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Pattern Recognition on Automated Guided Vehicles Two Wheel Drive (AGV 2WD) Robot for Location Detection Based on Raspberry Pi 4 Model B

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Abstract: AGV (Automated Guided Vehicle) equipped with artificial intelligence (AI) is anticipated to boost Indonesia's industrial development. The little computer used to generate this robot's artificial intelligence used mechanical gears similar to those found in an eight-wheeled, two-wheel-drive car. This article outlines and demonstrates the usage of an AGV-controlled approach to determine a place inside a building by detecting text in different locations throughout the building. The current technique employs the programming languages Python and OpenCV. Optical Character Recognition (OCR) has been tweaked or enhanced for usage with OpenCV. Multiple texts are read using OCR as the principal technique. In this instance, OCR functions at many stages of the process, in addition to being employed for exploring letters and words, word translation, character classification, linguistic analysis, and adaptive character classification. The output text from the system's document processing procedure will likely contain the location or even the position of an AGV robot once the process has concluded. This text is produced from the text that was previously submitted using the camera function. After a thorough search, the AGV robot will go to the next area before returning to its starting point. The method above can be implemented on the AGV lab's hardware, which has a solid basis.

Keywords: robot; AGV; movement system; computer vision; raspberry pi insert; artificial intelligence.

INTRODUCTION

In this world, industrialization is expanding at a rapid pace. Vechet, S, Krejsa. J, and Chen. K. S. (2020) describe how AI and ML are being applied to robots in Indonesia to automate factories. Automatic Guided Vehicles (AGVs), or vehicles with automatic control, are one type of robot that has seen extensive development in Indonesia, particularly those that are focused on industry Zhang. J & Liu-Henke. X (2020). Artificially intelligent robots on these AGVs allow them to follow predetermined paths through factory floors. Numerous vehicles today employ laser or LIDAR sensors, which use reflected light reflections to detect locations and guide drivers in the desired direction. The authors are Zhou. X, Chen. T, Zhang.T (2019). When compared to other manual transportation tools like forklifts, this AGV is both more productive and more durable. These AGVs can offer high levels of accuracy with a simple operating mode that helps keep costs down. These AGVs are built to the industry's standards for dependability. Li, Y., and Zhang, Y. (2020)

Path Guidance is a common mode of operation for the different kinds of AGVs in the business, and it involves a relatively straightforward system of navigation. This directional map was made to help you tweak the form of your final destination so that it precisely targets your starting position. The AGV robot's mechanism includes a DC motor for the rear wheels because of the simplicity with which DC motors can be controlled, and a motorized servo for the steering mechanism. By Afsari. K and Saadeh. M (2020). This AGV study utilizes the Raspberry PI 4 type B minicomputer. It is possible to use this Raspberry used as a microcontroller thanks to its 40 extra general-purpose input/output pins.

The AGV is propelled by a combination of a DC motor acting as the rear-wheel drive and a servo motor functioning as the steering wheel, giving the robot AGV a high degree of maneuverability. In this application, a

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DC motor is used due to the ease with which its control mode can be implemented in software. To adjust the angle of rotation, servo motor controllers. Su. Y. M, Peng. H. W, Huang. K. W, and Yang. C. S. (2019).

The Raspberry Pi's clock is much larger than those of competing microcontrollers, and its RAM is significantly more advanced than that of most other microcontrollers; in short, it has features more commonly associated with computers B. Setiawan, O. J. Aldo Wijaya, L. H. Pratomo, and S. Riyadi (2021). Computers the size of a microwave running the Python programming language and the OpenCV library are used in the development of this AGV robot; the library makes use of OCR, or optical character recognition, developed by Draganjac.I & Bogdan. S (2016). In order to convert analog images captured by a camera into digital data, a minicomputer uses optical character recognition (OCR) software, which is essentially a library.

Pattern Recognition on Robot AGV 2WD for Raspberry PI 4 Model B-Based Location Detection is the subject of this literature review.

LITERATURE REVIEW

Computer Vision

Computer Vision To process information in the form of images or videos captured by the camera, computer vision is a branch of artificial intelligence research. This computer vision can process data following a given command or algorithm. The Quick Response (QR) code is just one example. Human detection, thermal imaging, and other methods can also be used. Here, image processing is used to identify shifts in a physical object. Clearer information, higher-quality images, and the ability to analyze data benefit this type of computer vision Zhang, J *et al.* (2020).

OpenCV

OpenCV, where open denotes open source and CV denotes computer vision, is a library for such tasks. OpenCV is flexible and can be used in many image and video processing projects.

Python Programming Language

Python, being a high-level language, is used to create complex applications. Python is the most widely used programming language. Python's versatility means it can be put to use in a wide variety of contexts, including but not limited to: website development, machine learning, autonomous vehicles, software testing, data processing, data analysis, visualization, computing, image processing, WEB development, artificial intelligence, and so forth. Python is utilized in this study because it is accessible to many programmers and offers a wealth of valuable libraries that simplify writing programs for the AGV robot. Python is used on a Raspberry Pi 4 to run camera software and a motor/servo driver.

Compared to other microcontrollers like the Arduino series or other microcontrollers, Raspberry Pi's performance is much better than it was chosen as the central brain of this AGV. *Raspberry Pi* is a tiny, Python-programmable computer that can do amazing things. The internal I/O is the same as that of other microcontrollers. The most recent model of these inexpensive computers is the Raspberry Pi 4 Model B. The Raspberry Pi performs well in the realm of image and video processing. Compared to the Raspberry Pi 3, the Raspberry Pi 4 Model B features improved connection, memory capacity, and processing performance. Specifically, a 1.5 GHz Quadcore 64-bit ARM Cortex-A72 is utilized. Memory options for the Raspberry Pi 4 Model B are 1GB, 2GB, and 4GB of SDRAM LPDDR4. Raspberry Pi4 Model B Module, as seen in Figure 1

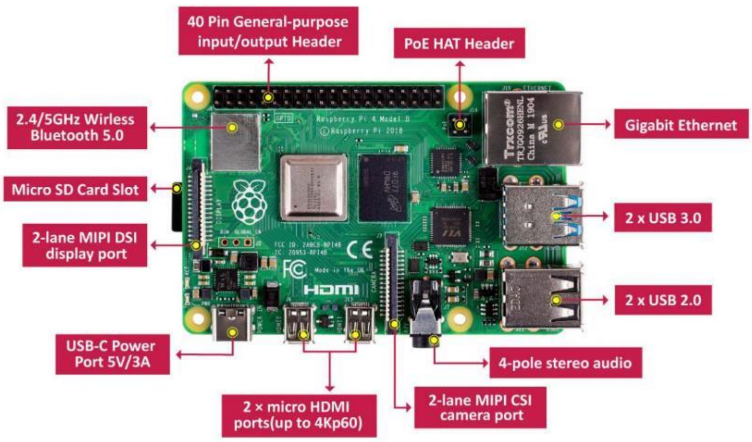

Fig. 1 Input Output Raspberry Pi4 Model B

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AGV (Automated Guided Vehicle)

Automatic guided vehicle. Advantages of AGVs include their extended running duration, high degree of precision, little need for maintenance, and independence from human control. Some AGVs are line-following vehicles that use sensors to go along predetermined routes, how the AGV's position will swap locations as a result of following a predetermined route. Lines are set up along magnetic routes, colored pathways, and lasers to serve as path guiding. Easy AGVs rely on route-guiding systems for mobility Ahmad.I, Moon.I, and Shin.S. J (2018). With computer vision, AGV motion may be controlled mechanically, beginning with scanning images and continuing through the movement of the vehicle itself. This AGV employs a DC motor for propulsion and a Servo motor for steering. The accuracy of the AGV movement system will be evaluated by comparing it to a trajectory pattern, which will be the subject of this study. This AGV is used in the industrial sector to transport things along predetermined paths or trajectories.

METHOD

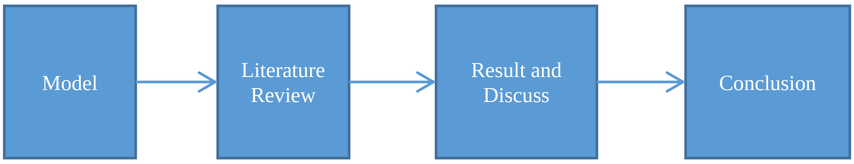

Fig. 2 Research Method

The flow of research conducted by Figure 2: A representation of the authors. Studies in literature are conducted on the basis of these images, results, discussions, and conclusions.

Model AGV Robot

The Raspberry Pi 4b, Raspberry Camera, Circuit Voltage Divider, DC into DC Converter, DC Motor, Servo Motor, 11.1 V Li-Po Battery, and Servo Motor are all needed to implement the robot AGV model where electronic components are arranged on the board. An AGV is a self-driving robot that can transport its passengers from one location to another. AGVs serve as robotic cargo carriers with a navigation system that allows them to move in a predetermined direction, either by following guides or lines on the floor or by using laser reflections. Setiawan. B. S, Kurnianingsih .F. A, Riyadi. S, & Pratomo. L. H. (2021)

Pattern Recognition Block Diagram

Figure 2 shows a system text recognition block diagram. This flowchart depicts the steps taken while processing text in order to determine where the AGV should go. The tool incorporates a camera sensor powered by a Raspberry Pi, making it capable of streaming video and translating it into text. This mini-computer, also known as a raspberry pi, is powered by a battery that has been converted using a scaled-down helicopter. When the pre-programmed raspberry processes the video stream, the camera reads the text. This automated guided vehicle (AGV) will read this text at the specified location, then transmit its position to a nearby raspberry pi expressed as (x,y) co-ordinates, which would trigger the motor to move to the specified location Zhong. Z, Sun. L, & Huo. Q (2017). In this study, the application was the VNC Viewer installed on a laptop which functions as a replacement for the monitor screen in the process or access raspberry Pi model 4 B. And the program uses Python language with libraries or libraries from OpenCV.

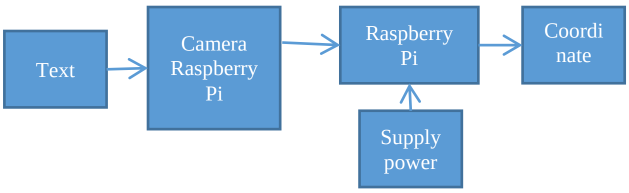

Fig. 3 System Text Recognition Block Diagram

A. Flow Chart Program

Below will be described the algorithmic arrangement of the programs used. The algorithm is in the form of a flowchart shown in Figure 3.

RESULT

A. Research Tools

In this study, a prototype tool can be produced that follows the predetermined design. To see the entire prototype of the tool shown in Figure 4. shows the components of the Raspberry Pi Model 4 B, the Raspberry Pi

Camera components, the components of the Lipo Battery, shows the L298N dual half-bridge motor driver component. Figure 4(E) shows the components of the voltage divider module.

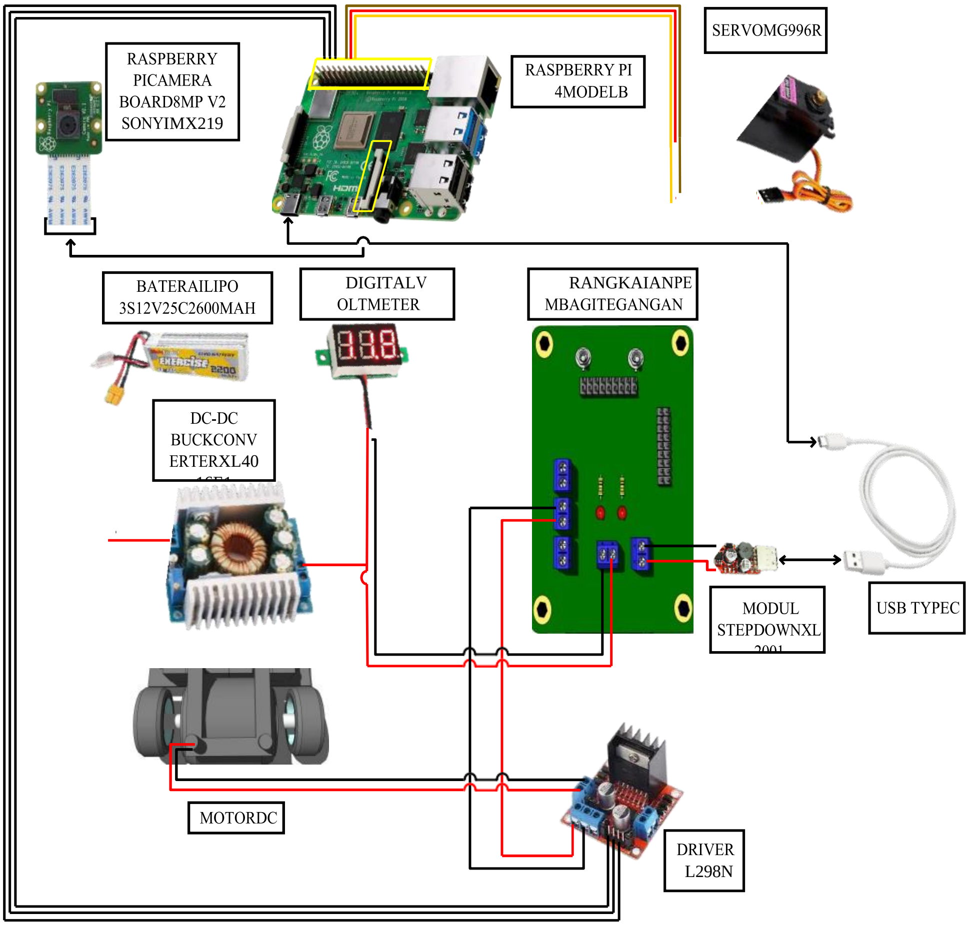

Fig 4. Wiring Diagram

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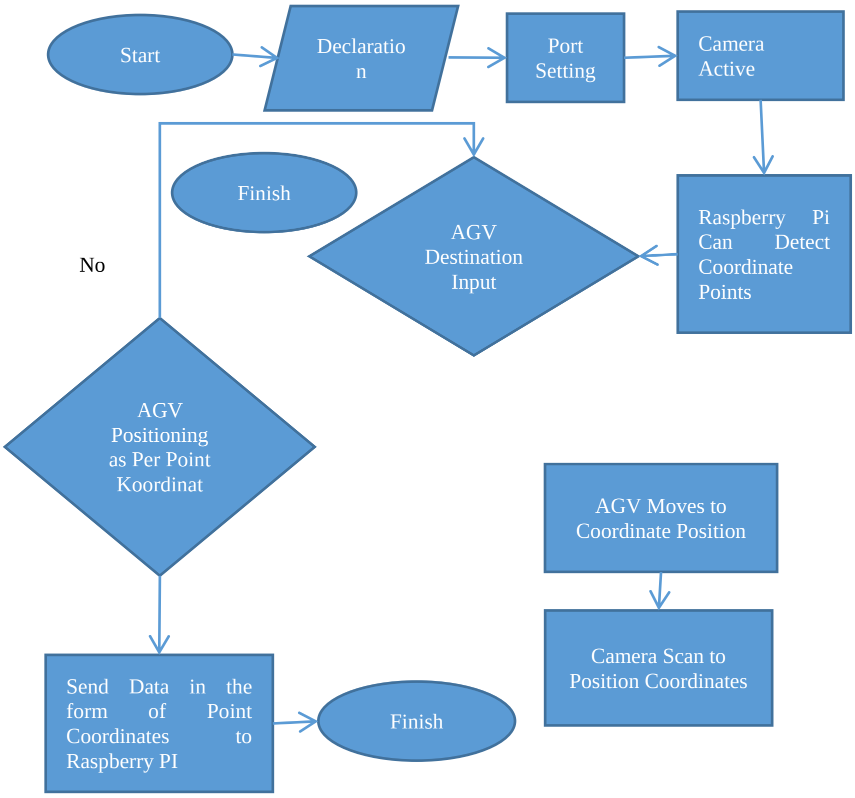

Fig. 5. Flowchart Program

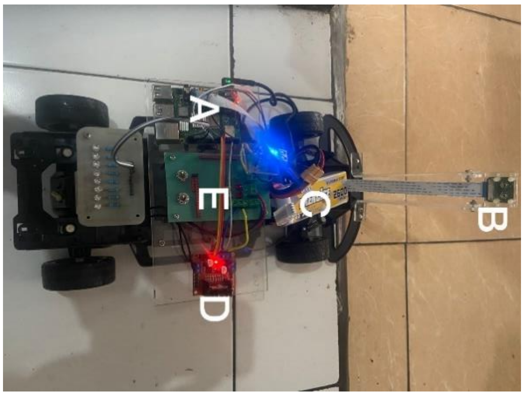

Fig. 6. Prototype Research Tools

The Raspberry Pi, also known as Raspi, is a credit-card-sized single-board computer (SBC) that can be used to run office software, video games, and high-definition media. The Raspberry Pi Foundation, a non-profit group founded by a group of developers and IT specialists affiliated with the University of Cambridge in England, is responsible for the creation of the Raspberry Pi.

There is now a new version of the Raspberry Pi available, and it has some very cool new features. Raspberry Pi 4 Model B, as it is officially known, is a newer model that boasts improved processing power. Two USB 3.0 ports, two USB 2.0 ports, a USB-C power port, and Bluetooth 5.0 are just some of the features of the Raspberry Pi 4 Model B. Additionally, an HDMI port is absent from the Raspberry Pi 4 Model B. It has two micro-HDMI ports instead. The Cortex-A72 architecture, quad-core 64-bit ARMv8 1.5 GHz, has made embedded SoCs more speedy recently.

A standard AGV robot's functioning involves the following five components:

1. Inertial guidance system This part of the AGV robot is in charge of receiving data and figuring out how to use it to move along a set path. Lasers, wires, and magnets are just a few of the many methods used for navigation..
2. System of protection Each AGV robot is equipped with function-specific safety components to ensure that all movements are carried out safely. A laser scanner that halts the vehicle when it detects an obstacle is an example of a security system.

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3. Power system. Batteries provide the energy required for movement to autonomously guided vehicle robots. Each AGV robot model will have its own set of batteries and charging protocol based on the specifics of the warehouse or factory.
4. System for motion The AGV robot incorporates a number of each AGV robot model will have its own set of batteries and charging protocol based on the specifics of the warehouse or factory.
5. Controls for motor vehicles The AGV robot's autonomous movement is made possible by a programmable logic controller (PLC) that verbalizes data sent from the software..

DISCUSSION

AGV Robot Transfer Results with Computer Vision

The trajectory pattern utilized by this AGV is depicted in Figure. This AGV robot is tested indoors with very bright lighting. AGVs use the words "pointA," "pointB," "pointC," "pointD," and "point P" as destination points when capturing images on paper using HVS. While the initial pattern beginning with the letter "P" is used as the parking position or the beginning of the AGV, it is also used as the parking position point (see figure 7)

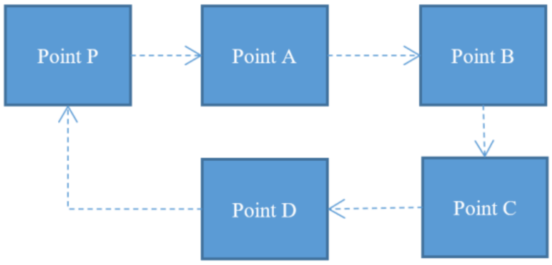

Fig. 7. AGV Robot Inspection Pattern

After the AGV robot gets the command to move position towards the specified coordinates (x,y), the AGV robot will move optimally and precisely. With a path coordinated with a size of 40 cm2 /square. In this work, position transfer is carried out directly or directly. Using the MG996R servo as its drive allows an AGV robot to rotate or maneuver from the initial position to the specified position.

Program Robot AGV

In the def Pola_A() function in this program, it is used to set which direction of the road the AGV robot uses to go to a coordinate point when detecting from the "P" pattern or start with the def command Pola_A(). This means the position of the AGV robot is heading to the "A" pattern.

Fig. 8 AGV Robot Program

In the def Pola_B() function and this program function, because the coordinate point of the "A" static definition to the "B" point coordinate is so broad and long that the def Pola_B() program can look more than the def Pola_A() with the maneuvering of the AGV robot from the Servo motor itself which is set through the above program with the initial movement of the maneuver to the left so that the position of the AGV robot is precisely at the coordinates of the definition of the destination point of the "B" Pattern.

Test Results

The accuracy of this OCR system is influenced by and depends largely on the quality of the preprocessing and segmentation phases, making them the most important phases of the preprocessing pipeline. In this case, we need to adjust the preprocessing and segmentation phases so that OCR reading could be performed at a comfortable distance, cutting down on reading errors by as much as 95%. The AGV's tracks, as depicted in Figure 5, will be displayed in the program's enhanced OCR mode. Inside, under bright lights, this AGV robot is

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put through its paces. Paper-based HVS serve as destination points for autonomous ground vehicles (AGVs) through the use of the words "pointA," "pointB," "pointC," "pointD," and "point P." While the AGV's starting point or parking location is identified by the initial pattern beginning with the letter "P."

Text reads from OEM and PSM pages with built-in OCR segmentation mode will be compared with modified OCR in an effort to reduce reading errors. Here, we use OEM-3 and PSM-7 settings designed to read a single text—"point A" and "point B"—to compare OCR's performance.

Section (a) text position of Figure 9 is read at a distance, resulting in ill-defined words, whereas section (b) shows the text read at a closely distance. This improved OCR can correctly read text from a distance of approximately 1–2 meters, and it produces words that match the reading we got when the picture was taken at a very close distance. This enhanced OCR can reduce typos in read documents by as much as 95%. Not all spoken words will be displayed on the camera's output screen if they don't match the text.

Fig. 9 Detecting Point A with Default OCR

Part (a) as can be seen in Figure 10, the default OCR setting for text detection does not accurately reproduce the words seen through the camera. Since reading errors are induced when the text detection distance is sufficiently large, the text in clause (a) is misread. As shown in subsection (c), with an enhanced OCR, a good reading can be obtained from a distance of up to about 1 meter. Because "pointB" does not match the text before it, the program produces a "-" in the output (see Figure 10). If an error is made while the AGV is trying to detect a location by reading text, it will try again until it succeeds. The modified or improved OCR will then be used to present the preface..

Fig. 10. Comparison Between Default OCR And Enhanced OCR When Detecting Point B

Figure 11 shows how the "PointC" and "PointD" text is read and processed by the AGV robotic camera. Its screen will then show the resulting image.

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Fig. 11. Detecting Points C and D with Enhanced OCR

Invariant and Zernike Moments

Moment invariant can be used as a pattern or object recognition extraction method. In this technique, ordinary moments (p+q) are represented digitally as a discrete two-dimensional function, f(x, y). The formula for the moment of invariance is used in this paper (1)

$$M_{pq} = \Sigma x\, (x-\dot{x})^{p}\, (y-\dot{y})^{q}\, f(x, y) \quad (1)$$

Formula (1), $\dot{x} = \Sigma\, x_x$, $\dot{y} = \Sigma_y y$ represent its center of mass or gravity. To accomplish translation invariance, it is presumed that the object's mass center lies at the origin of the initial digital image f(x, y). For clearly defined digital images, Zernike moments (m, n) are used in a fashion similar to that of regular moments (formula (2) below).

$$A_{nm} = (n+1/\pi)\, \Sigma x\, \Sigma_y\, f(x, y)\, V_{nm}\, (x, y),\ x^2 + y^2 \leq 1 \quad (2)$$

From(2),V nm (x, y) = V nm (p, Θ) = R_{nm} $(p)e\ jm$ and | m| ≤ n, and n - /m| is an even number. Then Rnm (p) can be defined as in formula (3).

$$R_{nm}(\rho) = \sum_{s=0}^{\frac{n-|m|}{2}} (-1)^s \frac{(n-s)!}{s!\left(\frac{n+m}{2}-s\right)!\left(\frac{n-m}{2}-s\right)!} \rho^{n-2s} \quad (3)$$

For the real shadow function f(x, y), only the term Vnm (p, Θ) is a complex number as in (4)

$$A_{nm} = \frac{n+1}{\pi} \sum_{xi} \sum_{yj} f(xi, yi) \quad (4)$$
$$[VR_{nm}(x,y) + JVI_{nm}(x,y)]\ xi^2 + yj^2 \leq 1$$

Based on the transformation from the (p, Θ) plane to the (x, y) plane, parts of the basis function that are real and imaginary Vnm (p, Θ) are represented by the fundamental functions VR and VI, respectively. As can be seen in Figure 11, the OCR system consists of parts that deal with acquiring images, processing them, segmenting them, extracting and selecting features, and recognizing them. In order to capture images of text or characters, a camera hooked up to a minicomputer is used. When a picture is taken, it is recorded in grayscale, but the image that is ultimately displayed is a binary one. In order to digitize the color/grayscale images, a preprocessing module must first convert them to binary, fix the skew detection, and digitize. An additional function of this procedure is to identify the presence of noise and rectify the image accordingly. The poor quality of the camera used to record the audio may be to blame for this background commotion.

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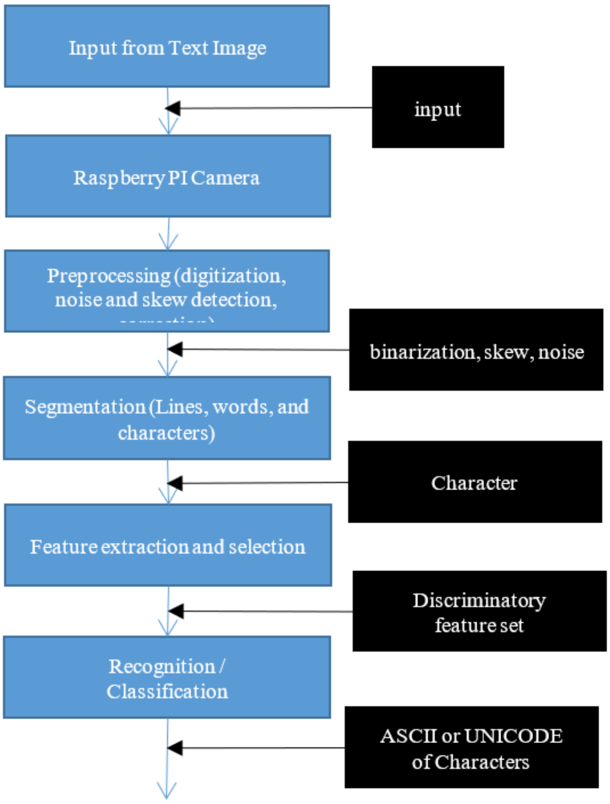

Fig. 12 Block Diagram of the OCR System

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CONCLUSION

Based on the research results from the implementation of the Raspberry Pi 4 Model B-based AGV 4WD, the following conclusions can be given:

a. AGV robots can be the right choice in the industrial field
b. AGV robots work optimally and precisely in determining the coordinate points on track
c. AGV robots have a trim physique or small dimensions so that they look compact and effective
d. By utilizing a DC motor, the torque and speed of the AGV robot are maximized.

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