Autonomous Path Following Car Using Beagleboard

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Abstract- ***The Phenomenal Growth of Industries Increases Import and Export Rate, So There Is an Enormous Requirement of Autonomous Vehicles. This Project Presents a Novel Approach to Achieve an Autonomous Path Following Car Using Beagleboard, A Single-Board Computer Which Works as The Central Control Unit of The Vehicle. The Objective Is to Create a Cost-Effective and Open-Source Platform for Autonomous Navigation for Various Applications. The System Consists of Beagleboard, Integrated with A Web Camera for Precise and Safe Navigation. The Output from A Web Camera Will Be Processed Through Opencv Library for Image Processing Techniques. The Beagleboard Processes the Sensor Data (Camera) And Makes Real-Time Decisions. It Can Be a Real-Time Safer Solution and Environmentally Friendly in The Future. The Results Show the Beaglebone Ai-Based Autonomous Path-Following Car's Dependability and Accuracy, Enabling It to Navigate Smoothly and Safely on A Variety of Roads.***

Indexed Terms- ***Beagleboard, Opencv, Image Processing, Autonomous Vehicle.***

I. INTRODUCTION

Modern Transportation Is Being Transformed By Autonomous Cars, Which Provide Safe, Effective, And Intelligent Navigation. The Beaglebone Black, An Effective and Affordable Single-Board Computer, Is Used in This Research to Demonstrate an Autonomous Path-Following Vehicle. The Autonomous Vehicle Is Made to Follow Predetermined Routes While Recognizing and Avoiding Obstacles in Real-Time. The Beaglebone Black-Based System Demonstrates a Scalable and Flexible Solution for Intelligent Robotic Applications by Combining Computer Vision, Control Algorithms, And Sensor Integration. Due To Its Potential to Transform Transportation, Autonomous Cars Have Attracted a Lot of Attention Recently. The Project Uses the Open-Source Beaglebone Platform, A Low-Cost Single-Board Computer, To Build an Autonomous Vehicle That Can Follow Predetermined Routes and Avoid Obstacles. The Goal of The Project Is to Create a Working Prototype for An Autonomous Path-Following Vehicle. The Goal of The Project Is to Ensure That the Car Can Follow a Predetermined Path While Avoiding Obstacles by Developing the Hardware and Software Components Required for Autonomous Navigation. Real-Time Mapping and Sophisticated Path Planning Are Advanced Features That Are Outside the Scope of The Project.

II. EASE OF USE

A. Literature Survey

1.Zakaria, Mohamad & Shing, Joo & Tomari, Razali. Implementation of Robot Operating System In Beaglebone Black Based Mobile Robot for Obstacle Avoidance Application. International Journal on Advanced Science, Engineering and Information Technology. 7. 2213. 10.18517/Ijaseit.7.6.3221. This Project Uses Beaglebone Black for Developing Obstacle-Avoidance Robot Information Gathered During Survey: Learned to Use the Beaglebone Black Microcontroller and Working of Obstacle-Avoidance System 2. Ismail, Abdul Halim & Ramli, Hafiz & Ahmad, M.H. & 0 Vision-Based System For Line Following Mobile Robots.

2. 642 - 645. 10.1109/Isiea.2009.5356366. This Project Uses Image Processing Technique to Navigate the Robot Through a Predefined Path Learned About Image Processing Information Gathered During Survey: Technique Used to Navigate the Robot Along the Path

3.Bilgin Seçkin, Tuna Ayan, Emin Germen, Autopilot Project with Unmanned Robot, Procedia Engineering, Volume 41, Pages 958-964, Issn 1877-7058. This Project Uses a GPS Module, A Single Board Computer, And A Webcam for Routing and Tracking

Processes. Information Gathered During Survey: Learned To Establish Connection Between Microcontroller And Host Computer Through Wireless Channel

4.Barai, Suvankar & Dey, A & Sau, Buddhadeb. (2016). Path Following Of Autonomous Mobile Robot Using Passive Rfid Tags.10.1109/Microcom.7522573. Path Following Robot Was Developed By Using Rfid Tags And Image Processing Techniques. Information Gathered During Survey: Understood How To Implement Custom Tags To Stop The Robot If Needed

5. J. Dupuis And M. Parizeau, "Evolving A Vision-Based Line-Following Robot Controller," In Computer And Robot Vision. The 3rd Canadian Conference On, Pp. 75–75. Line-Following Robot Was Developed By Using Vision-Driven Controller Used To Control Robot's Servos Information Gathered During Survey: Learned To Classify And Process The Image Features.

6. Astrid Rupp, Markus Tranninger, Raffael Wallner, Jasmina Zubača, Martin Steinberger, Martin Horn Fast And Low-Cost Testing Of Advanced Driver Assistance Systems Using Small-Scale Vehicles Volume 52, Issue 5, 2019, Pages 34-39

1. "Autonomous Car Using Beagle Board And Opencv" By A. K. Sharma And S. K. Singh. • This Paper Presents The Design And Development Of An Autonomous Car Using Beagle Board And Opencv. The Car Is Designed To Follow A Path Using Image Processing Techniques.

2. "Design And Implementation Of An Autonomous Car Using Beagle Board And Ros" By M. M. Islam And M. A. Hossain. • This Paper Presents The Design And Implementation Of An Autonomous Car Using Beagle Board And Ros. The Car Is Designed To Follow A Path Using A Combination Of Gps And Image Processing Techniques.

3. "Autonomous Vehicle Navigation Using Beagle Board And Opencv" By S. K. Singh And A. K. Sharma. • This Paper Presents The Design And Development Of An Autonomous Vehicle Using Beagle Board And Opencv. The Vehicle Is Designed To Follow A Path Using Image Processing Techniques.

4. "Autonomous Car Navigation Using Beagle Board And Ros" By M. M. Islam And M. A. Hossain. • This Paper Presents The Design And Implementation Of An Autonomous Car Using Beagle Board And Ros. The Car Is Designed To Follow A Path Using A Combination Of Gps And Image Processing Techniques.

III. THEORY OF PROBLEM

A. Problem Definition

Some Of The Challenges Faced During The Implementation Of Autonomous Path Following Car Using Beagle-Board Include Object Detection, A Critical Component Of Autonomous Navigation, But It Can Be Challenging To Detect And Classify Objects Accurately And In Real-Time. Developing An Effective Path Planning Algorithm That Can Handle Complex Environments And Obstacles Can Be Difficult. Autonomous Vehicles Require A Lot Of Power, And Managing Power Consumption Can Be Challenging, Especially When Trying To Optimize Performance.

Aim Of The Project

The Aim Is To Design An Autonomous Path Following Car Using Beagle Board, A Self-Driving Car That Can Navigate Through A Given Environment Without Human Intervention Using Image Processing Techniques. The Objective Is To Use The Beagle Board To Implement Image Processing Techniques With Camera To Detect The Car's Location, Identify Obstacles, And Follow A Path. The Car Should Be Able To Navigate Through Complex Environments, Avoid Obstacles, And Reach Its Destination Safely. It Creates Algorithms, Capable Of Recognizing And Interpreting Traffic Signs Accurately. The Ultimate Goal Is To Develop A Reliable, Efficient, And Safe Autonomous Car That Can Be Used In A Variety Of Applications, Such As Transportation, Surveillance, And Exploration. Overall, The Objective Of Developing An Autonomous Path Following Car Is To Create A Safer, More Efficient, And More Accessible Transportation System That Can Benefit Society In Many Ways.

B. How Beaglecar Works

To Design And Implement An Autonomous Path Following A Car Using Beagle Board Can Use Algorithms. Opencv Library For Processing The Output Received From The Web Camera, Which Can Improve Object Detection Accuracy. Techniques Such As Perspective Transformation, Image Threshold Can Be Used. The Hough Line Transform Is Used To Detect And Extract Lines From The Image. By Using Energy-Efficient Hardware Components And Optimizing Software Algorithms Can Improve Power Efficiency

The Core Algorithm For Path-Following Involves Sensor Data Processing, Decision-Making, And Motor Control. Here's A Basic Outline Of The Algorithm: Image Processing: Utilize An Usb Webcam To Perceive The Environment. Opencv Library Can Be Used For Object Detection And Obstacle Avoidance. Path Detection: Implement A Path Detection Algorithm To Recognize The Path Or Follow An Object/Person. This Can Involve Image Processing Techniques Like Edge Detection, Color Tracking, Or Feature Extraction To Identify The Path Or Target. Control System: Integrate The Motor Drivers With The Beaglebone Black And Write Code To Control The Motor's Speed And Direction.

Hardware And Software Required:

- Beagle-Bone Black
- ·webcam
- Open Cv
- Dc Motors
- L298n Motor Driver
- 5v Battery

IV. IMPLEMENTATION AND WORKS

A. Hardware Architecture:

The Hardware Architecture Typically Includes A Beagleboard, A Motor Driver, A Web Camera And Dc Motor Wheels. The Beagleboard Processes Data From The Web Camera And Opencv Library Works On The Output Received From The Camera, To Determine The Car's Position And Orientation. The Motor Driver Controls The Car's Movement Based On The Feedback From The Sensor(Web Camera).The Beagleboard Runs A Software Stack That Includes A Real Time Linux Operating System Called Debian ,Computer Vision Algorithms(Opencv), Pid Controller And Adafruit Library For Motor Control.

- *Software Architecture:*

The Software Architecture Of The Autonomous Vehicle Is Presented In Section 4. The Robot Operating System (Ros), Which Controls Communication Between Various Modules, Is Implemented On The Linux-Based Operating System That Powers The Beaglebone Black. We Go Through Methods To Integrate Sensor Drivers, Computer Vision Libraries, Control Strategies, And Reasoning For Making Decisions.

Step-By-Step Process:

1. Capture Image: - Use A Camera Connected to The Beaglebone Black To Capture A Video Stream Or Images Of The Ground.
2. Preprocessing: - Convert The Captured Frame To Grayscale To Simplify Processing. - Apply Image Filters (E.G., Gaussian Blur) To Reduce Noise And Enhance Line Visibility.
3. Thresholding: - Apply Thresholding To Create A Binary Image Where The Line Is Highlighted Against The Background.
4. Region Of Interest (Roi) Selection: - Define A Region Of Interest Where The Line Is Expected To Appear (The Lower Portion Of The Image).
5. Line Detection: - Using The Canny Edge Detection Technique To Identify Edges In The Binary Image. - Apply The Hough Transform To Detect Lines In The Edge-Detected Image.
6. Line Tracking: - Identify The Lines Detected By The Hough Transform. - Calculate The Average Position Of The Detected Lines.
7. Control Output: - Based On The Position Of The Lines, Determine The Car's Deviation From The Desired Path. - Compute Control Commands For The Car's Actuators (Steering, Throttle, Brake) To Adjust Its Position.
8. 8.Loop: - Repeat The Above Steps In A Loop To Continuously Process New Frames And Adjust The Car's Behavior In Real Time.

B. Implementation

Path Following Accuracy: To Increase The Accuracy, The Robot Is Optimized By Averaging The Values Obtained From The Pixel Summation Method. The

Accuracy Is Greater Than The Existing Systems Which Use Sensors.

Response Time : The Response Time For The System To Make Decisions While Following The Path Is Tuned To Maximum By Decreasing The Image Quality And Focusing On Performance During Image Processing.

Smoothness Of Movement : The Car's Motion Will Be Smooth, This Will Be Achieved By Using And Tuning The Pwm Values. Reliability And

Robustness : The Microcontroller Used In This Project Beaglebone Black Is More Reliable Than Similar Boards Such As Raspberry Pi. This Board Can Be Used In Real-World Situations And Complex Environments.

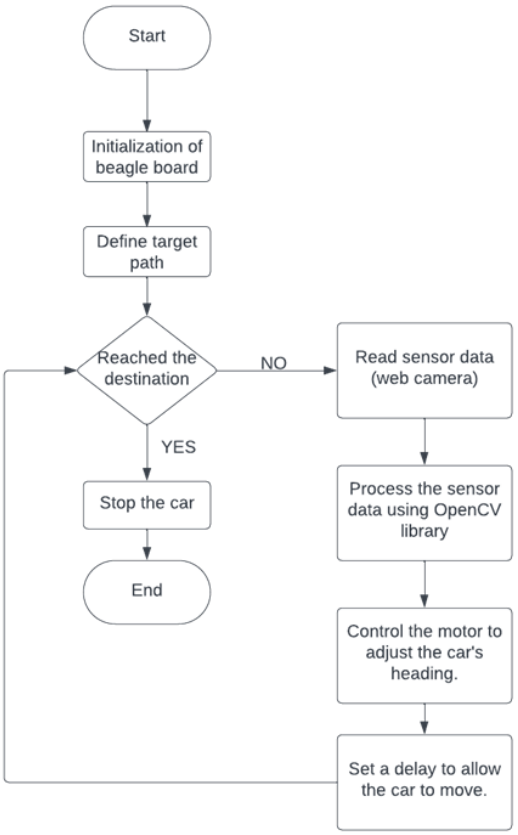
Scalability : The Proposed Method/Architecture Can Be Easily Scaled To Handle More Complex Environments Or Multiple Vehicles Simultaneously.
User Dashboard : The User Can View The Values Obtained While Image Processing On A Dashboard In Real-Time. This Also Helps In Increasing The Accuracy Of The System By Turning The Values.

Software Components:
The Software Components Include:

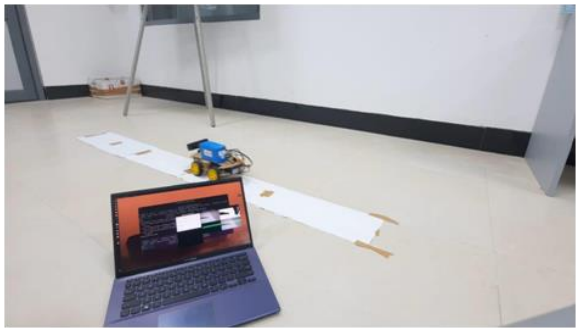
- Linux Os : Running On Beaglebone.
- Python : Main Programming Language For Control And Data Processing.
- Opencv : Used For Image Processing.
- Robot Operating System (Ros) : Provides Robotics Middleware.
- Path Planning Algorithms : For Defining And Following Paths.
- User Interface : Developed Using Web Technologies For Remote Control And Monitoring.

V. RESULT AND DISCUSSION

Workflow:



Dashboard:



CONCLUSION

The Project Successfully Demonstrates The Development Of An Autonomous Path-Following Car Using The Beaglebone Platform. It Showcases The Potential Of Beaglebone In Robotics Applications And Lays The Foundation For Further Advancements In Autonomous Vehicle Technology. The Conclusion Of The Project Autonomous Path Following Car Using Beagleboard Is A Successful Implementation. The Beagleboard Capabilities Allows It To Perform Real-Time Processing And Make Real-Time Decisions While Navigating The Path. Looking Ahead There Are Several Promising Directions In The Research Of Autonomous Path Following Car Using Beagleboard. Autonomous Path-Following Vehicles Powered By Beagleboard Or Other Embedded Systems Have A Bright Future

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