH OUR EV3 ROBOT. THIS HAS ALLOWED US TO ENHANCE THE SIZE AND WEIGHT BALANCE OF OUR ROBOT. WE HAVE PRINTED VARIOUS BEAMS WHICH ARE NOT AVAILABLE IN THE EV3 KIT, A CASE FOR THE OPENMV CAMERA WHICH ENABLES THE OPENMV TO BE ATTACHED FIRMLY TO THE ROBOT, AND CLAWS WHICH HELP THE ROBOT TO GRAB THE VICTIMS.



THE ROBOT'S JOURNEY

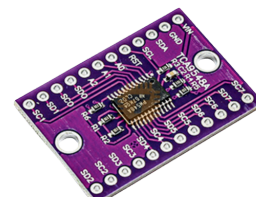


A 2500 MAH LIPO CELL HAS BEEN USED TO POWER THE 2 NANOS AND OPENMV CAMERA



THE EV3 BRICK IS THE MAIN CONTROLLER OF THE ROBOT, IT CONNECTS THE ARDUINO AND EV3 SENSORS AND ACTUATORS.

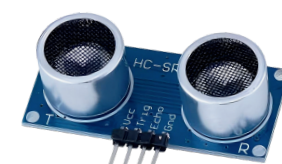
WE HAVE USED A I2C MULTIPLEXER TO CONNECT MULTIPLE I2C SENSORS TO THE ROBOT.



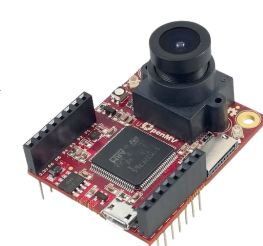
2 LIMIT SWITCHES HAVE BEEN USED FOR FINDING WALLS INSIDE THE EVACUATION ZONE.



WE HAVE UTILISED AN ULTRASONIC SENSOR TO DETECT SPEED BUMPS AND DESCENDING RAMPS.



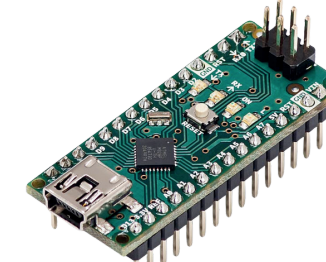
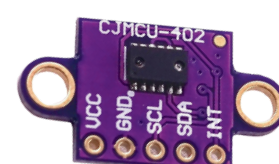
THE ROBOT IS EQUIPPED WITH AN OPENMV CAMERA FOR SENSING VICTIMS AND EVACUATION POINTS. IT ALSO DETECTS THE GOAL TILE.



A ANALOG IR HAS BEEN USED TO DOUBLE CHECK CHECK SILVER TAPE TO ENTER THE EVACUATION ZONE.



2 TIME OF FLIGHT SENSORS HAVE BEEN USED FOR EXIT AND OBSTACLE DETECTION.



WE HAVE USED 2 ARDUINO NANOS FOR MULTIPLE SENSORS AND ACTUATORS.



A 8 BIT LED HAS BEEN USED TO IMPROVE THE VIEW OF THE OPENMV



2 EV3 LARGE MOTORS HAVE BEEN USED FOR DRIVING THE ROBOT.



2 EV3 MEDIUM MOTORS ARE USED TO CONTROL THE ARM.



2 COLOUR SENSORS HAVE BEEN USED TO DO LINE FOLLOWING AND SENSE INTERSECTIONS.



A MIND SENSORS GYRO SENSOR HAS BEEN USED TO DETECT RAMPS.

TEAM

OUR ROBOTICS JOURNEY BEGAN IN 6TH GRADE THROUGH EV3 CLASSES, IGNITING A PASSION THAT DROVE US TO FORM A TEAM AND DESIGN AUTONOMOUS ROBOTS. ALONG THE WAY, WE'VE ACHIEVED 2ND PLACE AT ROBOCUP NATIONALS INDIA IN 2024 AND 2025, SECURED 1ST PLACE IN THE PRIMARY CATEGORY AT RCAP 2023 IN SOUTH KOREA, THE SECONDARY CATEGORY AT RCAP 2024 IN QINGDAO, AND 1ST PLACE AT THE SINGAPORE OPEN IN APRIL 2025.



AYAAN SURI

AYAAN, OUR TEAM LEAD, OVERSEES THE ROBOT'S HARDWARE AND ELECTRONICS. HE HAS DESIGNED CUSTOM 3D-PRINTED PARTS THROUGH 3D MODELLING, HANDLED THE EV3 PROGRAMMING, AND MANAGED THE TEAM'S DOCUMENTATION.



SHAURYA MAHAJAN

SHAURYA IS ONE OF OUR PROGRAMMERS. HE HAS MADE THE BASIC FRAMEWORK FOR EV3 PROGRAMMING. HE HAS ALSO CODED THE ARDUINO NANO.



TANASH GARG

TANASH IS ONE OF OUR PROGRAMMERS, RESPONSIBLE FOR CODING THE OPENMV CAMERA. HE ALSO MANAGES THE TEAM'S MEDIA PRESENCE AND HAS CONTRIBUTED TO THE TEAM'S DOCUMENTATION.



LEGO MINDSTORMS

THE EV3 SOFTWARE ALLOWS FOR ADVANCED CONTROL OF ROBOTS AND COMMUNICATION WITH SENSORS. IN RGB MODE, THE COLOR SENSOR MEASURES THE INTENSITIES OF RED, GREEN, AND BLUE LIGHT FOR PRECISE COLOR DETECTION. THE I2C BLOCK FACILITATES DATA EXCHANGE BETWEEN THE EV3 (AS MASTER) AND ARDUINO (AS SLAVE). ADDITIONALLY, THE GYRO BLOCK MONITORS ROTATION, HELPING THE ROBOT DETECT RAMPS IT ENCOUNTERS.



OPENMV IDE

THE OPENMV IDE IS CRUCIAL FOR PROGRAMMING THE OPENMV H7 PLUS, WHICH DETECTS GOAL TILES AND VICTIMS IN THE EVACUATION ZONES. WE USED EDGE IMPULSE TO LABEL A DATASET OF IMAGES HIGHLIGHTING FEATURES OF VICTIMS. AFTER CREATING AND TRAINING A MACHINE LEARNING MODEL, WE INTEGRATED IT INTO THE OPENMV H7 PLUS. THIS SETUP ALLOWS FOR REAL-TIME DETECTION OF VICTIMS.



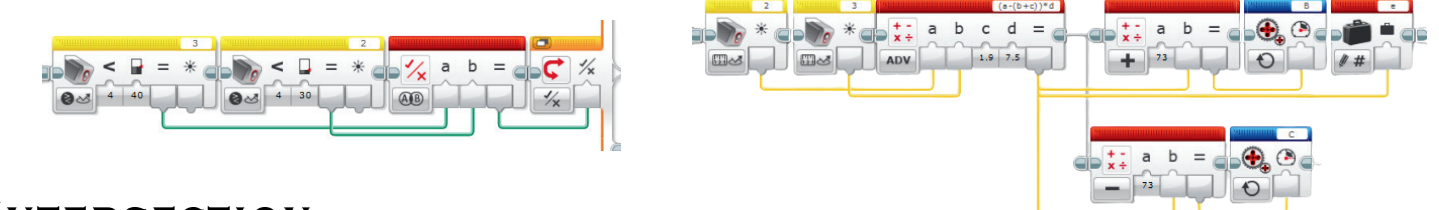
ARDUINO IDE

THE ARDUINO IDE IS UTILIZED FOR ITS SIMPLICITY IN PROGRAMMING AND INTEGRATING SENSORS. IT SUPPORTS VARIOUS LIBRARIES, SUCH AS SERVO, WIRE.H, MUX, AND TIME-OF-FLIGHT (TOF) SENSOR LIBRARIES, WHICH FACILITATE SEAMLESS COMMUNICATION BETWEEN COMPONENTS. THESE LIBRARIES HELP MANAGE MOTOR CONTROL, DATA TRANSFER, AND SENSOR READINGS EFFICIENTLY.



LINE FOLLOWING ALGORITHM

WE HAVE DEVELOPED A PROPORTIONAL LINE FOLLOWER USING EV3 COLOUR SENSORS FOR BETTER ACCURACY. THE SYSTEM USES A SPECIFIC MATHEMATICAL FORMULA WITH THE ADVANCED MATH BLOCK OF EV3 TO DETERMINE AND MAINTAIN THE ROBOT'S DIRECTION, RESULTING IN SEAMLESS NAVIGATION THROUGH DIFFICULT LINE PATTERNS.

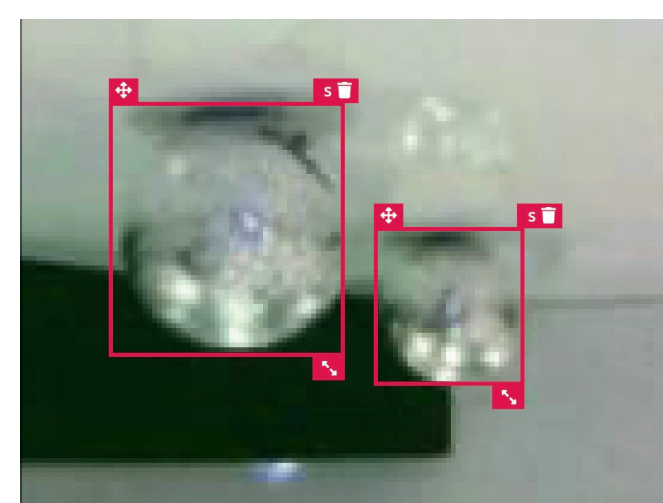
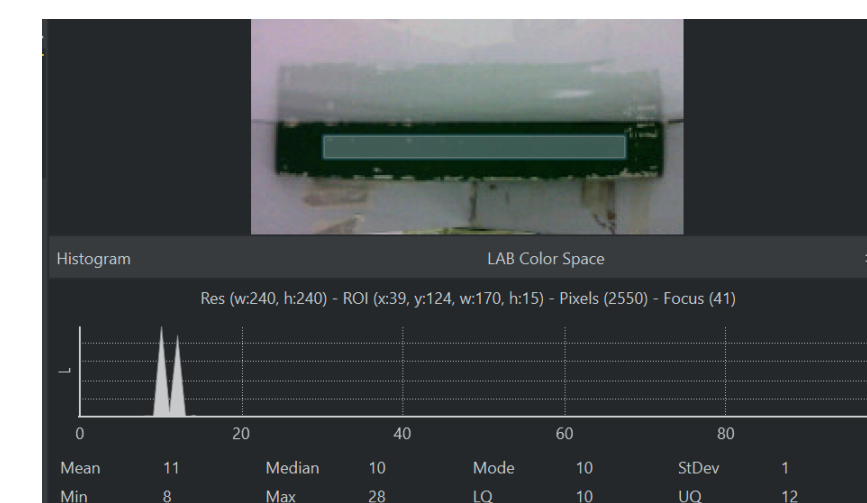


INTERSECTION

WE HAVE MADE A DOUBLE BLACK ALGORITHM TO DETERMINE WHEN THE ROBOT REACHES AN INTERSECTION. UPON REACHING AN INTERSECTION, THE ROBOT DETECTS THE GREEN SQUARES USING ITS COLOUR SENSORS AND ADJUSTS ITS POSITION BASED ON THE ALIGNMENT WITH THE LINE. IF IT ENCOUNTERS A SHARP TURN, IT USES THE PATHFINDER ALGORITHM TO REALIGN ITSELF CORRECTLY.

EVACUATION ZONE

THE ROBOT ENTERS THE EVACUATION ZONE, DETECTS WALLS AND IDENTIFIES RESCUE VICTIMS WITH THE OPENMV CAMERA. IT ALIGNS THE VICTIM TO THE CENTRE OF THE CAMERA'S VIEW AND MOVES FORWARD UNTIL EITHER THE EV3 COLOUR SENSOR DETECTS A SILVER OR BLACK LINE OR THE ARM ULTRASONIC CONFIRMS THE VICTIM'S PRESENCE BEFORE PICKING UP THE VICTIM. IF THE VICTIM IS NOT DETECTED, THE ROBOT RELEASES AND RESCANS. ONCE A VICTIM IS PICKED UP, THE ROBOT DROPS IT AT THE DESIGNATED EVACUATION POINT. AFTER COMPLETING THE RESCUE, IT ALIGNS WITH THE WALL USING THE FRONT ARM AND USES THE SIDE IR TOF SENSOR TO DETECT AN EXIT, SEAMLESSLY EXITING THE ZONE WHILE MAINTAINING ALIGNMENT WITH THE LINE.



VICTIM DETECTION

WE USE THE OPENMV CAMERA TO DETECT VICTIMS IN THE EVACUATION ZONE THROUGH CUSTOM-TRAINED MACHINE LEARNING MODELS. WHEN THE ARDUINO SENDS A COMMAND VIA THE UART CHANNEL TO THE CAMERA, THE CAMERA SCANS FOR SILVER AND BLACK REGIONS. IT THEN MARKS THE DETECTED VICTIM WITH A CIRCLE, CHECKS THE CENTRE COORDINATES, AND COMPARES THEM AGAINST A DEFINED THRESHOLD. IF THE COORDINATES MEET THE CONDITION, THE CAMERA SENDS A CONFIRMATION SIGNAL BACK TO THE ARDUINO, INDICATING THE VICTIM'S PRESENCE.

