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Mole Robot (MolBot): Development of pipe damage detector robot

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Abstract

To get an improved image or to obtain any useful information from it, image processing is a method of implementing any operations on an image. In the method of classifying and detection of images, this process mainly contributes to the innovation of technology. The implementation of image processing in robots had been used in earlier but with different uses. Using FPV Camera 720p OIN in the projects lets it transmits live video streaming to any device attached to it. This paper shows the robustness of image processing as it detects defects on pipes. Covering the inner external part of the pipe, the robot can pass through inside the pipe. With the accuracy of 67%, the project will be tested in different pipes and drainages for the application.

Introduction

Due to its ability to provide better passageways for the waters from different homes, manufacturing companies and other infrastructures that prevent water pollution and mild to moderate flooding, canals and drainage systems have been useful among cities (Mohamad, 2017).

The sketch of the crack is prepared manually during the manual inspection and the conditions for the irregularities are noted. Since the manual method is largely based on the expertise and experience of the expert, quantitative analysis lacks objectivity.

The application of image processing(Hernandez, Fajardo, & Medina, 2019; Alon et al., 2020) and data augmentation(Hernandez, Fajardo, Medina, et al., 2019), the detection and classification of an objects will result to a higher accuracy. Hence the procedure is to extract features and apply a specific algorithm to classify the object. Using deep learning, image detection and classification has gone from variety of applications from vehicle, plants, animals and others. Using Darknet53 or You Only Look Once (YOLO V3) which is faster than other image classification and is the most famous because of fast and high accuracy output (Ma et al., 2020). With some key features that it works faster and more reliable, it also produces less parameters rather than the lower version.

In the light of the problems mentioned above, the attempt to solve this problem using the Mole bot project was made into action. Mole Bot, the primary subject of this study is intended to be used for inspecting pipe damages and drainage systems within the area of

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Marikina City. It features a 720p camera (Ibrahim et al., 2011) real time object detection that uses deep learning Python 3 and OpenCV. It also has a wireless control system (Anaya et al., 2015). This will enable transmissions of live video feedback to the personnel on the ground depicting the kind of residues and cracks found in the pipes.

The robot can also be adapted with sensors to relay any other perilous information. In the course of the project, the set objectives was achieved which in a nutshell was to build a prototype Mole bot with the agility, Steer ability, Size and shape flexibility, Safe process , Recovery of Robot, User friendly Steering and regulator system, Toughness ,Accurate and High Quality Video response functionality (Zhao et al., 2019)

Methods

Gathering Components And Materials

The materials and components that was used in the project was purchased through online shopping and some from the physical store. The materials and components are chosen according to the specific assignment designated to the material. The remote controlled (RC) mobile built by the researchers used mechanisms that are well-matched with each other and are credited separately. These comprise the succeeding:

3D printed PLA chassis, 2300 Kv brushless motor, 9g steering servo- 2 pieces, Hobbywing 30A ESC, FLYSKY I6 Transmitter, FLYSKY I6 Receiver, FPV Camera 720p OIN, FPV receiver 5.8 GHz, Rubber tires 1/18 scale, 2 cell Li-po battery 7.8 V

The first process of the research is by the design and assembly of the project. The preparation of the layout was premeditated through illustration of the design. The researcher created a 3D model of the chassis of the robot in Computer Aided Design (CAD) software. The next step was printing of the 3D model with PLA material and tested the following parts needed as seen on Figure 1. The testing includes stress test, Obtain and review existing test material and End Test Design.

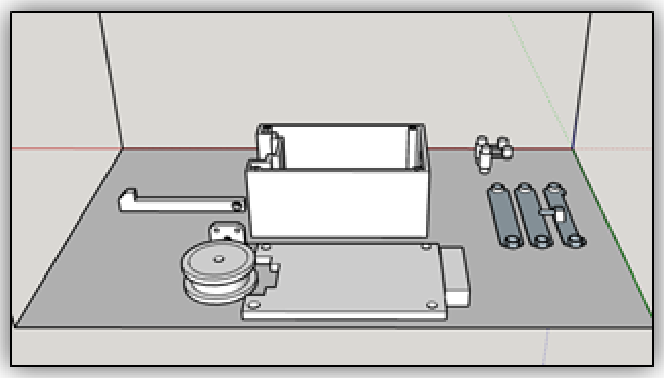

Figure 1: Mole Robot 3D model

The figure below shows the circuitry of the project. The receiver acknowledge the signal from the controller which controls the motor's speed and direction powered by a 7.8 V power source.

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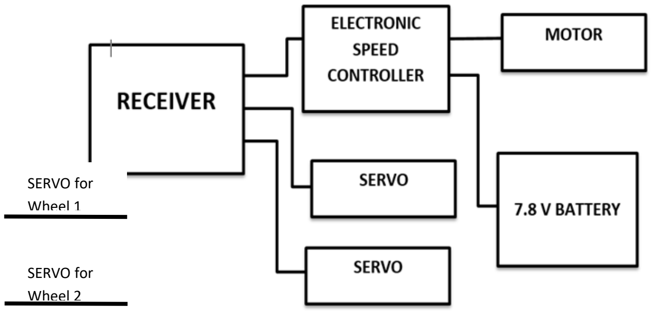

Figure 2: Mole Robot's Circuitry

Testing

For the live video streaming response feature of the MolBot a 720p FPV Camera with transmitter is mounted to the Framework. A basic FPV set-up consists of an on-board camera, mounted on the vehicle, which is then connected to a small, mounted transmitter. Typically runs on a 5.8GHz frequency. The transmitter sends a signal to a receiver that is linked to a viewing device, such as a portable monitor or FPV goggles. The camera receiver can be connected to any monitor, Smartphone device, Tablet, and goggles for live streaming. The algorithm (Cui et al., 2018; Lu & Lu, 2019) then processes the image for the detection and gives the feedback of classifying the object. The accuracy depends on the quantity of the dataset and most of the data passes through data augmentation.

Figure 3: Testing of the MolBot

Testing the live video feedback and viewing it in different platforms using the receiver and transmitter technology.

Results and Discussion

The researcher first tested the ability of the MolBot to detect cracks and damages on pipes from the inside to view if it would be as accurate as the result from the outer side of the pipe. Figure 4 show the Mole Robot's Camera with Automatic Image-based crack Detector tested from the outside of the pipe. The MolBot can detect crack from the live video transmitted from the robot to the video platform. Figure 5 shows the Mole Robot's Camera with Automatic Image-based crack Detector tested from the inside of the pipe. This study on Mole Robot (MolBot): Development of pipe damage detector robot can detect cracks accurately for about 67% as shown in the figure 5. The Mole Robot can also successfully move inside the stable pipe. In figure 6, another test was conducted by detecting crack not only from pipes but also in walls. The detection was as accurate as in processing damages on pipe's inner and

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outer core. The plane detection shows the pattern that it can be used in different application such as concrete walls, wood, and any surface which will have a damage or crack using the same dataset and algorithm.

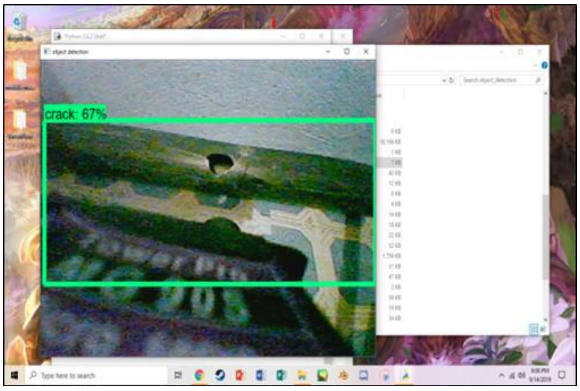

Figure 4. Detecting damages from outside of the pipe.

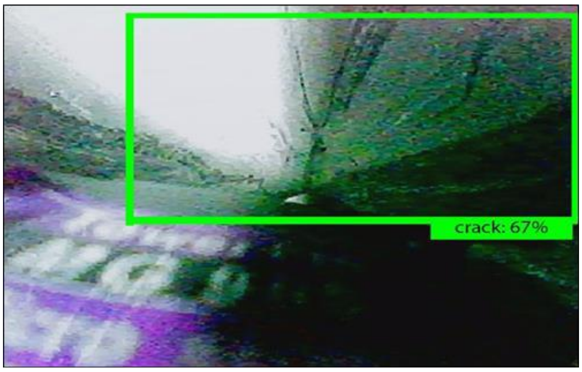

Figure 5. Detecting damages from inside of the pipe.

Figure 6. Testing the application in different area.

The Mole Robot (MolBot): Development of pipe damage detector robot is a remote controlled robot that has a maximum range of about 1100m from the transmitter. The robot is applicable for long range operations on pipelines. The 720p Camera with transmitter is connected to a mobile device with a camera receiver.

The video being taken can be observed in a larger screen depending on the device associated. The researchers continued to improve the accuracy of the robot in detecting cracks or damages however, the small amount of dataset, it was not possible. The researchers trained

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the object detection Artificial Intelligence (AI) to detect objects and pipe damages more accurately. The result of the test for accuracy is indeed precise to what the object detection AI is showing. Based on the results of this study the prototype Robot was able to perform successfully its function to detect cracks and damages among pipe lines.

The researchers was able to produce a remote controlled robot that can accurately detect pipe cracks for about 67%. The Mole Robot (Molbot) is not only capable of detecting cracks and damages it can still be trained using OpenCV Python 3 to detect other objects. The Mole Robot can also help in determining the kind of sludge or any object that causes the clogging of pipes.

Conclusion

Based on what was accomplished, the Remote Controlled robot is able to achieve the idea of inspecting pipeline using a 720p FPV Camera mounted with automatic image-based crack detection programmed using OpenCV Python 3. Utilizing the MolBot in pipe inspection operations will be effective and accurate. With the MolBot it will be faster and easier to determine the cracks or damages inside the pipelines. The implementation of these on an actual scenario will pose least work for manual inspections of pipelines. However, model structure needs to be enhanced and the steering must be fit in any other types of pipe. Additional dataset will also be needed to increase the accuracy of the project.

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