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Smart Lawn Mower

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***Abstract*: Artificial Internet of Things (AIoT) is a domain where objects around us gets smarter in the way smart lawn cutter is an intelligent lawn cutter that know how to mow a garden on its own using artificial intelligence with computer vision and ultrasonic sensors which uses ultrasonic sounds to calculate distance between obstacle and lawn mower. The lawn cutter knows the object in front of it and decides whether it's an obstacle to be avoided or a wall to make turn and if grass is present in the field the smart lawn mower moves in parallel direction unlike other lawn mowers to save time and energy, magnetometers are used to make the lawn mower move in a specific direction so that the space is left un mowed the lawn mower is connected to a web server through internet to store data of the garden or field and the web server connects to mobile app to control the mower through internet from anywhere. The lawn mower is also capable of reaching its charging dock by using GPS (Global Positioning System) and charges itself so no human interaction is needed.**

***Keywords*: Raspberry pi, Ultra sonic, Sensors, Pi camera, DC Motor, Smart machines.**

1. Introduction

In today's world everything is becoming smarter, lawn mowers are not exception like autonomous vehicles lawn mowers can be autonomous in a garden or park. Earlier days the grass would be cut using cutting blades and then came the manual mowers, but they did not have any engine to it. Later on, lawn mower having a motor which runs on petrol came into the markets which are manually operated, causes pollution and takes lot of time. Smart lawn mowers can be smart enough to save time and as it runs in battery its environment friendly. In the moto of autonomous driving the first step is to make machines like lawn mower autonomous it's the first step toward driving automations.

The smart lawn mower that we have designed is a powered by raspberry pi 3 and 12v battery that runs the DC motors Pi camera and ultrasonic sensors are used to guide the mower in its path avoiding the obstacles in a smart way. The mower is also connected to internet to a mobile app so the user can control the mower through internet some data from public weather API are used to decide whether it is safe for the mower to get to the garden. These kinds of smart decisions made by the mower makes the lawn mower smart. Existing smart mowers are random in moving but in our case we use magnetometer and GPS to make the mower move in a uniform manner to save time and mow smarter.

Section 2 presents a brief overview of the existing literature on this topic. Working of autonomous vehicles is been discussed and some of the common sensors to achieve autonomous driving's are studied. Section 3 describes the process of building the smart lawn mower the setting up of raspberry pi with the motor driver and making connection with the server and usage of the smart sensors are discussed. Section 4 presents the results of the experiments. The working of lawn mower is various grounds and areas are noted and the performance in different types of grass are studied and cutting precisions are calculated. Section 5 describes the interpretation of the results, and gives a formal conclusion to the project.

2. Literature review

1. Mohammad Rubaiyat Tanvir Hossain, Md. Asif Shahjahal, Nowroz Farhan Nur", Design of an IoT Based Autonomous vehicle with the Aid of Computer Vision", International Conference on Electical, Computer and Communication Engineering (ECCE), Bangaladesh, Feb- 2017.In this paper the author said Automated car is one of the latest trends which has been massively recognized by people all around the world as they want maximum security and comfort during driving. In recent days' road accident is one of the prime concerns for the people. It became very frequent and uncertain. Since 1920 the research for vehicle automation has been conducted on, although first promising trials took place around 1950s. During 1980 the first ever autonomous car has been seen. Netherlands and Spain have allowed testing robotics cars in traffic. Google self-driving car is a recent trend. Google self-driving cars are designed to navigate safely through cities. They have sensors designed to detect objects as far as two football fields away in all directions including human and vehicles. Society of Automotive engineers (SAE) has classified automated vehicles into six categories from level-0 to level-5. Researchers have been done regarding traffic light detection using heuristic models and color segmentation. Various lane detection techniques have been observed. Lane detection techniques using Open CV based on receiver operating characteristic curve and Detection Error Trade-off curve and

using perspective image have already been worked on.

2. Muhammad Wasif, "Design and Implementation of Autonomous Lawn Mower Robot Controller", IEEE, 2011. Behavior-Based approach is employed for robot controllers in order to perform the desired task in outdoor environment, which is normally dynamic and unstructured. Behavior based controller overcomes all of these deficiencies by using sense-act methodology in parallel fashion, while throwing away all dependencies on global world information. Optocouple sensor are used to find a differentiation between mown and un-mown grasses. Moreover, obstacle avoidance algorithm would work for static obstacles not for dynamic ones without global and local positioning the robot's localization is problematic.
3. T. H. T. Yuki Iwano, "Development of the trimmer-type mowing system against a slope", Dec-2016.In this paper the publisher has mention about the trimmer type mowing system. A mowing system that can mow a patch of land adjacent to an obstacle such as a wall is presented. Rotary-cutter-type mowing robots are currently available in the market. A cutter is located at the centre of the robot. The robot is also the same cutter-type mowing robot when these robots are used for cutting grass, grass that is close to an obstacle remains uncut. The rotary-cutter-type mowing robot have been developed similarly in various laboratories. Hence, these uncut sections have to be mowed manually. The designed a trimmer-type mowing system that can mow close to obstacles while maintaining safety. Then improve performance of mowing system can cut grasses and hard stem (e.g. Canada golden-rod).
4. Rithvik Reddy, "Autonomous Solar Based Lawn Mower", International Journal of Pure and Applied Mathematics, vol. 119, 2018. In this paper the publisher tells about the Solar based Lawn Mower. In today's busy world where time is the most precious thing, spending time on lawn mowing should be avoided and for this to happen we have to make the lawn mowers autonomous, easy to operate, more efficient and environment friendly. Earlier the grass would be cut using cutting blades and then came the manual mowers, but they did not have any engine to it. Later on, lawn mower having a motor which runs on gasoline came into the markets which are manually operated, causes pollution and they have several severe health effects. As they run on gasoline they require regular maintenance or else there would be wear and tear in the equipment and the lawn mower would break down. These lawn mowers are also large in size and are difficult to operate and are not easily portable. In the recent past gasoline lawn mowers were replaced by electric lawn mowers which are eco-friendly compared to the lawn mowers which run on gasoline but they should be charged at a charging station and run manually. Lead acid batteries are used in these electrical lawn mowers which have lower depth of discharge (DoD) and round trip efficiency. Apart from this the weight of these lawn mowers are more than 25 kilograms and are bulky in size which would make them difficult to operate and transport from one place to another. The proposed system would overcome all the problems mentioned above as it runs on a battery which is powered by solar energy. This would not only be eco-friendly causing no harm to one's health but also would save the time of humans as very less human interference is required. The batteries would charge using the solar energy and one does not have to charge the bot separately for this purpose. In order to preserve the charge in the batteries we have come up with an idea that the rotor blades would turn on only when green color is detected. A camera is mounted on the top of the bot and by image processing the grass is detected using the hue saturation value of green color. This is done using a raspberry pi. In order to make the bot eco-friendlier and efficient we are using lithium ion batteries.
5. Neha, Syeda Asra, "Automated Grass Cutter Robot Based on IoT", International Journal Of Trend in Scientific Research and Development, vol-2. In this paper the publisher has mention about the Automated grass cutter. In park, school and college they were maintain a large size of lawn. The gardener used a hand scissors or trimmer to cut the lawn regularly but it consumes more time to cut and also very difficult to mow in same size. Hence this work to make a battery powered automatic grass cutter. It is very use to handle by the unskilled gardeners. it is very easy to operate and it consists of rotary blade, roller, etc. The blade removes the extra growth of the lawn and the roller gives the light pressure to the top surface of the lawn.
6. J. D Tiamai Guo, "Simple convolution neural Network on Image Classification", IEEE, 2017. In recent years, deep learning has been used in image classification, object tracking, pose estimation, text detection and recognition, visual saliency detection, action recognition and scene labeling. In this paper they build a simple Convolution neural network on image classification. This simple Convolution neural network completed the image classification. On the basis of the Convolution neural network, we also analyzed different methods of learning rate set and different optimization algorithm of solving the optimal parameters of the influence on image classification.
7. O. Durr, "Deep learning on a Raspberry Pi for Real Time Face Recognition", 2015. In this paper the publisher said about the Real Time Face Recognition. The fast and accurate pipeline for real-time face recognition that is based on a convolution neural network (CNN) and requires only moderate computational resources. After training the CNN on a desktop PC we employed a Raspberry Pi, model B, for the classification procedure. Here, we reached a performance of approximately 2 frames per second and more than 97% recognition accuracy. The proposed approach outperforms all of Open CV's algorithms with respect to both accuracy and speed and shows the applicability of recent deep learning techniques to hardware

with limited computational performance.

3. Methodology

Smart lawn mower uses ultrasonic sensors, pi camera to identify the obstacles and avoid them. The lawn mowers is intelligent enough to avoid obstacles and mow on its own without human interaction

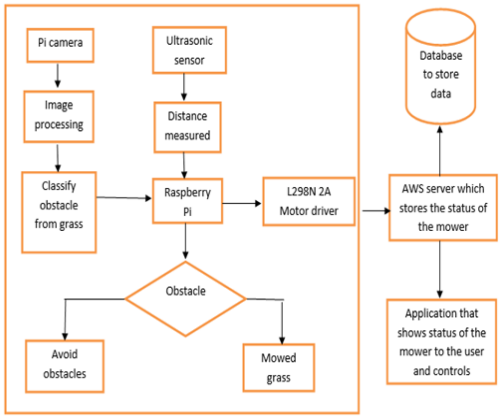

Fig. 1. Block diagram of lawn mower

A. *Smart mower module*

Smart mower module consists of raspberry pi and two motor driver. The sensors are three ultrasonic sensors and a pi camera all give their input to raspberry pi and it controls the mower and sends data to the web server. The mower module also has the blade that is used to cut the grass in a specific height. The motors are powered by 12V lithium ion battery. The raspberry pi is powered with 5v lithium ion battery.

B. *Server Module*

A web server is running in a cloud so that the data from the raspberry pi can be communicated with it all the time. Web server runs a flask server with python. a convolution neural network (CNN) modal is trained SSD algorithm on some obstacle images is running on the flask server the image sent to the web server is passed to the modal and prediction with the image name obstacle type and the position of the obstacle are made and response is sent. It also handles request from user and passes it to the lawn mower.

C. *Architecture of convolution neural network*

Convolution neural network gets the input image and convert it into a 3-dimensional array of pixel values then a convolution layer is applied on the image to get the basic features using feature map and the max pooling is applied to the images to further decrease the dimension of the convolution layer then all the pixel values are flattened and are input as a neural network to learn the features. The neural network learns using gradient decent algorithm. After learning the modal is capable of prediction the objects sent as input

D. *Gradient descent algorithm and activation functions*

The gradient descent algorithm, along with the back propagation technique, is used to optimize the weights of the neural network. During the forward pass, the network uses the weights to predict the output. The “cost” or error value i.e. the difference between the actual and predicted output is back propagated through the network and the gradients are used to update the weight matrices. During epochs the neural network trains itself through weights in each node in network. The gradients then slops to the bottom of the curve and converges. Denotes the error values of nodes in layer l. denotes the weight matrix from layer l to layer l+1. g is the activation function, denotes the input values to layer l, and is the activation at layer.

4. Results and discussion

Lawn mower using highly advanced technologies like convolution neural network for object recognition and sensors like ultrasonic sensor to find the distance between obstacles with the help of growing technology, the project has been successfully implemented. Thus the project has been successfully designed and implemented. This lawn mower will be smart enough to mow the lawn on its own an IOT help to achieve interconnectivity between machines. A lawn mower has been developed for the use of residences and establishments that have lawns where tractor driven mowers could not be used.

5. Conclusion and future scope

The smart lawn mower is automated with all the inputs from sensor and the mowers can mow the garden are field all by itself without any human interaction and send the details to web server and lets the user communicate with the smart lawn mower with android application.

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