Agricultural robot designed for seeding mechanism

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Abstract:

In the field of agriculture, plantation begins with ploughing the land and sowing seeds. The old traditional method plough attached to an OX and tractors needs human involvement to carry the process. The driving force behind this work is to reduce the human interference in the field of agriculture and to make it cost effective. In this work, apart of the land is taken into consideration and the robot introduced localizes the path and can navigate itself without human action. For ploughing, this robot is provided with tentacles attached with saw blades. The sowing mechanism initiates with long toothed gears actuated with motors. The complete body is divided into two parts the tail part acts as a container for seeds. The successor holds on all the electronics used for automating and actuation. The locomotion is provided with wheels covered under conveyor belts. Gears at the back of the robot rotate in equal speed with respect to each other with the saw blades. For each rotation every tooth on gear will take seeds and will drop them on field. Camera at the front end tracks the path for every fixed distance and at the minimum distance it takes the path pre-programmed.

Introduction:

Ploughing the land and sowing seeds is the root of any plantation or cultivation. Farmer sowing seeds [1] [2] manually without any machinery is the tradition way. The next modification is the introduction of tractors [3] [4]. Tractors are used to plough land and so seeds automatically. It reduced the effort to farmer. Tractors replaced the work of OX in fields. The main problem of existing technology[5] [6], it is costly and unable to be operated by the farmer. The robot discussed here can act as a better replacement of the above mentioned problems. The robot can also visualize its own path to cover entire farm. The prime function depends on distance detection by extracting pixels from the frame.

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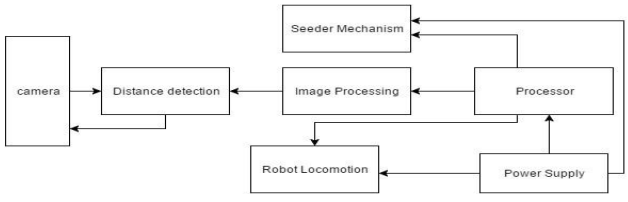


Figure 1: illustrates the entire block diagram of robot

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1. Distance detection used in proposed model.

Image processing is a method which is used to convert an image into a digital form of data to perform various operations on it. The operations are performed in an image to extract the required information. In image processing, the input is given as an image or video frame to get the desired output of characteristics associated with the image. Image processing can be used for various purposes like image sharpening and restoration, image recognition, measurement of the pattern, etc. Image processing is generally done in three steps. The first step is the importing of an image. The second step is analyzing and manipulating the image which includes image enhancement, data compression, etc. The final step is the resulting image which is based on image analysis.

The sudden changes of discontinuity in an image are called edges. Edge detection technique is used to find the discontinuity in the image based on various factors like image brightness, contrast, etc. Edge detection with various masks is used for image segmentation. The various operators of Edge detection are Prewitt operator, sobel operator, Robinson compass mask, kirsch compass mask, laplacian operator. The prewitt operator is used to detect edges horizontally and vertically. Sobel operator is similar to the prewitt operator as it calculates the edges in both horizontal and vertical direction. Robinson compass masks rotate the image in all major directions to calculate the edges.

Kirsch compass mask is a derivative mask which is used to find edges in an image. Laplacian operator is a second derivate mask which is further divided into positive laplacian and negative laplacian. They both are used to find the edges in an image. Our primary concern is to detect distance from one end to the other end of field. This can be achieved by taking an image and identifying any particular object in that image. Then by taking more images one after the other and comparing the images to evaluate the distance between robot and end of the field. To determine the distance from the camera to a known Object we use triangle similarity.



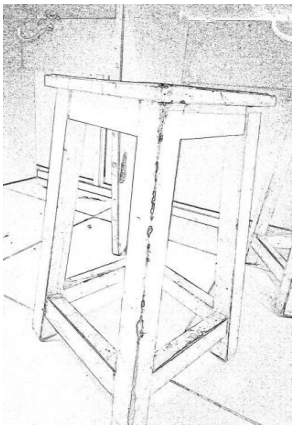


Figure 2 demonstrates the edge detection for a generalized image.

(A) Pre Image Processing **(B) Post Image Processing**

In triangle similarity we consider the number of pixels covered in one picture. The object will be placed at a distance A and of considered width X.

The number of pixels covered in this picture be K. therefore the focal length of the camera can be noted by.

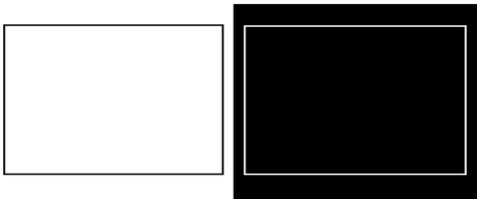


Figure 3: Square Objects Used For Edge Detection.

J = (A*K)/X.

As long as we approach the object the number of pixels covered decreases. Let the new Distance be A'. From the previous formula focal length can be determined and with change in pixel rate the new distance can be identified.

A'= (J*X)/K

The object is particularly a square shaped. It is identified easily and all the edges can be taken out. The edges of a square give good response in calculating the number of pixels linked in it. By comparing the pixel ration distance is calculated. The robot functions according to the distance calculated.

The above algorithm is coded using python. Such that the processor used in this model is able to do fast image processing using python.

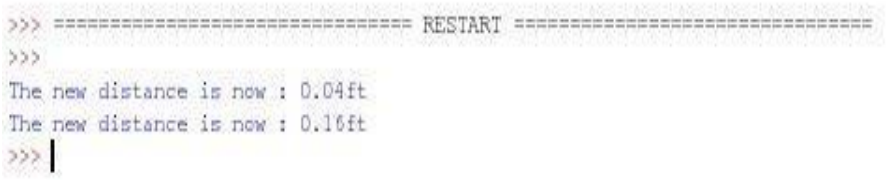


Figure 4: Results of distance detection.

2. Hardware mechanism:

This mechanism would consist of a large chassis with dimensions30cm *30cm*10cm.Themetal used for chassis is galvanized iron .We used this because it doesn't get rust easily. It is light weighted. This would help us in reducing the weight of our mechanism. There would be four rotating actuators at the bottom of chassis, which would act as wheels to the mechanism, sow used 60-rpm dc motors. We use dc motors because our model is cost efficient model; dc would help us in this area as it is available of low cost.

This motor is very much required for our mechanism as it supports us in every aspect by converting electrical energy To mechanical energy by consuming low power compared to some other motors like stepper, servo etc. The main use of this is it is easy to maintain.



Figure 5: shows the camera used in object identification and distance detection.

The torque of our motor is 5 kg's as there is an equal distribution of load on the actuators these should be ready to bear them. The wheels are covered by a conveyer belt as the movement of the mechanism is on the wet field so to bear that field and move on that we use them. Internally we would be using two rotating actuators again as there is working gear system in side which would sow the seed staking from inside the carrier. Here there is a usage of two 10rpm dc motors.



Figure 6: shows the gear mechanism used in rear part of the robot for seeding mechanism.

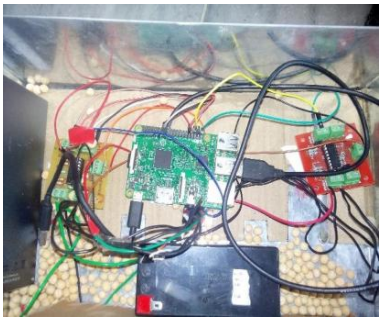


Figure 7: shows the electronics and connections for the model.

3. Results

The robot referred here is made up of galvanized ion. This adds stability and strength to the robot. Robot actuation is obtained from dc motors of 5kgtorque, speed of rotation perminuteis60.These motors are attached to wheels covered with conveyor belt. This helps in actuation and to over ride small obstacles in field. The front part of the robot is fitted with tentacles. These are made such that the tentacles get extra push from robot. At the end of tentacles saw blades are attached. Saw blades dig the land. The robot here is in particular for wet fields. Saw blades are helpful to dig which refer in ploughing the land. The rear part of the robot there are two long tooth edge ars. These help in sowing seeds. All the seeds are placed from the top of the robot and these gears are made to rotate at 10rpm. Gears are actuated with dc motors of 5kg torque. saves the image and proceeds further. After specific time it takes one more image and compares with previous image. The distance reduced is analyzed and again moves on. At a point it will change its direction of motion and the same repeats again and again. This helps to cover the entire field

The rotation of back actuators helps in pouring the seeds from the robot to the ploughed land, this can be viewed in above figure6.The complete robot is powered up with 12V dc supply. Motor driver boards are connected to all the actuators and these are controlled with raspberry pi3.The powerful 1.2GHz processor helps in controlling the whole robot easily. After the initiation of robot, it takes image and identifies the particular object by the defined parameters.

By assembling the model the robot is able to plough the land and sow seeds. The motors used for locomotion gave the best results while crossing over obstacles. The sowing mechanism has good capacity to sow al the seeds. As the processor used here is raspberry pi. It gave us fast image processing results and it bought good control of motors. The attached tentacles were able to plough the land. This robot is confined to wet land sand it can plough two rows. Seeder to sow seeds follows the same line.

4. Future Proposal

In future model, the number of gears used for seeding is increased. More number of rows can be covered easily. In the next version, dedicated processor for image detection and sowing seeds mechanism will be implemented. The powering system will be changed from12V lead acid battery to high power batteries. Use of solar energy will also be included. This makes the robot more efficient. The robot future model has a display which will be given to the farmer. It deals with the control of robot and also it transmits the video that is been focused by the robot. These changes improve the speed of the robot. This also gives better results than existing technology.

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