International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 06 | June - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

"Automatic Human Following Trolley using Raspberry pi"

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Abstract -

This paper represents the human following trolley using a raspberry pi. Our project focuses on developing an intelligent trolley that possesses the ability to autonomously navigate and evade obstacles, while also establishing interaction and communication with a designated individual. The primary objective is to design and construct a robot that not only tracks the target person but also advances towards them, taking care to avoid any obstacles encountered during the tracking process. To streamline this operation, we have incorporated a unique tag system, which is affixed to the person to be followed by the trolley. A compact Raspberry Pi camera continuously captures images of the distinct tag, comparing them to the original reference image. Upon successful matching, the trolley proceeds further, while simultaneously utilizing ultrasonic sensors to circumvent any obstacles in its path. The tag serves as a crucial element in ensuring uniqueness and simplifying the overall task. The mechanical structure of the trolley has been thoughtfully designed, and electrical components are employed to enable its functionality. All computational processing is carried out using a Raspberry Pi platform.

Key Words: Raspberry Pi, Ultrasonic Sensor, Pi Camera, Motor, Motor driver.

1. INTRODUCTION

In modern metropolitan areas, individuals often encounter challenges when navigating supermarkets and purchasing items using trolleys. It can be cumbersome to manually push a trolley to different sections of the store to retrieve the desired products. Now, envision a solution where a trolley autonomously follows you as you move through malls and grocery stores, carrying the items you intend to purchase. This project aims to create an autonomous trolley that utilizes image processing to track and follow a specific individual.

The primary objective of this follower robot is to track and follow a designated person. This is accomplished through the integration of an ultrasonic sensor and a Raspberry Pi camera, which work in tandem to detect the person's presence and initiate the following mechanism. The Raspberry Pi analyzes the captured images and processes the necessary control actions to direct the trolley accordingly. Moreover, the system is designed to avoid obstacles encountered along the way, ensuring smooth and safe navigation.

By implementing this autonomous trolley, we aim to simplify the shopping experience for individuals, offering convenience and assistance in maneuvering through stores. The project's success lies in the efficient coordination between the ultrasonic sensor, image processing capabilities, and Raspberry Pi control, enabling the trolley to faithfully trail the designated person while effectively maneuvering through the environment.

2. LITERATURE SURVEY

In [1] this project focuses on controlling a robot using an Android app. The app sends commands to the robot, allowing it to move in different directions. The Raspberry Pi receives these signals and performs the necessary control actions.

[2] in this project, a robotic arm is controlled using an Android application. The arm mimics the movements of a human hand. The Android app communicates with the Raspberry Pi, reducing delays and server issues by utilizing Wi-Fi.

In [3] this project involves implementing a wireless robot using integrated circuits, parallel ports, Atmega 168 Microcontroller, Arduino, X-bee, and Zigbee technologies. The robot operates autonomously without the need for wired connections.

In [4] a robotic cart is developed to track and follow a specific target in an unstructured environment. The system utilizes a microcontroller and ultrasonic sensor to identify and pursue the targeted person.

In [5] a robot automatically follows a person by using a unique tag placed on the individual. The robot continuously captures images of the tag and tracks the person based on the matching.

In [6] this project involves a trolley that follows a person while carrying goods. Additionally, a barcode reader is integrated into the trolley to streamline the billing process.

In [7] an intelligent space is developed, focusing on human-centered robotic systems. Multiple Distributed Indoor Navigation Devices (DINDs) are installed throughout a wide area to measure the positions of targeted objects within the iSpace.

3. COMPONENT USED

I. Raspberry Pi Zero

The Raspberry Pi Zero is a small-sized, single-board computer that is part of the Raspberry Pi family. It is designed for projects that require a compact and low-cost computing solution. The Raspberry Pi Zero shares many features with its larger counterparts but comes in a more minimalistic form factor. It is powered by a Broadcom BCM2835 system-on-a-chip (SoC) with a 1GHz ARM11 core. Although it is not as powerful as the newer Raspberry Pi models, it can still handle a wide range of tasks. The Raspberry Pi Zero typically has 512MB of RAM, providing enough memory for most lightweight computing applications.

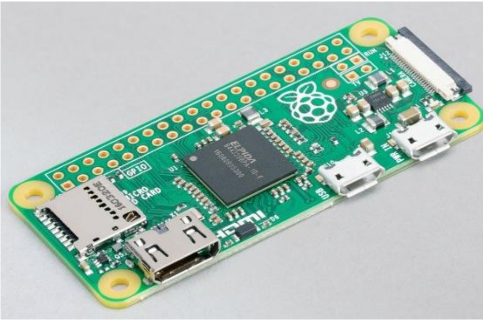


Fig.1: R-pi zero

II. Pi Camera Module

The Pi Camera, also known as the Raspberry Pi Camera Module, is a camera accessory specifically designed for Raspberry Pi boards. It allows users to capture photos and videos directly with their Raspberry Pi, making it a versatile tool for a wide range of projects. The Pi Camera can be controlled programmatically using Python or other supported programming languages. This allows users to adjust camera settings, capture images, record videos, and perform image processing tasks. The Pi Camera offers high-quality imaging capabilities, capable of capturing still photos with a resolution of up to 12 megapixels. It can also record videos in various resolutions, including Full HD (1080p) and HD (720p).

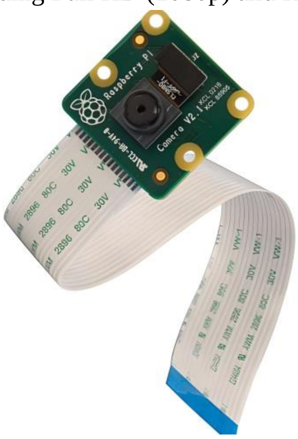


Fig.2: Pi Camera Module

III. Ultrasonic sensor

An ultrasonic sensor is a device that uses sound waves at ultrasonic frequencies to detect the presence and distance of objects. It emits high-frequency sound waves and measures the time it takes for the sound waves to bounce back after hitting an object. This information is then used to determine the distance to the object. Ultrasonic sensors operate on a non-contact principle, meaning they do not need physical contact with the object they are detecting. This makes them suitable for applications where contact is not desirable or possible.

Fig.3: Ultrasonic sensor

IV. DC motor

A DC (Direct Current) motor is an electrical device that converts electrical energy into mechanical motion. It operates on the principle of electromagnetic induction, utilizing the interaction between a magnetic field and electric current to generate rotational motion. It operates on 12v dc supply.

Fig.4: Motor

V. Motor driver

The L298 is a popular motor driver IC (Integrated Circuit) commonly used to control DC motors or stepper motors in robotics and automation projects. It allows for the control of motor speed and direction using digital signals from microcontrollers or other control circuits. The motor driver utilizes an H-bridge configuration, which consists of four high-current Darlington transistor pairs. The L298 has separate control input pins for each motor, allowing control signals to determine the motor's direction (forward or reverse) and enable/disable the motor output. It also features separate power supply pins for the motor and control logic. he L298 is capable of driving motors with a peak current of up to 600mA per channel (or 1.2A when combined). However, the actual current handling capability may depend on factors such as the IC's temperature and the presence of heat sinks.

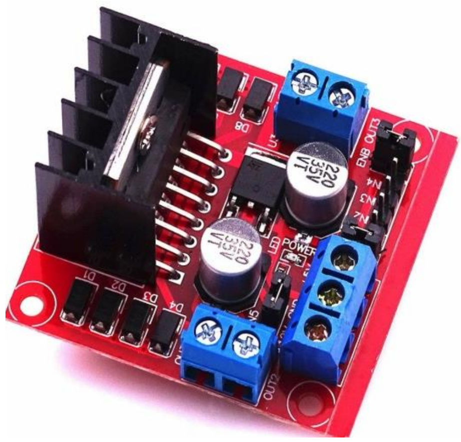


Fig.5: Motor driver

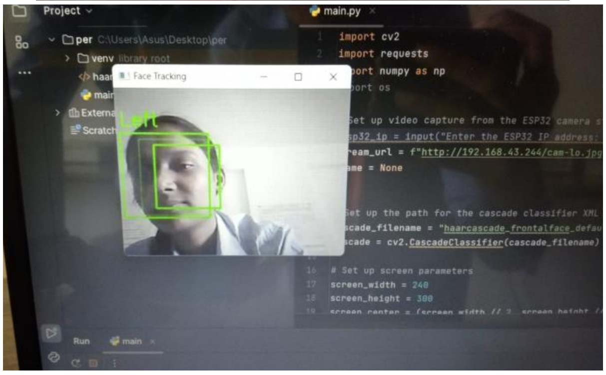
4. RESULTS AND DISCUSSION

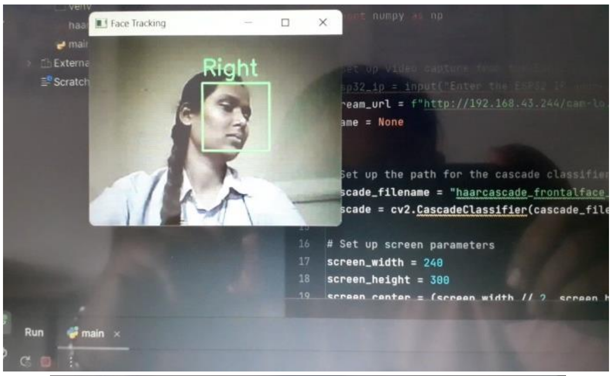
Our work aimed to develop an automated trolley that follows the using human image and video processing technique. A camera is mounted in front of the trolley, which continuously captures the user's image or any other things present in-front of it. The trolley is programmed to follow the user who is having a valid human face, by recognizing it. If the user moves forward, left, right, backward, and stop the trolley will do the same by maintaining a constant distance from the user.

Compared to existing solutions, which we're using different sensors like a kinetic sensor, motion sensor and ultrasonic sensor for following the human, our project has a single camera that is programmed to perform all the operations performed by those sensors, using the image and video processing. This makes our project more efficient in space allotment, consumption of power. Our project is comparatively low cost those existing hardware solutions. The basic model of the trolley was designed which consists of:

- Pi-camera, which is fixed in front of the trolley. • Carrier, which can fit around 500-580cc of volume into it, is placed at the backward position of the trolley.
- DC motor with wheels with one caster wheel is used for the movement and DC motors are used to rotate these wheels.
- Raspberry-pi zero is used as a microcontroller.

Here are some pictures of result. In below images shows forward, right, left photos.





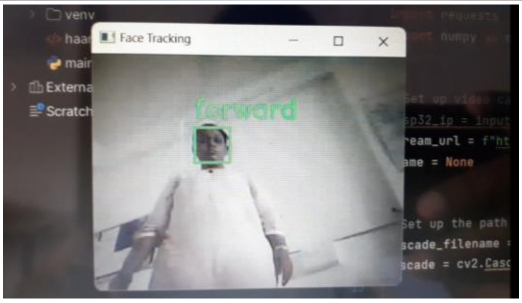


Fig.6: Model photos

When the user with face comes in-front of the trolley, the face image is captured by the camera and the sticker's HSV value is determined. The first window of the input image captured by the camera. Second window shows the HSV converted image of the input. If the input image's HSV value is equal to the HSV value of the face, then it is considered foreground, and the unmatched rest region of the input image is considered to be the background. The background will be subtracted, and the third window shows the image of the detected part. Only the foreground is masked as shown in the fourth window of

5. WORKING METHODOLOGY

Trolley consists of a robotic vehicle having two wheels and one freewheel mounted along with different sensors and modules, i.e. ultrasonic sensor and camera. The camera is vertically adjusted and is initially mounted at the

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height of 4ft from the ground to enhance the visual capability and effectiveness. The user controls the trolley as it follows a particular person by a unique identification tag.

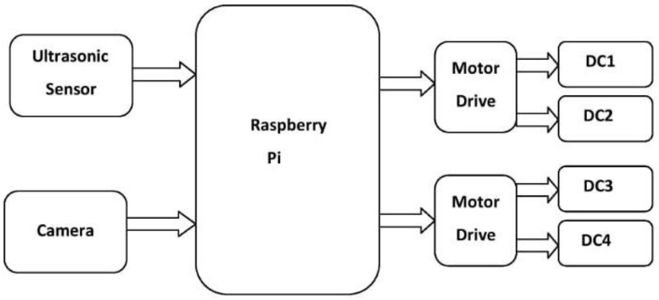

Fig.7: Block diagram

3. CONCLUSIONS

The Automatic Human Following Trolley using Raspberry Pi project aims to design and fabricate a robot that can autonomously track and follow a specific person in a crowded environment such as supermarkets or malls. The trolley utilizes image processing techniques through a small Pi camera to continuously capture and compare images of a unique tag placed on the person. By detecting and matching the tag, the trolley is able to track and move towards the person while avoiding obstacles using ultrasonic sensors. The use of Raspberry Pi as the central processing unit allows for efficient control and decision-making in real-time. The integration of an Android app provides convenient and intuitive control of the trolley's movement through commands such as forward, backward, left, and right.

This project addresses the common problem faced by individuals in supermarkets, where they have to manually push a trolley to navigate through the store. By automating the trolley to follow the user, it enhances convenience and eliminates the need for constant physical exertion.

Further, it can be used in agricultural fields, war fields, etc., Where there is an uneven surface, by keeping this programming part for detection and recognition constant and adding some more efficient mechanisms as per the demand of the environment that is, using big and rough wheels, good power source, etc.

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