

Autonomous Theft Proof Food Delivery Robot For E-Com

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Abstract—This project presents the development of a low-cost, efficient, and autonomous food delivery robot designed for e-commerce applications, utilizing an ESP32 camera module as its core vision system. The robot is engineered to navigate indoor environments, delivering food or packages within short distances, such as in restaurants, cafes, or office settings. Equipped with the ESP32 camera, the robot captures real-time video live streaming. The system integrates IoT capabilities to enable remote monitoring and control, allowing users to deliveries or track the robot's movement through a mobile app. Its compact design and reliance on readily available components ensure cost-effectiveness and scalability for small businesses. This innovation aims to enhance operational efficiency in food delivery, reducing human labor while improving customer experience in dynamic environments.

Index Terms—Esp32 camera, Real time video live streaming, IoT capabilities, cost-effectiveness, operational efficiency, etc.

I. INTRODUCTION

The rise of e-commerce and on-demand services has led to an increased demand for efficient and autonomous delivery solutions. Traditional food delivery methods often involve human couriers, which can be costly, time-consuming, and subject to delays due to traffic or workforce limitations. To address these challenges, autonomous delivery robots have emerged as a promising alternative, offering a reliable and cost-effective solution for last-mile deliveries in controlled environments such as restaurants, cafes, and office spaces.

This project focuses on developing an autonomous theft-proof food delivery robot using an ESP32 camera module as its primary vision system. The robot is designed to navigate indoor environments autonomously, ensuring accurate and secure deliveries. Equipped with IoT integration, the system allows users to monitor and control the robot remotely

via a mobile application, enhancing operational efficiency and security. The ESP32 camera module enables real-time video streaming, ensuring that users can track the robot's movement and verify deliveries. One of the key advantages of this project is its cost-effectiveness. By utilizing readily available hardware components, such as the ESP32 microcontroller, motor drivers, and basic sensors, the system remains affordable and scalable for small businesses. Additionally, its compact design allows it to make over efficiently within confined spaces. By minimizing human intervention and improving delivery efficiency, this autonomous robot aims to revolutionize food delivery in e-commerce applications.

II. PROPOSED METHODOLOGY

The proposed system is an autonomous, theft-proof food delivery robot designed for indoor environments such as restaurants, cafes, and offices.

It utilizes an ESP32 camera module as its primary vision system for real-time video streaming and navigation. The robot is equipped with IoT capabilities, allowing remote monitoring and control through a mobile application.

The system incorporates motor drivers and sensors for obstacle detection and path planning, ensuring smooth and efficient movement. The delivery compartment is secured to prevent unauthorized access, enhancing security. The compact design and use of cost-effective components make it a scalable solution for small businesses.

By integrating autonomous navigation, IoT-based tracking, and theft-proof delivery mechanisms, this system aims to optimize food delivery processes, reduce labor dependency, and enhance customer satisfaction in dynamic environments.

The design and development of an autonomous, theft-proof food delivery robot that leverages the capabilities of the ESP32 microcontroller for real-time control, navigation, and communication. With the rising demand for contactless and secure delivery solutions in the e-commerce sector, particularly in food delivery, this system aims to offer a reliable and efficient robotic delivery mechanism that reduces human intervention while enhancing the overall security and customer experience.

At the core of the system is the ESP32, a powerful yet cost-effective microcontroller that supports both Wi-Fi and Bluetooth communication. This allows seamless integration with cloud platforms, mobile applications, and real-time tracking systems. The robot is equipped with a GPS module to navigate autonomously through predefined routes, dynamically updating its path based on real-time location and environmental inputs. Obstacle avoidance is achieved through the integration of ultrasonic sensors that detect and respond to any physical barriers, ensuring smooth and safe traversal across varying terrains.

Overall, this system presents an innovative, scalable, and secure solution for food delivery automation in the e-commerce domain. By combining autonomous navigation, real-time tracking, and robust theft-prevention mechanisms, the proposed system addresses critical challenges in last-mile delivery and sets the foundation for future advancements in robotic logistics.

III. IMPLEMENTED DESIGN

In the modern era of rapid technological advancement and increasing demand for convenience, the e-commerce and food delivery industries are growing at an unprecedented rate. However, these services face several challenges such as delivery delays, safety of goods, and most importantly, the security of unattended packages. To address these issues, this essay presents the concept and implementation of an Autonomous Theft-Proof Food Delivery Robot a smart solution designed to ensure safe, efficient, and secure delivery of goods without human intervention.

The GPS module establishes a connection and tracks the robot's location in Realtime. Geo-fencing

techniques are implemented to define authorized areas, and any movement outside these areas triggers an alert. The live feed system captures video footage, which is processed in real-time using image processing algorithms to detect suspicious activities or potential theft incidents.

The integration of GPS (Global Positioning System) technology into robotic or autonomous systems has transformed how real-time tracking and location monitoring are handled. In the described system, a GPS module is embedded within the robot, enabling it to establish a satellite-based connection to determine its geographical location with high accuracy. This positional data is continuously updated and transmitted to a central monitoring system, allowing operators to observe the robot's movements on a map in real-time.

BLOCK DIAGRAM

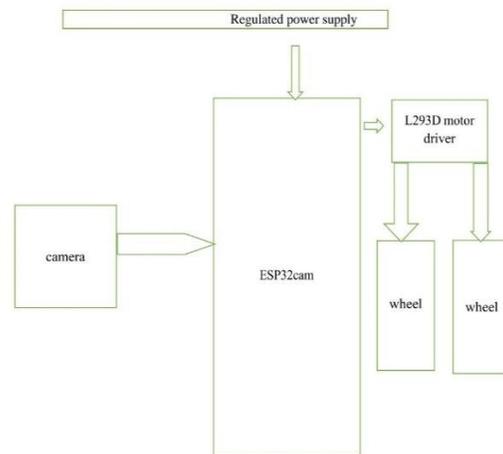


Fig1: Block Diagram

A critical component of this system is geo-fencing, a virtual boundary defined by GPS coordinates that demarcates the authorized operational area for the robot. Geo-fencing involves the pre-configuration of specific geographical zones where the robot is permitted to operate. These zones are programmed into the robot's onboard software or cloud-based control system. Once active, the robot continuously compares its current GPS coordinates with the geo-fence boundaries.

If the robot crosses these boundaries—intentionally or due to error—it triggers an immediate alert. This alert can be sent to security personnel or system

administrators via SMS, email, or mobile app notifications. This feature is particularly important for applications such as surveillance, patrolling, and securing restricted zones, where unauthorized movement could indicate theft, malfunction, or tampering.

WORKING PRINCIPLE

1. Autonomous Navigation – The robot uses sensors and an ESP32 camera module to detect obstacles and navigate predefined indoor paths efficiently.
2. Real-Time Monitoring – The ESP32 camera streams live video, allowing users to track the robot’s movement via a mobile application.
3. IoT-Based Control – Users can remotely control and monitor deliveries using an IoT-enabled mobile app for enhanced operational efficiency.
4. Secure Delivery Mechanism – A theft-proof compartment ensures food safety, opening only upon authorized verification at the destination.
5. Power Management – The system operates on a rechargeable battery, optimizing energy consumption for prolonged autonomous operation.

SOFTWARE TOOL:

Arduino IDE Software. You can get different versions of Arduino IDE from the Download page on the Arduino Official website. You must select your software, which is compatible with your operating system (Windows, IOS, or Linux). After your file download is complete, unzip the file.



Fig2: Arduino Zip

Open your first project. Once the software starts, you have two options:

- Create a new project.
- Open an existing project example.

To create a new project, select File --> New

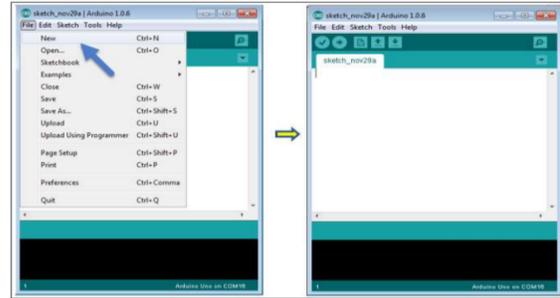


Fig3: Create a new project.

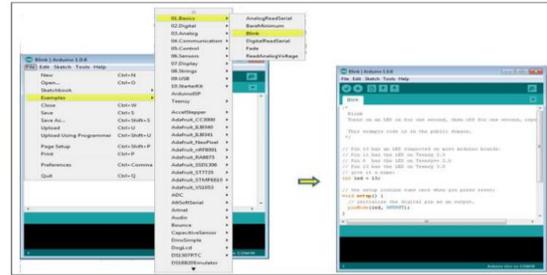


Fig4: Open an existing project example

Before explaining how we can upload our program to the board, we must demonstrate the function of each symbol appearing in the Arduino IDE toolbar.

- A. Used to check if there is any compilation error.
- B. Used to upload a program to the Arduino board.
- C. Shortcut used to create a new sketch.
- D. Used to directly open one of the example sketches.
- E. Used to save your sketch.

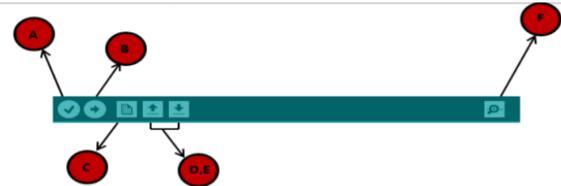


Fig5: Arduino IDE toolbar

IV. RESULTS

The autonomous theft-proof food delivery robot presented in this project offers an efficient, cost-effective, and secure solution for e-commerce applications. By leveraging the ESP32 camera module for vision and IoT integration for real-time monitoring, the system enhances food delivery operations in controlled indoor environments like restaurants, cafes, and offices. Its autonomous navigation reduces human labor while ensuring timely and accurate deliveries. The theft-proof compartment safeguards deliveries, increasing reliability and customer trust. The compact

design and use of affordable components make the system scalable for small businesses, reducing dependency on traditional delivery methods. With advancements in IoT and automation, this robot has the potential to revolutionize last-mile delivery, improving operational efficiency and customer satisfaction. Future enhancements could include AI-based navigation, multi-floor delivery support, and integration with existing e-commerce platforms.

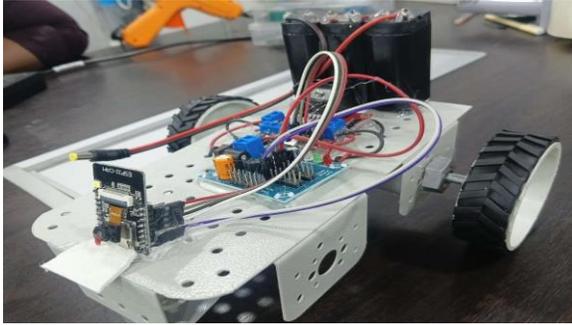


Fig6: Output Design
REFERENCES

[1] "Donkey Car", Docs.donkeycar.com, 2016. [Online]. Available: <https://docs.donkeycar.com/>.

[2] A. Courses et al., "OpenCV", Opencv.org, 2020. [Online]. Available: <https://opencv.org/>.

[3] "TensorFlow", TensorFlow, 2020. [Online]. Available: <https://www.tensorflow.org/>.

[4] A. Satan, "Bluetooth-based indoor navigation mobile system," 2018 19th International Carpathian Control Conference (ICCC), Szilvasvarad, 2018, pp. 332-337.

[5] M. Zaafer Barahim, M. Razvi Doomun and N. Joomun, "Low-Cost Bluetooth Mobile Positioning for Location-based Application," 2007 3rd IEEE/IFIP International Conference in Central Asia on Internet, Tashkent, 2007.

[6] Kim YJ, inventor; Samsung Electronics Co Ltd, assignee. I2C communication system and method enabling bidirectional communications. United States patent application US 11/028,319. 2005 Jul 28.

[7] P. Liang, Y. L. Chang and S. Hackwood, "Adaptive self-calibration of vision-based robot systems," in IEEE Transactions on Systems, Man, and Cybernetics, vol. 19, no. 4, pp. 811-824, July-Aug. 1989.

[8] Jain, Aditya Kumar. "Working model of Self-driving car using Convolutional Neural Network,

Raspberry Pi and Arduino." 2018 Second International Conference on Electronics, Communication and Aerospace Technology (ICECA). IEEE, 2018.

[9] Géron, Aurélien. "Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems." O'Reilly Media, 2019.

[10] M. Currey, "Arduino with HC-05 Bluetooth Module in Slave Mode | Martyn Currey", Martyncurrey.com, 2020. [Online]. Available: <http://www.martyncurrey.com/arduino-with-hc-05-bluetooth-module-in-slave-mode/>. [Accessed: 24-Oct-2020].

[11] Kaspar Sakmann, "Behavioral Cloning — make a car drive like yourself", Medium, 2016. Available at: <https://medium.com/@ksakmann/behavioral-cloning-make-a-car-drive-like-yourself-dc6021152713>.

[12] YongChai Tan, Bent Fei Lew, KhimLeng Tan, KaeVin Goh, KienLoong Lee, and ZhiChao Khor, "A new Automated Food Delivery System using autonomous track guided center-wheel drive robot," 2010 IEEE Conference on Sustainable Utilization and Development in Engineering and Technology, Petaling Jaya, 2010, pp. 32-36.

[13] M. Kocsis, J. Buyer, N. Submann, R. Zollner, and G. Mogan, "Autonomous Grocery Delivery Service in Urban Areas," 2017 IEEE 19th International Conference on High Performance Computing and Communications; IEEE 15th International Conference on Smart City; IEEE 3rd International Conference on Data Science and Systems (HPCC/Smart City/DSS), Bangkok, 2017, pp. 186-191.

[14] A. Buchberger, K. Lassnig, S. Loggie, C. Mühlbacher, and G. Steinbauer, "An Autonomous Vehicle for Parcel Delivery in Urban Areas," 2018 21st International Conference on Intelligent Transportation Systems (ITSC), Maui, HI, 2018, pp. 2961-2967.

[15] S. Senthilkumar, R. Nithya, P. Vaishali, R. Valli, G. Vanitha, L. Ramachandran, "AUTONOMOUS NAVIGATION ROBOT," International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 02 | Feb pp: 2395-0072, 2017.