

| Program Profile |              |                                                                                                                                             |
|-----------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Program         | Program name | <b>Automatic Mini-Guard Rover: A Surveillance Solution with Facial Recognition</b>                                                          |
|                 | Category     | (Select one category from A1–A8 or B1–B8 and write it here. For example, if the program is A1: Student Support and Engagement, write 'A1'.) |

| Summary of Program  |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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| Program Name        |                    | <b>Automatic Mini-Guard Rover: A Surveillance Solution with Facial Recognition</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Category            |                    | A3. Industrial Application B3: Innovation Technology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Abstract of Program |                    | <p>The Mini Surveillance Robot integrates a camera, facial recognition, and a claw mechanical gripper to provide an advanced solution for monitoring and security. This compact, autonomous robot navigates various environments, delivering real-time video feeds, identifying individuals using facial recognition algorithms, and removing obstacles from its path. Its portable and minimalist design enables deployment in confined or hard-to-reach areas, making it suitable for residential, commercial, and industrial surveillance. The intelligent system supports anomaly detection, motion tracking, and alerts, enhancing situational awareness and minimizing human intervention. Applications include home security and real-time monitoring for warehouse security and surveillance.</p> <p><b>Keywords: Facial recognition, Surveillance, Mechanical gripper, Obstacle removal &amp; Security.</b></p> |
| Details of Program  |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Planning            |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Objectives          | Long-term Goals    | <input type="checkbox"/> Enhance the radar system into a <b>comprehensive surveillance and safety solution</b> for vehicles.<br><input type="checkbox"/> Contribute to the development of <b>intelligent transportation systems</b> with built-in threat detection.<br><input type="checkbox"/> Provide a scalable framework that can be adapted for <b>military, security, and civilian applications</b> involving autonomous vehicles and smart monitoring.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                     | Short-term Targets | <input type="checkbox"/> Develop a <b>vehicle-mounted radar system</b> capable of multi-object tracking.<br><input type="checkbox"/> Integrate <b>thermal monitoring and video streaming</b> features for real-time observation.<br><input type="checkbox"/> Implement an <b>object identification mechanism</b> to determine whether detected objects are harmful or                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                     | Rationale          | The increasing demand for intelligent vehicle systems highlights the need for advanced sensing technologies capable of ensuring safety and security in dynamic environments. Traditional vision-based systems often fail under poor visibility conditions such as fog, smoke, or darkness. Radar, combined with thermal imaging and real-time video streaming, offers a reliable solution for                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

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|                  |                      | <p>continuous monitoring and decision-making.</p> <p>This research addresses the gap by developing a <b>vehicle-mounted radar system</b> that not only tracks multiple objects but also identifies whether those objects pose potential harm. The integration of <b>thermal monitoring</b> and <b>real-time video streaming</b> enhances situational awareness, enabling faster and more accurate threat recognition.</p> <p>In the short term, the system improves road and vehicle safety by assisting drivers or autonomous platforms in identifying harmful objects. In the long term, it contributes to the development of <b>smart surveillance systems</b> and <b>intelligent transportation technologies</b>, with potential applications in both civilian and defense sectors.</p>                                                                                                                                                                                     |
| Subject (Leader) | Initiator(s)         | Enamul Hoq                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                  | Champion(s)          | Enamul Hoq                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                  | Major team member(s) | Md.Shariful Islam, Ahmed Farhan, Prof.Dr.Md. Mizanur Rahman, Rezwan us Saleheen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Environment      | Nature/Society       | <p><b>Positive Impacts:</b></p> <p>Enhanced Public Safety: Detects and tracks suspicious individuals using facial recognition in real-time.</p> <p>Support for Law Enforcement: Aids in criminal investigations by identifying persons of interest quickly.</p> <p>Remote Surveillance: Monitors sensitive or hazardous areas (e.g., military zones, disaster sites) without risking human life.</p> <p>Emergency Alerts: Can send real-time alerts in case of accidents or abnormal human behavior.</p> <p>Cost-Effective Security: Reduces the need for continuous human patrols, saving operational costs.</p> <p><b>Potential Concerns:</b></p> <p>Privacy Invasion: Continuous facial tracking may raise ethical concerns about mass surveillance.</p> <p>Bias in AI: Inaccurate identification due to biased or incomplete training data can lead to false positives.</p> <p>Job Displacement: Automation may reduce employment opportunities in the security sector.</p> |
|                  | Industry/Market      | <ol style="list-style-type: none"> <li>1. Security and Surveillance <ul style="list-style-type: none"> <li>○ Airports, government buildings, border control, malls, warehouses</li> <li>○ Need for 24/7 monitoring with reduced manpower</li> </ul> </li> <li>2. Defense and Military <ul style="list-style-type: none"> <li>○ Perimeter security, reconnaissance in dangerous zones</li> </ul> </li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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|  |                    | <ul style="list-style-type: none"> <li>○ Autonomous patrolling in war zones or restricted areas</li> </ul> <ol style="list-style-type: none"> <li>3. Smart Cities &amp; Urban Infrastructure <ul style="list-style-type: none"> <li>○ Integration with IoT and surveillance networks</li> <li>○ Public area monitoring, traffic management, and crowd control</li> </ul> </li> <li>4. Industrial and Commercial Facilities <ul style="list-style-type: none"> <li>○ Factory floor surveillance, inventory protection</li> <li>○ Reducing internal theft and unauthorized access</li> </ul> </li> <li>5. Environmental Monitoring <ul style="list-style-type: none"> <li>○ Wildlife protection zones, nature reserves</li> <li>○ Disaster-prone areas and remote weather stations</li> </ul> </li> <li>6. Private and Residential Use <ul style="list-style-type: none"> <li>○ Home security systems for smart homes and gated communities</li> </ul> </li> </ol> <p><b>Market Opportunities:</b></p> <p><b>Startup Potential:</b> Affordable rover solutions can be tailored for schools, homes, or small factories.</p> <p><b>Custom AI Models:</b> Locally trained facial recognition to suit specific cultural or regional demographics.</p> <p><b>Modular Designs:</b> Add-ons like temperature sensors, gas detectors, or GPS can expand market reach</p> |
|  | Citizen/Government | <p><b>Government Applications &amp; Use Cases:</b></p> <ol style="list-style-type: none"> <li>1. National Security and Border Control <ul style="list-style-type: none"> <li>○ Patrolling restricted zones, borders, and military bases</li> <li>○ Real-time facial recognition for identifying threats or wanted individuals</li> </ul> </li> <li>2. Public Infrastructure Monitoring <ul style="list-style-type: none"> <li>○ Deployed in rail stations, airports, and ports for crowd surveillance</li> <li>○ Useful in managing protests, political gatherings, and public safety operations</li> </ul> </li> <li>3. Smart City Integration <ul style="list-style-type: none"> <li>○ Part of smart city projects under Digital Bangladesh or similar e-Governance initiatives globally</li> <li>○ Rovers can integrate with traffic control, public alerts, and environmental monitoring systems</li> </ul> </li> <li>4. Disaster Response and Emergency Services <ul style="list-style-type: none"> <li>○ Government agencies can use them in flood zones, collapsed buildings, or chemical hazard areas for rescue missions</li> <li>○ Equipped with sensors, they can assess danger zones without risking human lives</li> </ul> </li> </ol>                                                                                                            |

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| Resources | Human resources               | To develop and deploy the Automatic Mini-Guard Rover with Facial Recognition, a combination of human, financial, and technological resources is essential. The project would require a skilled team comprising a Project Manager to oversee planning and execution, AI/ML Engineers to develop and train facial recognition algorithms, Embedded and Robotics Engineers to integrate sensors and design rover mobility, and Software Developers for UI and data management systems. Additional personnel like Cybersecurity Experts, Field Operators, Quality Assurance Testers, and Legal Advisors are needed to ensure secure, ethical, and regulation-compliant implementation.                                     |
|           | Financial resources           | The total financial support required to complete this project is approximately BDT 4,50000/=                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|           | Technological resources       | Technologically, the rover will utilize platforms like Raspberry Pi, Arduino, or NVIDIA Jetson Nano for processing, along with AI libraries such as OpenCV, TensorFlow, or PyTorch. It will incorporate a high-resolution camera (possibly with night vision), ultrasonic or infrared sensors, GPS for navigation, and Wi-Fi or 4G modules for communication. The rover will be powered by a lithium-ion battery, with optional solar charging for environmental friendliness. Software will be developed in Python, C++, and ROS (Robot Operating System), with data stored securely in cloud platforms like AWS or Firebase.                                                                                         |
| Mechanism | Strategy<br>(Weight/Sequence) | <p>The strategic options must follow this <b>execution sequence</b>:</p> <ol style="list-style-type: none"> <li>1. Requirement Analysis and Planning</li> <li>2. Core Technology Selection</li> <li>3. AI Model Development</li> <li>4. Mechanical Design &amp; Prototyping</li> <li>5. System Integration</li> <li>6. Testing &amp; Validation</li> <li>7. Pilot Deployment</li> <li>8. Feedback &amp; Optimization</li> <li>9. Full Deployment &amp; Market Scaling</li> </ol> <p>By executing these strategies in a logical and resource-optimized sequence, the project ensures both technical robustness and market viability, while addressing ethical, operational, and environmental concerns effectively.</p> |
|           | Organization                  | <p><input type="checkbox"/> Centralized control through <b>NodeMCU/ESP32</b> as the core controller .</p> <p><input type="checkbox"/> Modular structure:</p> <ul style="list-style-type: none"> <li>• <b>Vision Module</b> – ESP32-CAM for streaming &amp; recognition.</li> <li>• <b>Sensing Module</b> – ultrasonic for obstacle detection.</li> <li>• <b>Actuation Module</b> – robotic arm &amp; motors.</li> <li>• <b>Control &amp; Communication Module</b> – Wi-Fi and mobile app interface .</li> </ul> <p><input type="checkbox"/> Designed to support <b>scalability</b> and integration with other IoT systems .</p>                                                                                        |
|           | Culture                       | <p><input type="checkbox"/> Addresses <b>security and ethical responsibility</b> in surveillance robotics (avoiding intrusive, unnecessary monitoring) .</p> <p><input type="checkbox"/> Encourages a <b>culture of safety and automation</b> where robots minimize human risk exposure .</p> <p><input type="checkbox"/> Supports adoption in contexts like <b>smart cities, hazardous environments, and defense</b> while balancing privacy 【10†source<br/>Relay</p> <p>👉 Would you like me to fill this directly into your provided table</p>                                                                                                                                                                       |

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| Doing                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                   |
| Launch date                 | February, 2025                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                   |
| Responsible organization    | The program will be executed primarily by World University of Bangladesh, with potential collaboration from healthcare institutions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                   |
| Program content and process | <ol style="list-style-type: none"> <li>1. <b>Introduction</b> <ul style="list-style-type: none"> <li>○ Background and motivation</li> <li>○ Overview of the Mini-Guard Rover concept</li> <li>○ Objectives of the project</li> </ul> </li> <li>2. <b>Literature Review / Related Work</b> <ul style="list-style-type: none"> <li>○ Existing security and surveillance solutions</li> <li>○ Advances in robotics, AI, IoT in security</li> <li>○ Gaps and challenges addressed by this project</li> </ul> </li> <li>3. <b>System Design and Architecture</b> <ul style="list-style-type: none"> <li>○ Hardware components (sensors, motors, processors)</li> <li>○ Software components (facial recognition algorithms, control system)</li> <li>○ Communication and networking setup (IoT integration)</li> <li>○ Block diagrams and system flow</li> </ul> </li> <li>4. <b>Implementation Methodology</b> <ul style="list-style-type: none"> <li>○ Step-by-step development process</li> <li>○ Programming languages and tools used</li> <li>○ Integration of hardware and software</li> <li>○ Testing and debugging procedures</li> </ul> </li> <li>5. <b>Key Features and Innovations</b> <ul style="list-style-type: none"> <li>○ Autonomous navigation</li> <li>○ Real-time facial recognition</li> <li>○ Remote monitoring and control</li> <li>○ Energy efficiency and portability</li> </ul> </li> <li>6. <b>Challenges and Solutions</b> <ul style="list-style-type: none"> <li>○ Technical difficulties encountered</li> <li>○ Cost and resource constraints</li> <li>○ Security and privacy considerations</li> <li>○ Approaches to overcome these issues</li> </ul> </li> <li>7. <b>Applications and Use Cases</b> <ul style="list-style-type: none"> <li>○ Home and office security</li> <li>○ Public surveillance and safety</li> <li>○ Disaster monitoring and rescue support</li> <li>○ Potential commercial and industrial uses</li> </ul> </li> <li>8. <b>Impacts and Benefits</b> <ul style="list-style-type: none"> <li>○ Impact on students (learning, skills development)</li> <li>○ Impact on professors and university (research, curriculum)</li> <li>○ Responses from industry, government, and market</li> <li>○ Societal and technological benefits</li> </ul> </li> <li>9. <b>Measurable Outputs</b> <ul style="list-style-type: none"> <li>○ Performance metrics (accuracy, range, battery life)</li> <li>○ Prototype demonstrations</li> <li>○ Documentation and research outputs</li> </ul> </li> <li>10. <b>Future Work and Directions</b> <ul style="list-style-type: none"> <li>○ Planned simulation studies and sustainability impact analysis</li> <li>○ Potential upgrades and scaling possibilities</li> </ul> </li> </ol> |                                                                                                   |

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|                                       | <ul style="list-style-type: none"> <li>○ Alignment with Sustainable Development Goals (SDGs)</li> </ul> <ol style="list-style-type: none"> <li><b>11. Conclusion</b> <ul style="list-style-type: none"> <li>○ Summary of achievements</li> <li>○ Final remarks on significance and potential</li> </ul> </li> <li><b>12. References</b> <ul style="list-style-type: none"> <li>○ Cited research papers, articles, and resources</li> </ul> </li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Key highlights of the content/process | <ol style="list-style-type: none"> <li><b>1. Autonomous Patrolling:</b> <ul style="list-style-type: none"> <li>○ Rover moves independently using motors and sensors.</li> <li>○ Obstacle detection ensures safe navigation.</li> </ul> </li> <li><b>2. Motion Detection:</b> <ul style="list-style-type: none"> <li>○ PIR sensor or camera-based motion detection triggers surveillance mode.</li> </ul> </li> <li><b>3. Real-time Face Capture:</b> <ul style="list-style-type: none"> <li>○ Captures images/videos of detected intruders using camera module.</li> </ul> </li> <li><b>4. Facial Recognition System:</b> <ul style="list-style-type: none"> <li>○ Uses AI to detect and recognize faces.</li> <li>○ Compares with pre-saved database of authorized persons.</li> </ul> </li> <li><b>5. Decision Making:</b> <ul style="list-style-type: none"> <li>○ <b>Matched Face</b> → Logs entry, no alert.</li> <li>○ <b>Unknown Face</b> → Triggers alert (buzzer, SMS, email, etc.).</li> </ul> </li> <li><b>6. Live Alerts &amp; Logging:</b> <ul style="list-style-type: none"> <li>○ Sends real-time alerts to admin/security team.</li> <li>○ Maintains log of time, image, and action taken.</li> </ul> </li> <li><b>7. Energy Efficient &amp; Portable:</b> <ul style="list-style-type: none"> <li>○ Battery-powered mobile surveillance unit suitable for indoor/outdoor.</li> </ul> </li> <li><b>8. Modular Design:</b> <ul style="list-style-type: none"> <li>○ Easy to upgrade: GPS, night vision, cloud sync, or more cameras.</li> </ul> </li> <li><b>9. Cost-Effective Security Solution:</b> <ul style="list-style-type: none"> <li>○ Replaces manual patrol with smart AI-enabled automation.</li> </ul> </li> </ol> <p><b>Applications</b></p> <p>The Automatic Mini-Guard Rover is a smart surveillance system designed for real-time patrolling and facial recognition. It can be used in various applications such as home security, office and industrial surveillance, school and campus safety, and military base monitoring. By automatically detecting motion and identifying individuals using AI-based facial recognition, it helps prevent unauthorized access and ensures safety without constant human intervention. This portable, battery-powered rover is ideal for sensitive zones like hospitals, warehouses, and event venues, offering an efficient and cost-effective alternative to manual security systems.</p> |

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| Differences from traditional approaches | Unlike traditional security systems that rely on fixed CCTV cameras and human guards, the Automatic Mini-Guard Rover offers mobile, intelligent, and autonomous surveillance. Traditional systems often lack real-time identification or require manual monitoring, whereas this rover uses facial recognition to instantly verify individuals and raise alerts for unknown faces. It can patrol dynamically, avoid obstacles, and cover blind spots that static cameras cannot. Moreover, it reduces dependency on constant human presence, lowers operational costs, and enhances security through smart automation and real-time responses.                                                                                                                                                                   |
| Progress as of today                    | The design of a new type of Automatic Mini-Guard Rover is finished.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Problems in implementation              | Implementing the <b>Automatic Mini-Guard Rover</b> comes with several challenges. One major issue is the <b>high initial cost</b> , as components like AI-enabled processors (e.g., Raspberry Pi or Jetson Nano), quality cameras, sensors, and batteries can be expensive. Developing a reliable <b>facial recognition system</b> also requires a well-trained dataset and processing power. Additionally, integration of hardware and software demands technical expertise, and real-time operation may face issues such as <b>connectivity problems, power limitations, and environmental interference</b> (e.g., poor lighting or rough terrain). Ensuring data security and maintaining system updates are also ongoing concerns., supercomputers, etc., which are not cost-effective for a single project. |
| Approaches to solve the problems        | To overcome the high cost, <b>low-cost alternatives</b> like Raspberry Pi Zero or open-source components can be used, and parts may be sourced locally or through educational grants. For facial recognition, <b>pre-trained lightweight models</b> (e.g., MobileNet) can reduce computational requirements and improve speed. Modular design allows gradual upgrades, spreading out expenses. Power issues can be managed with <b>efficient battery management systems</b> or solar charging. Software complexity can be reduced using open-source libraries like OpenCV and TensorFlow. Finally, involving students or tech communities can lower development costs and improve system reliability through collaboration and testing.                                                                          |
| Completion date, if completed           | It is scheduled to be finished by the end of 2025.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Seeing                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Impacts on students                     | The <b>Automatic Mini-Guard Rover</b> project has a significant impact on students by enhancing their practical knowledge in areas like robotics, AI, IoT, and embedded systems. It encourages <b>hands-on learning</b> , critical thinking, and problem-solving skills by integrating hardware and software components. Students gain real-world experience in programming, circuit design, and machine learning, preparing them for careers in modern technology fields. It also promotes teamwork, project management, and innovation, as students work collaboratively to build a functional, socially relevant security solution.                                                                                                                                                                           |
| Impacts on professors                   | Professors are satisfied with the program's progress, noting strong research outputs and effective student engagement. They value the interdisciplinary collaboration and the program's alignment with advancing healthcare innovation and SDG 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Impacts on university administration    | The Automatic Mini-Guard Rover project offers professors opportunities to engage in innovative teaching and research by integrating emerging technologies like AI and IoT into the curriculum. It encourages interdisciplinary collaboration, enriching academic programs and fostering a culture of innovation. For the university, the                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

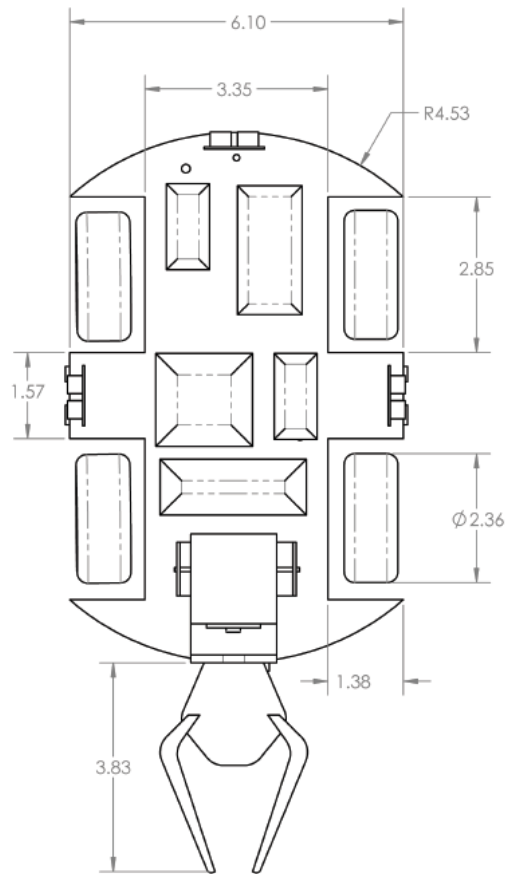
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|                                         | project enhances its reputation by showcasing practical, cutting-edge student work and promoting industry-relevant skills. It also strengthens partnerships with technology sectors and attracts prospective students interested in hands-on, future-focused learning experiences.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Responses from industry/market          | The industry views the Automatic Mini-Guard Rover project as a promising innovation that aligns with growing demands for affordable, autonomous security solutions. Market stakeholders appreciate its practical application of AI, IoT, and robotics in addressing real-world surveillance challenges. The project demonstrates the potential for scalable, customizable security technology, attracting interest from startups and established companies alike. It also highlights the readiness of graduates to contribute to evolving tech sectors, encouraging industry partnerships for further development and commercialization.                                                                                                                                                                                                                                                                                                                                                                |
| Responses from citizen/government       | The government recognizes the Automatic Mini-Guard Rover project as a valuable contribution to national security and technological advancement. It supports such initiatives for promoting innovation in defense, public safety, and smart city development. Government agencies may offer funding, grants, or policy support to encourage further research and deployment of autonomous surveillance systems. The project aligns with national goals of fostering tech education, enhancing security infrastructure, and driving economic growth through emerging technologies.                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Measurable output (revenues)            | <p><b>Functional Prototype:</b> A fully operational Mini-Guard Rover capable of autonomous navigation and real-time facial recognition.</p> <p><b>Accuracy Rate:</b> Percentage of correct facial identifications during testing (e.g., 90%+ accuracy).</p> <p><b>Operational Range:</b> Distance coverage for surveillance and communication (e.g., 100 meters).</p> <p><b>Battery Life:</b> Duration of continuous operation on a single charge (e.g., 2-3 hours).</p> <p><b>Software Performance:</b> Response time for image processing and alert generation (e.g., under 2 seconds).</p> <p><b>User Interface:</b> Development of a user-friendly control dashboard or mobile app.</p> <p><b>Documentation:</b> Complete technical reports, design schematics, and code repositories.</p> <p><b>Student Engagement:</b> Number of students involved and hours spent on project development.</p> <p><b>Research Output:</b> Publications, presentations, or patents resulting from the project.</p> |
| Measurable input (expenses)             | The program has used an initial investment of 40,000 BDT covering hardware development, software engineering, and pilot testing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Cost-benefit analysis for effectiveness | A cost-benefit analysis will be done at the end of the project to understand the impact of the project on sustainable development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Future Planning                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Where does the project go from here?    | Currently in its early stages, the project will proceed with completing experimental work followed by simulation studies. These simulations will evaluate the project's impact on sustainable development and its alignment with the United Nations Sustainable Development Goals (SDGs). This approach will help identify areas for improvement and potential real-world applications, guiding further development toward creating a socially and environmentally responsible security solution.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |



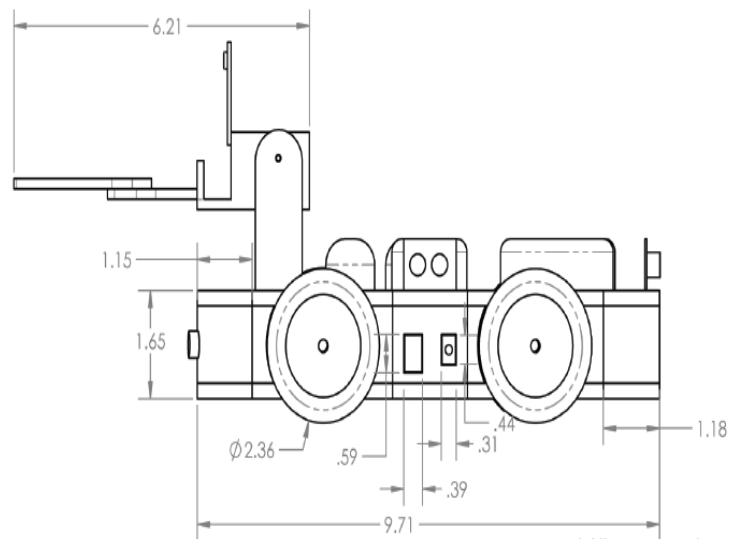
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Addendum

|                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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| Exhibits, pictures, diagrams, etc. | <p>Below figures show that the Block diagram and Mechanical Drawing</p> <pre> graph TD     Battery1[Battery] --&gt; ArduinoNano[Arduino Nano]     ArduinoNano --&gt; NodeMCU[Node MCU]     UltrasonicSensor[Ultrasonic Sensor] --&gt; NodeMCU     RoboticArm[Robotic Arm] --&gt; NodeMCU     ServoMotor[Servo Motor] --&gt; NodeMCU     ESP32CAM[ESP32 CAM] --&gt; NodeMCU     NodeMCU --&gt; MotorDriver[Motor Driver]     Battery2[Battery] --&gt; MotorDriver     MotorDriver --&gt; Motor1[Motor 1]     MotorDriver --&gt; Motor2[Motor 2]     MotorDriver --&gt; Motor3[Motor 3]     MotorDriver --&gt; Motor4[Motor 4]     NodeMCU &lt;--&gt; Wi-Fi[Wi-Fi]     Wi-Fi --&gt; VideoStreaming[Video Streaming]     RoboticArmController[Robotic Arm Controller] --&gt; Wi-Fi     MovementController[Movement Controller] --&gt; Wi-Fi   </pre> |
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\* All measurement in cm



\* All measurement in cm

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| Reports, mimeos, monographs, books, etc.                            | It is expected to publish four Scopus-indexed scientific articles. In addition, a seminar will be conducted to disseminate the experimental results.                                            |
| Others which may help explain the program (including website links) | The development of a Mini Surveillance Robot equipped with a Camera and Facial Recognition system signifies a progressive advancement in the field of automated security and surveillance. This |

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|  | <p>compact and mobile unit integrates the capabilities of real-time video monitoring, autonomous navigation, and intelligent facial recognition algorithms, creating a versatile tool for enhancing safety in a wide range of environments—including residential areas, commercial facilities, educational institutions, and public spaces. Its core advantages lie in its ability to perform continuous surveillance, deliver instant alerts, and detect potential threats with minimal human intervention. Furthermore, the integration of AI-driven facial recognition enhances its ability to distinguish between authorized individuals and unknown entities, contributing to proactive threat management.</p> |
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