

Beach Cleaning Bot Based on Region Monitoring Using Raspberry Pi

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Abstract:

This paper discusses about the development of beach cleaning bot. The paper focuses on two main aspects: conveyor belt mechanism and region monitoring system. In order to remove the waste from the sandy surface, we developed the conveyor belt mechanism. To identify the waste the bot was equipped with pi camera module this helps the bot to continuously monitor the sandy surface. Region monitoring is based on object detection (image processing) which is used to detect the waste and respond accordingly. For object detection process Tensorflow and OpenCV software are used.

Keywords: beach cleaning bot, conveyor belt mechanism, region monitoring system, pi camera

I. INTRODUCTION

The scientific survey says that beach sand is more contaminated than the water column. The bacteria present in sea shore sand due to the waste are 2 to 23 times higher than in the water. And the amount of the bacteria in the beach sand is 30 to 460 times more than in the water. Due to this natural productivity of the coastal zone gets affected and it ruins the tourism too. However most of the robots used for beach cleaning process are remote controlled and it requires a human operator. In this paper, the discussion is about the development of a non-remote controlled beach cleaning bot. This Paper was designed for the capable collection of the waste from the polluted beaches. The conveyor belt mechanism is based on the action of picking up of the waste from sandy surface. Also developed the region monitoring system,

this is used for continuous monitoring of the sandy surface for locating the waste. This allows the bot to track the waste.

II. LITERATURE SURVEY

The above mentioned problem can be overcome by this paper where an embedded system is employed. An Embedded system is a controller with a targeted function within a large mechanical or electrical, often with real time computing constraints. Here a hardware component is attached over a software component. An embedded system is a microcontroller or microprocessor. Here raspberry pi microcontroller is used. Embedded system has several components, they are

- Hardware
- Software application

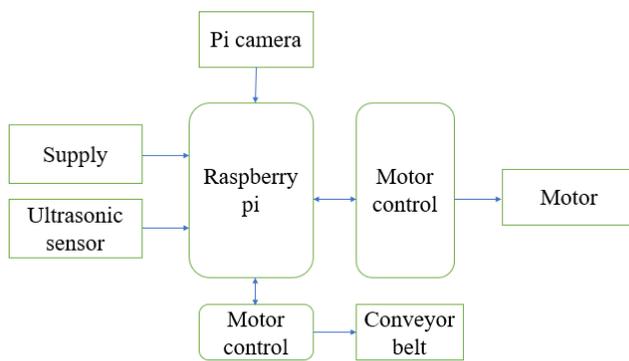


Fig.1 Block Diagram

III BLOCK DIAGRAM DESCRIPTION

Fig.1 shows the block diagram of both hardware and software requirements.

Software Requirement

The software requirements are Raspbian OS, Anaconda, Python and libraries like Tensorflow, OpenCV, LabelImg.

Raspbian OS- Raspbian is a free operating system optimized for the raspberry pi. An operating system contains a set of basic programs and utilities that enables the raspberry pi to run freely.

Anaconda- It is a free and open source for the python and programming languages for scientific computing. It also aims for simplifying the package management and deployment. The main objective of anaconda is machine learning.

Python- It is a widely used high level programming language used for web applications. Python has a design philosophy that emphasizes code readability. Python has an automatic memory management feature that props the multilevel programming.

Tensorflow- It is a free and open source software library for dataflow and differentiable programming across a wide range of tasks. The main purpose of tensorflow is for machine learning application. The application of tensor flow is automated image captioning software.

OpenCV- OpenCV is a library of programming functions mainly aims at real time computer vision. The library is a cross platform and it is free for use.

There are various applications for OpenCV they are

- Object identification(object detection)
- Motion understanding
- Gesture recognition
- Motion tracking
- Facial recognition

OpenCV also has an inbuilt statistical machine learning library.

LabelImg- It is a graphical image annotation tool. It helps to label the object by bounding boxes in the images. Finally the annotations are saved as XML files for machine learning(object detection).

Tensorflow and OpenCV software are to be installed for image processing (object detection). Along with the above mentioned software labelImg is also used. It is used for labelling the trash like tin-can, paper. After completing the labelling process, training (machine learning) process begins it may take several hours (3-5 hours based on the CPU version). The machine learning process is a essential part it ensures the pi camera for fast identification of the trash (waste).

Hardware Requirement

Fig.2 shows the beach cleaning bot. The hardware consists of raspberry pi, pi camera module, DC motor, gating circuit, gears, and conveyor belt. The dimensions of the bot are length-60cm, width-25cm and height-15cm.

Driving mechanism- The driving mechanism is comprised of two crawlers. The crawlers are made up of plastic material, which enables the bot to move smoothly in the sandy surface. The

crawlers are driven by a pair of DC geared motor (rated speed-200 rpm, operating voltage-12V, rated torque-2kg-cm). This makes the bot to run freely both in forward and in reverse direction.

Conveyor belt- The conveyor belt is installed to remove the waste from the sandy surface or any other surface. The conveyor belt is driven by a pair of DC geared motor (rated speed-200 rpm, operating voltage-12V, rated torque-2kg-cm). 7 shaped spikes are equipped in the conveyor belt and the edges of the spike are made sharp, this ensures the proper removal of waste from the sand. The 7 shaped spike collects the waste & this conveyor belt will be in rotational motion, thus the waste will be dumped in the bin that is placed in the backside of the bot.

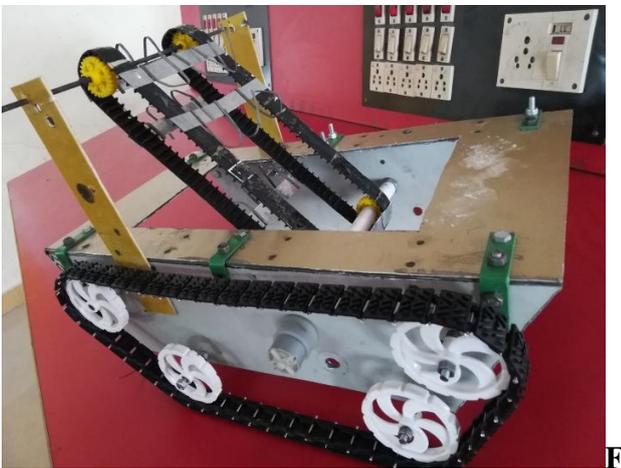


fig. 2 Beach Cleaning Bot

Gears- A gear is a rotating part having cut teeth, which is connected with another toothed part to transmit the torque. The gears are used to change the speed and torque by changing its gear ratio.

DC Motor- A DC motor is a rotating electrical machine operated on DC supply. In general, electrical motor converts the given electrical energy into mechanical energy. The speed of

DC motor is controlled by varying the supply voltage.

Motor driver - It is a little current amplifier. The most important function of the motor driver is to take a low current control signal and then convert it into a high current control signal that can drive the motor. A motor driver is an integrated circuit, which is generally used to control the motors in autonomous robots.

Pi camera module - It is generally used to take high clarity videos and also to take photographs. The camera consists of an electronic circuit board, this is connected to the serial interface port in raspberry pi camera. One of the major features of pi camera is the fixed focus lens.

Raspberry Pi- The raspberry pi is a microcontroller. It is a series of tiny single board computer. Raspberry pi consists of memory card, System On Chip (SOC), GPU, ROM, I/O peripherals, DDR RAM memory, ethernet port, USB port and HDMI on it. It can be directly connected to a computer monitor or TV & it uses a standard keyboard along with the mouse.

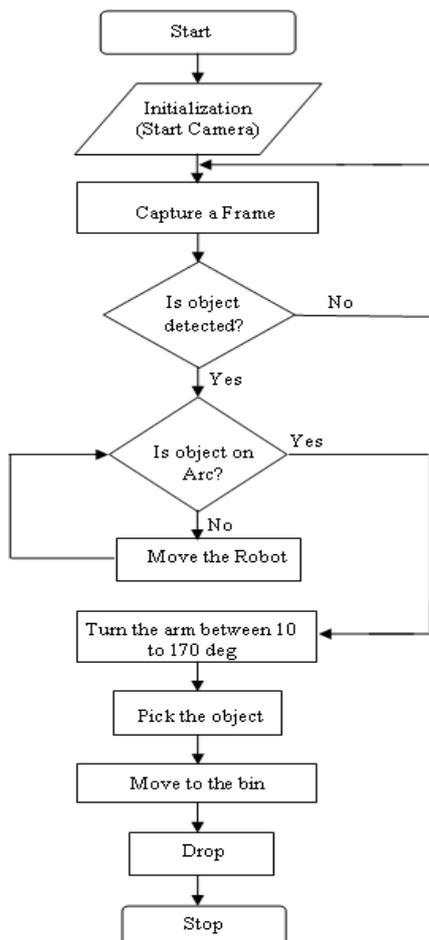
Battery – It is the device consisting of one or more electrochemical cells with external connections provided to power electrical devices. The battery used here is 12V with a rated current of 4-8A lithium ion battery which has a capacity of 4400mAh.

IV OPERATION OF BEACH CLEANING BOT

The System is mainly based on Raspberry Pi 3 Model B+ which has broadcom BCM2837 64-bit quad core processor running at 1.2GHz with 1GB RAM memory. It has BCM43143 WiFi on board with 40-pin extended GPIO Pins and CSI camera port for connecting the raspberry pi camera which is being run by a programming language Python, which is a beginner's language. Raspberry Pi can be operated as a single board computer, which can work exactly

like PC when it is interfaced with any external hardware and peripherals like monitor, keyboard etc. Raspberry Pi is the main component of the project since all the other components are controlled by Raspberry Pi like Pi Camera, Conveyor belt. The movement of the robot is controlled by the gear motor coupled to the wheels. The gear motors are operated by motor drivers which are controlled by raspberry. Since the raspberry pi can supply upto 5V, an external supply of relay with a 12V battery is given which makes the gear motor to work faster than the usual speed.

FLOWCHART



The paper mainly focuses on the capturing of the image and separating the images captured waste, which works on the principle of image processing. The image of any object is acquired by Pi camera. The original camera module is replaced by raspberry Pi

camera module v2. It attaches via a 15cm ribbon cable to the CSI port on the raspberry Pi. This camera works with all modules of raspberry Pi 1, 2 and 3. The original image which is captured by raspberry pi which is in jpeg format. Since jpeg compression technique is a lossy compression, quality of image is reduced and does not support layered images. In this project it is difficult to differentiate between the dry and wet waste in the JPEG format, so the image is converted into gray scale image, which is a range of shades of gray without apparent color. The darkest possible shade is black which is a total absence of transmitted or reflected light, the lightest possible shade is white. Gray scale (or a gray level) image is simply one in which the only colors are shades of gray. The images from any other sort of color images are differentiated to provide less information for each pixel. The grayscale intensity is saved as an 8-bit integer, giving 256 possible combinations of different gray shades from black to white. If the levels are evenly spaced, then the difference between successive gray levels is better than the gray level resolving power of the human eye. Gray scale images are mostly used because now a days most of the display and image capture hardware can only support 8-bit images. After that while processing the image, the gray level image is further converted into binary image that is a digital image which has only two possible values for each pixel. Typically, the two colors used for a binary image are black and white.

The major part of the bot is conveyor belt, which is used for trash (waste) collection. The web application connects the python with the raspberry pi. Also it is a cross platform and open source for remote desktop software application. So once the software and all the hardware parts is implemented the output of the system is initially picking of garbage and placing it to the respective bins. The conveyor belt performs the function of pick and drop bot.

The linear and rotational movement of the body is described by Degree of freedom implement degrees of movement, degrees of movement implies the number of axis the body can move. HDMI cable is the proprietary audio/video interface. It is used for transmitting uncompressed video data and compressed or uncompressed digital audio data from an HDMI-compliant source device, such as a display controller, to a compatible computer monitor, video projector, digital television, or digital audio device. HDMI is one of the digital substitute for analog video standards.

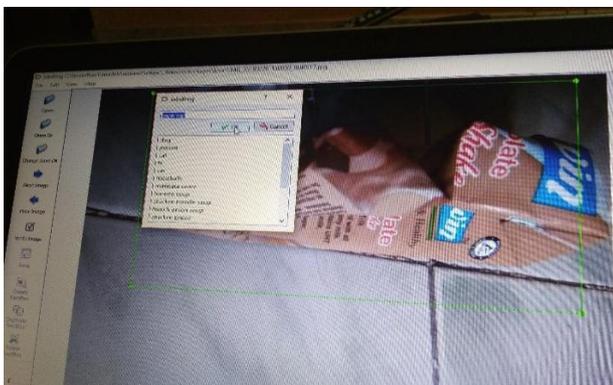


Fig. 3 Image Processing

In this paper it is a vital role to collect a database of debris(waste) images and then train those images that have been captured according to its types. Then by using the pi camera module we are going to capture a real time image which can be called as a testing image. Finally the pi camera should detect that particular image and decide whether it is a waste or not. If pi camera detects the debris then the conveyor belt will remove it, if it does not detect then the raspberry pi will give a signal to the bot to move forward. Here the waste is detected (sensed) by the image processing or object detection technique. The bot also has the ability to analyze what kind of waste is present on the surface, which can be done by coding (programming) part.

V CONCLUSION

Automated waste segregation by region monitoring has been successfully implemented for removal of waste at a domestic level. Accuracy and overall efficiency has been improved by using raspberry pi microcontroller. It can only segregate one type of waste at a time with an assigned priority. It will be easy to handle and user friendly.

By this paper the beach cleaning bot can completely eradicate the beach pollution and also can ensure the safety of marine lives.

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