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IoTrix

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PHASE-01

QUESTION SET

Submission Deadline

15 NOV

11:59 PM

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PROBLEM STATEMENT

ACCESSIBLE E-RICKSHAW AUTOMATION SYSTEM (AERAS):

Location-Based Ride Request Platform

Design an application-less, e-rickshaw ride request system using a physical game-matrix interface for elderly and special needs individuals.

TARGET USERS: Senior Citizens (≥60), Autistic & Special Needs Individuals
TOTAL MARKS: 100 (90 mandatory +10 Bonus)

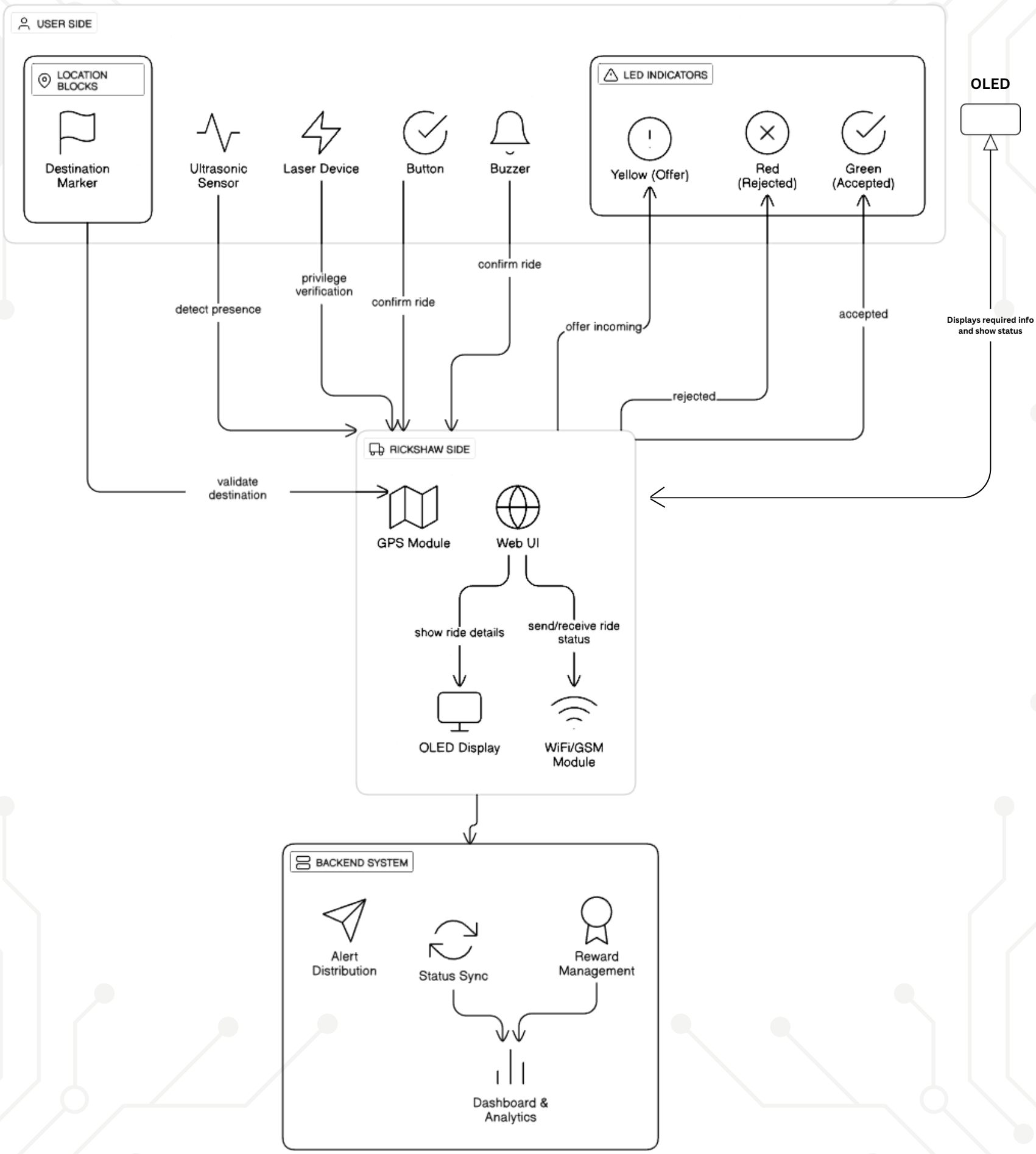
The system must enable users to request rides by standing on designated location blocks, verified through multi-sensor authentication, with real time backend coordination of registered rickshaw pullers and reward-point distribution.

SCENARIO:

The Bangladesh government plans to provide a digitalized e-Rickshaw service for senior citizens and underprivileged individuals. It's an incentive-based transportation sector initiative where registered privileged persons get access to the services, whereas the rickshaw pullers earn redeem points for serving. At the end of the month, they exchange those redeem points for a good amount of wealth.

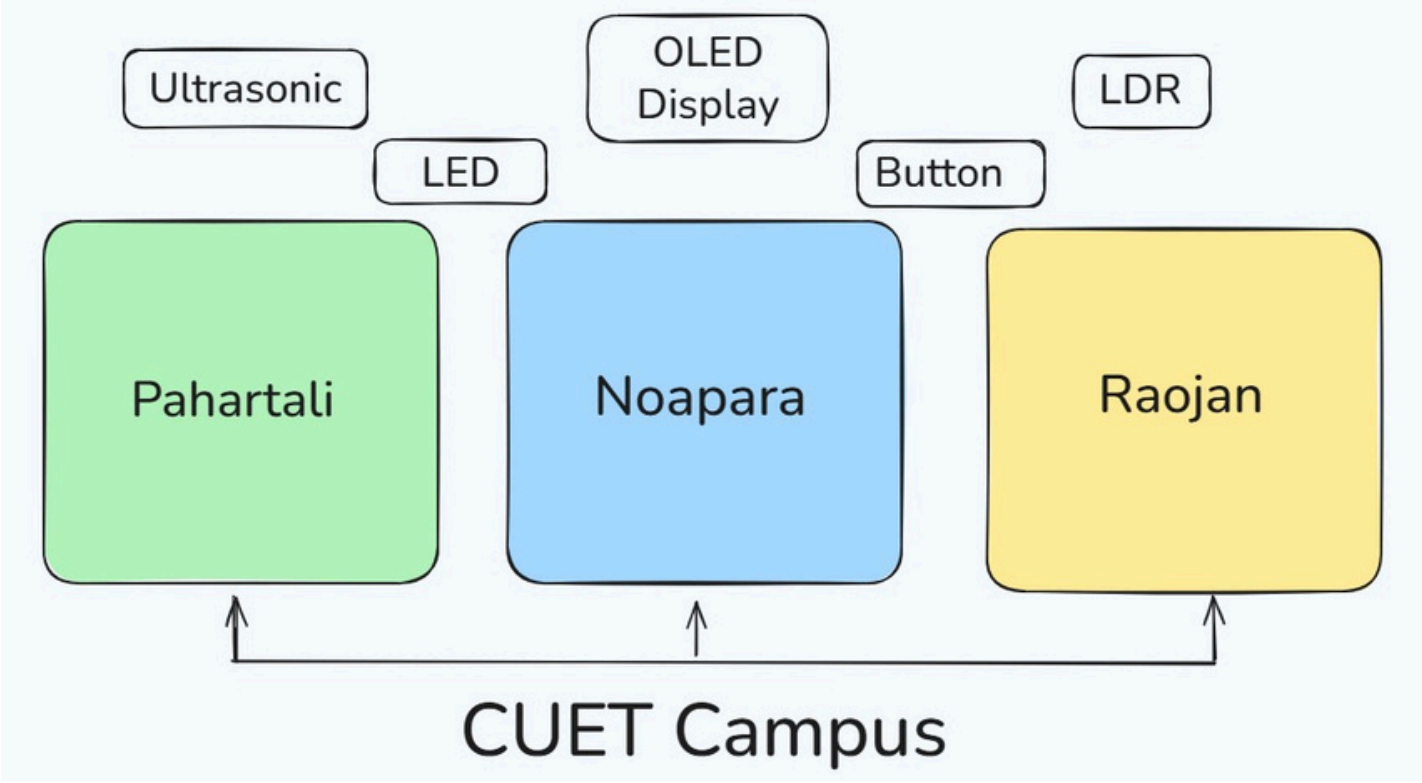
At CUET Campus, users stand on designated location blocks (piles) representing different destinations (Pahartoli, Noapara, Raojan). Through multi-sensor verification (ultrasonic, LDR, laser frequency), users request rides without mobile apps. The backend coordinates registered rickshaw pullers via reward points.

SYSTEM ARCHITECTURE OVERVIEW



SYSTEM ARCHITECTURE OVERVIEW

A Demonstration of Location Based *Pile Block* overview:



SYSTEM ARCHITECTURE OVERVIEW

USER SIDE (App-less Interface):

- Physical Location Blocks (destination markers in Pile System)
- Ultrasonic Sensor (distance detection ≤10m, time ≥3sec)
- User Laser Device (privilege verification)
- Confirmation Button/Buzzer
- User Authentication and Route information shown in OLED Display
- LED Indicators (Yellow: offer incoming, Red: rejected, Green: accepted)

RICKSHAW SIDE:

- OLED Display (ride details, navigation)
- GPS Module (drop-off verification)
- Web UI (accept/reject, track rides)
- Backend Communication Module (WiFi/GSM)

BACKEND SYSTEM:

- Rider Alert Distribution System
- Real-time Status Synchronization
- Point Reward Management
- Admin Dashboard & Analytics

EVALUATION CRITERIA

MARKS DISTRIBUTION:

Section A: Hardware Implementation	**40 marks**
├── User-side (sensors, LEDs, button, OLED)	20 marks
└── Rickshaw-side (OLED, GPS, UI)	20 marks
Section B: Software & Backend	**25 marks**
├── Backend coordination	10 marks
└── Admin dashboard & database	15 marks
Section C: Integration & Testing	**15 marks**
├── End-to-end journey	8 marks
└── Edge cases	7 marks
Section D: Documentation	**10 marks**
Section E: Big Idea Evaluation	**10 marks (BONUS)**

TOTAL: 90 marks + 10 bonus = 100 maximum

JUDGING WEIGHTAGE:

Innovation & Social Impact	30%
Technical Execution	50%
Presentation & Documentation	20%

SECTION A:

HARDWARE IMPLEMENTATION & TESTING [40 MARKS]

A1. USER-SIDE LOCATION BLOCK UNIT [20 MARKS]

TEST CASE 1: Ultrasonic Distance Detection ***[5 marks]***

CONDITIONS:
- Person approaches the location block
- Distance measurement range: 0m to 10m
- Time threshold: t = 3 seconds continuous presence

Required Tests:
(a) Person at 15m → Expected: No trigger
(b) Person at 8m for 2sec → Expected: No trigger
(c) Person at 9m for 3.5sec → Expected: Trigger activated
(d) Person at 5m for 5 seconds → Expected: Trigger activated
(e) Person moves from 8m to 12m within 3 seconds → Expected: Reset/No trigger

EVALUATION:
· Accuracy of distance measurement (±5cm tolerance): 2 marks
· Consistent 3-second timing (±0.2s tolerance): 2 marks
· Edge case handling (movement, multiple people): 1 mark

SECTION A:

TEST CASE 2: LDR + Laser Privilege Verification ***[6 marks]***

CONDITIONS:
- After ultrasonic trigger, user must verify privilege
- User directs laser (specific frequency) at LDR sensor
- LDR must detect correct frequency and reject others

REQUIRED TESTS:
(a) No laser directed at LDR → Expected: No privilege granted
(b) Incorrect frequency laser (e.g., standard pointer) → Expected: Rejected
(c) Correct frequency laser for 0.5 seconds → Expected: Privilege confirmed
(d) Correct laser but from 2m distance → Expected: Test detection range
(e) Ambient light interference (sunlight) → Expected: No false positive
(f) Laser directed at angle (not perpendicular) → Expected: Test acceptance cone

Evaluation:
- Frequency discrimination capability: 2 marks
- False positive rate <5%: 2 marks
- Response time <1sec: 1 mark
- Environmental robustness: 1 mark

SECTION A:

TEST CASE 3: Button/Buzzer Confirmation System [4 marks]

CONDITIONS:
- After privilege verification, user confirms location selection
- User presses button while standing on specific location block
- System must log selected destination

REQUIRED TESTS:
(a) Button pressed before privilege verification → Expected: No action
(b) Button pressed after privilege verification → Expected: Request sent
(c) User changes position to different block before pressing → Expected: Update location
(d) Double-press within 2 seconds → Expected: Ignore duplicate
(e) Press-and-hold for >5 seconds → Expected: Timeout/Error handling

Evaluation:
- Sequential logic correctness: 2 marks
- Debouncing implementation: 1 mark
- User feedback (buzzer sound patterns): 1 mark

SECTION A:

TEST CASE 4: LED Status Indicators System ***[5 marks]***

CONDITIONS:
- Yellow LED: Offer incoming from rickshaw puller
- Red LED: Offer rejected / No puller available
- Green LED: Ride accepted, rickshaw arriving

REQUIRED TESTS:
(a) Immediately after confirmation → Expected: All LEDs OFF
(b) Puller accepts within 10 seconds → Expected: Yellow ON
(c) No puller accepts within 60 seconds → Expected: Red ON (timeout)
(d) Puller confirms pickup → Expected: Green ON, Yellow OFF
(e) Multiple rejections then acceptance → Expected: Proper LED sequence
(f) Power failure during LED operation → Expected: State recovery

EVALUATION:
- Timing accuracy: 2 marks
- Correct state transitions: 2 marks
- Visual clarity and user understanding: 1 mark

SECTION A:

TEST CASE 5: OLED Display Information System ***[6 marks]***

CONDITIONS:

- Display shows real-time ride requests
- Shows user location, destination, current points
- Display updates on acceptance/completion

REQUIRED INFORMATION:

• Request notification Screen: User Pickup location (block ID), destination, estimated distance, Potential points reward
• Active Ride Screen: Current location (GPS), Destination location, Navigation guidance (direction/distance), Timer (ride duration)
• Completion Screen: Total Points earned, ride summary, Next request availability

REQUIRED TESTS:

(a) Incoming request → Expected: Display details
(b) Multiple requests → Expected: Queue with priority
(c) GPS signal lost → Expected: Error + last location
(d) Display refresh → Expected: ≤2sec latency
(e) Sunlight/night readability → Expected: Adaptive contrast

EVALUATION:

• Information completeness: 2 marks
• Refresh/latency: 2 marks
• UI/UX clarity: 1 mark
• Environmental adaptability: 1 mark

SECTION A:

TEST CASE 6: Web Application ***[7 marks]***

CONDITIONS:
- Puller receives notification of ride request
- Can accept/reject requests
- Confirms pickup and drop-off
- Views points balance and history

REQUIRED TESTS:

(a) Notification System:
- Request received → Expected: Audio/vibration alert + display
- Multiple notifications → Expected: Prioritized list (nearest first)
- Accept timeout (30 seconds) → Expected: Auto-pass to next puller

(b) Acceptance Flow:
- Puller clicks "Accept" → Expected: User's Yellow LED turns ON
- Puller clicks "Reject" → Expected: Offer goes to next puller
- Acceptance confirmation sent to backend → Expected: <2 seconds

(c) Navigation Integration:
- Display route to pickup location → Expected: Map integration (optional)
- Arrival at pickup → Expected: "Confirm Pickup" button enabled
- Confirm pickup → Expected: User's Green LED turns ON

SECTION A:

(d) Drop-off Verification:

- Arrival at destination block → Expected: GPS verification (±50m radius)
- Incorrect location drop → Expected: Point reward PENDING status
- Correct location drop → Expected: Points REWARDED immediately

(e) Points Dashboard:

- View total points balance → Expected: Real-time sync with backend
- View ride history (last 10 rides) → Expected: Date, location, points
- Point redemption information → Expected: Displayed rewards catalog

EVALUATION:

- Notification reliability: 1 mark
- Accept/reject flow correctness: 2 marks
- GPS drop-off verification accuracy: 2 marks
- Points tracking accuracy: 1 mark
- UI responsiveness: 1 mark

SECTION A:

TEST CASE 7: GPS Location & Point Allocation ***[7 marks]***

CONDITIONS:
- Rickshaw must drop user at correct destination block
- GPS coordinates must match block location (within tolerance)
- Point reward or pending status based on accuracy

LOCATION BLOCKS COORDINATES (Demo Setup):
- CUET Campus Block: 22.4633°N, 91.9714°E
- Pahartoli Block: 22.4725°N, 91.9845°E
- Noapara Block: 22.4580°N, 91.9920°E
- Raojan Block:22.4520°N, 91.9650°E

POINT CALCULATION FORMULA:
Base Points = 10
Distance Penalty = (Actual Distance from Block / 10m)
Final Points = Base Points - Distance Penalty (minimum 0)

REQUIRED TESTS:
(a) Drop at exact block location → Expected: +10 points (Full reward)
(b) Drop within 50m of block → Expected: +8 points (Partial reward)
(c) Drop 51-100m from block → Expected: +5 points (Reduced reward)
(d) Drop >100m from block → Expected: PENDING (Admin review required)
(e) GPS unavailable at drop location → Expected: Manual verification mode
(f) User requests admin review → Expected: Point status locked until review

EVALUATION:
- GPS accuracy (±20m): 2 marks
- Point calculation: 2 marks
- Pending/review logic: 1 mark
- Edge cases: 2 marks

SECTION B:

SOFTWARE & BACKEND SYSTEM [25 MARKS]

B1. BACKEND COORDINATION SYSTEM [10 MARKS]

TEST CASE 8: Rider Community Alert Distribution ***[5 marks]***

CONDITIONS:
- When user confirms ride request, alert sent to registered pullers
- Alert priority based on proximity to pickup location
- First-accept wins, others notified of unavailability

REQUIRED TESTS:
(a) Single request, 5 pullers online → Expected: All 5 receive notification
(b) Alert priority order → Expected: Nearest puller gets notification first
(c) First puller accepts within 10s → Expected: Others get "request filled" message
(d) No puller accepts within 60s → Expected: User's Red LED ON, request expires
(e) Puller A accepts, then cancels → Expected: Re-alert to remaining pullers
(f) 3 simultaneous requests, 5 pullers → Expected: Smart distribution (no overlap)

EVALUATION:
·Alert broadcast reliability: 2 marks
·Priority/proximity algorithm: 1 mark
·Race condition handling: 1 mark
·Timeout and retry logic: 1 mark

SECTION B:

TEST CASE 9: Real-time Status Synchronization ***[5marks]***

CONDITIONS:
- User LED status, OLED display, mobile UI all synchronized
- Backend database updates in real-time
- Admin dashboard reflects current system state

SYNCHRONIZATION POINTS:
1. Request Creation → User LED (waiting), Puller UI (notification)
2. Ride Acceptance → User LED (yellow), Puller OLED (navigation)
3. Pickup Confirmation → User LED (green), Backend (ride active)
4. Drop-off → Points update, History log, LED reset

REQUIRED TESTS:
(a) Button to LED latency → Expected: <3sec
(b) Network interruption → Expected: Cache locally, sync on reconnect
(c) Admin modifies points mid-ride → Expected: Real-time OLED update
(d) Database query load (100 simultaneous requests) → Expected: Response <5sec
(e) Conflict resolution (2 pullers accept same ride) → Expected: First timestamp wins

EVALUATION:
- End-to-end latency: 2 marks
- Data consistency: 2 marks
- Network failure recovery: 1 mark

SECTION B:

B2. ADMIN DASHBOARD & DATABASE [15 MARKS]

TEST CASE 10: Admin Monitoring ***[5 marks]***

Real-time overview, ride management, analytics.

REQUIRED FEATURES:

(a) Real-time Dashboard Overview:

- Total active users (on blocks), online pullers, active rides count
- Pending point reviews, system health indicators

(b) Ride Management:

- View all ride history (filterable by date, location, user, puller)
- Manual point adjustment for disputed rides
- Ban/suspend abusive users or pullers

(c) Analytics:

- Most requested destinations (graph)
- Average wait &completion times
- Puller leaderboard

EVALUATION:

- Dashboard completeness: 2 marks
- Data visualization: 2 marks
- Control functionality: 1 mark

SECTION B:

TEST CASE 11: Point Reward Management System [5 marks]

CONDITIONS:
- Points accumulated per successful ride
- Point redemption for rewards (e.g., free rides, vouchers)
- Admin can modify point values and rewards catalog

REQUIRED TESTS:
(a) Puller completes 5 rides correctly → Expected: 50 points balance
(b) Puller redeems 30 points → Expected: Balance = 20, reward issued
(c) Admin increases base point from 10 to 15 → Expected: Future rides reflect new value
(d) Point fraud detection (GPS spoofing) → Expected: Flag and suspend account
(e) Point expiration policy (180 days) → Expected: Auto-deduct expired points

EVALUATION:
- Point tracking: 2 marks
- Redemption workflow: 2 marks
- Fraud detection mechanism: 1 mark

SECTION B:

TEST CASE 12: Database Design ***[5 marks]***

Schema with Users, Pullers, Rides, Locations, Points_History tables.

REQUIRED TESTS:
(a) Concurrent writes (10 rides completing simultaneously) → Expected: No data loss
(b) Database backup and recovery → Expected: Daily automated backups
(c) Query optimization (retrieve ride history for last 30 days) → Expected: <2 seconds
(d) Data integrity constraints (foreign keys, null checks) → Expected: No orphan records
(e) Privacy compliance (anonymize user data after 1 year) → Expected: Auto-anonymization

EVALUATION:
·Schema design (normalization, relationships): 2 marks
·Query performance optimization: 2 marks
·Data integrity and constraints: 2 marks
·Backup and recovery strategy: 1 mark

SECTION C:

INTEGRATION & SYSTEM TESTING [15 MARKS]

TEST CASE 13: End-to-End User Journey ***[8 marks]***

Complete flow from user request to ride completion.

WORKFLOW:

1. User approaches CUET Campus block (Pahartoli destination)
2. Ultrasonic detects at 8m for 3.2sec
3. User directs laser → Privilege confirmed
4. Button pressed → Request to backend
5. Backend alerts 3 nearest pullers
6. Puller B (2.5km) accepts <8sec
7. User Yellow LED ON
8. Puller arrives, confirms pickup → Green LED ON
9. Puller drives to Pahartoli block
10. Drops at exact location → GPS verified
11. 10 points credited to Puller B
12. LEDs reset, system ready for next user

EVALUATION:

- Flow without errors: 2 marks
- Status transitions: 2 marks
- Point calculation: 1 mark
- System returns to idle state: 1 mark
- Database logging: 2 mark

SECTION C:

TEST CASE 14: Edge Cases & Failure Scenarios ***[7 marks]***

(a) Multiple Users on Same Block [2 marks]
User A and B both trigger → First verification wins, second queued

(b) Puller Cancels Mid-Ride [1.5 marks]
Emergency occurs → Re-alert others, user notified, no penalty

(c) Power Failure at Block [1.5 marks]
Block loses power → Backend maintains state, ride continues

(d) GPS Signal Loss [1 mark]
Poor signal → Manual verification, admin review

(e) Network Partition [1 mark]
Disconnection → Offline cache, sync on reconnect

SECTION D:

DOCUMENTATION & PRESENTATION [10 MARKS]

D1. Circuit Diagrams [3 marks]

- User-side block unit (sensors, LEDs, button)
- Rickshaw-side (OLED, GPS, communication)
- Pin configuration, power supply details

D2. Software Architecture [3 marks]

- System diagram (user, rickshaw, backend, admin)
- Data flow diagram showing all interactions
- API endpoint documentation

D3. VIDEO DEMONSTRATION [4 marks]

- Complete working prototype video (5-10 minutes)
- Shows all test cases passing
- Explains system operation with narration
- Installation setup

SECTION E:

BIG IDEA EVALUATION [BONUS 10 MARKS]

E1. SOCIO-ECONOMIC IMPACT [4 marks]
Explain how your system addresses:
(a) Mobility challenges for elderly/special needs individuals
(b) Economic benefits for rickshaw pullers (reward points)
(c) Scalability to other cities/regions
(d) Long-term sustainability and adoption barriers

E2. INNOVATION & UNIQUENESS [4 marks]
Justify your design choices:
(a) Why app-less approach for target users?
(b) How does game-matrix physical interface improve accessibility?
(c) Advantages of multi-sensor verification vs traditional methods
(d) Novel features not found in existing ride-hailing systems

E3. SYSTEM INTEGRATION & FEASIBILITY [2 marks]
Demonstrate technical depth:
(a) Data flow from user interaction to ride completion
(b) Hardware-software communication strategy
(c) Handling multiple simultaneous requests

SUBMISSION PROCEDURE

***DEADLINE:* 15 November 11:59 pm (UTC +6, Bangladesh Standard Time)**

****Submission form will be provided in the classroom***

SUBMISSION REQUIREMENTS:

1. *SOURCE CODE (GitHub Repository)*:

Provide a public repository link that contains your solutions and necessary documentation. Documentation file can be a README (.md) or a Doc file.

Warning: Don't update or commit any changes after the submission!

It must include the following aspects:

- ✓ User-side microcontroller code (Arduino/ESP32/Raspberry Pi)
- ✓ Rickshaw-side Web-app
- ✓ Backend server (Node.js/Python/Django/any)
- ✓ Admin dashboard code
- ✓ README with setup instructions

2. HARDWARE DOCUMENTATION & TECHNICAL REPORT (PDF)

3. VIDEO DEMONSTRATION (5-10 minutes)

Provide a video demo of your hardware part working simulation. Upload the video to Google Drive and share the general access with anyone using the link (Viewer).

It must include the following aspects:

- ✓ Working prototype demo
- ✓ Test cases execution
- ✓System walkthrough with narration

SUBMISSION PROCEDURE

Disclaimer:

The authority reserves the right to change any rule without prior notice. The organizing committee has the right to disqualify or ban any team based on violations such as: -

-Using a fake identity.
- Plagiarism/pre-made projects.
- Breaking competition rules
- Time violations (late submissions/presentations).
- Not following the player etiquette
- Previous accusations or misconduct
- The decision of the judges will be final in case of any disputes.

Good luck to all participants!

CONTACT

For any inquiries regarding **IOTRIX**, feel free to reach out to our organizing team

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