PestaBot

Alaa Khaled, Radwa Saleh, Sara Osama
ID: 14204
G.N: 4
STEM Assiut School
Grade 11, semester 2, 2018-2019

Keywords: Spider mite – pesticides- robot - agricultural base – rattlesnake

Abstract

Have you ever wondered why does industry take the greatest sector in any developed country GDP? Almost all of the recent progress on earth happens in the area of industry. In fact, it is needed in all fields of life from the simplest to the most complex. despite the presence of many problems associated with it. What about the consequences of these problems? They lead to global challenges that may have a solution. For example, there are about 12600 industrial facilities in Cairo responsible for about 50% of the proportion and size of air pollution an example of products that are a main source of air pollution is pesticides, during the manufacturing of pesticides workers are at increased risk because they deal with various toxic chemicals, raw materials, toxic solvents and inert conveyors. Spraying an excessive proportion of pesticides on plants leads to tissue contamination of almost all life forms on the ground due to OC compounds. This is considered one of the most serious negative impacts on the environment, so we have updated the proportion of pesticides that sprayed daily by a small robot similar in its mission Rattle snake. Because Rattle snake has a sensor which sense the temperature between his eyes can determine where the prey and then shoot poison from his mouth. a successful robot should save money and energy, prevent spraying large amounts of pesticides with no crops damaged, our little robot is able to distinguish the location of the insect through a camera in the front of it and then sprays the pesticide only on the insect so the amount of pesticides sprayed, it also works with a solar cell in order to utilize sunlight. In addition to that less pesticides sprayed and the crops are safe from the red spider mite.

Introduction

The industry is the most important economic activity because industrial growth helps in reducing the unemployment and poverty, industrial growth also can earn foreign exchange by exporting the finished goods and modernizing the agricultural activities can be helped by it. So it was important to improve the efficiency of industry as it's the grand challenge for this semester. Pesticides are sprayed to the whole field without specifically looking for the insects that will be killed and it's a big problem because it's possible that the field has large area without insects and spraying pesticides to this area could harm the crops and make them unhealthy. Spraying the whole field randomly costs too much money for the pesticides and agriculturalists always need workers who use machines to spray the field and keep it safe from insects so this costs them a lot of money. There are many prior solutions to this problem and one of them is the "helicopter" that flies above the field without a pilot because it's remote controlled, it's capable of carrying 15 kilograms of pesticides, it covers an area that needs 20 farmers to spray it and it's capable of spraying 240 hectares of area in an hour. The disadvantage of using the helicopter is wasting big amount of pesticides without benefits. Then the solution that was chosen to work on in this semester is a robot. The solar cells are used in the robot to make it able to move and change its way in paths in the field. A camera will be added to the robot to allow it to see the eggs of the spider mite which are put in a net and also the spider mite itself, after the camera sees the spider mite or its eggs, the spider mite is detected so the robot will make the decision of spraying the spider mite or the eggs by the pesticides that will destroy the net. There will also be color sensor in the robot and when it detects the red color, it will rotate with the angle of 90 degrees, and if it detects the blue color, it will rotate with 90 degrees in the other direction. The reason why this solution is better than prior solutions is that the design requirements that were chosen are achieved as:

1- the cost was decreased because the agriculturalists won't need workers to spray the field 3 times a week as the robot will cost 500 and the workers take 70-100 L.E in 3.
times a week so if we calculated it in a month the robot would be cheaper than the money for the workers. Another pro of the robot is that its lifetime is very long.
- The cost was also decreased because the amount of pesticides was decreased because the field isn't sprayed totally but just the leaf that the spider or the eggs are on it.

2- The efficiency was increased because pesticides are sprayed within a small distance from the spider which guarantees the death of the pest.
3- Decreasing the toxicity because less amounts of pesticides are sprayed as the leaves that aren't harmed with the spider won't be sprayed.

Small ideas can change the world and a small robot can face problems that have been bothering us for years and that's our pestabot.

Materials & Methods

Material	picture	Material	picture
wood		Solar panel	
Jumpers		Servo motor	
Robot wheels		OV7670 - camera	
Arduino uno board		Arduino shield	
Arduino breadboard		Pump	

Material	Picture	Material	Picture
Pesticide container		Pipe	

Table 1(materials)

Constructing a prototype requires several steps to follow in order to achieve its mission, the methods our robot was constructed with were the following:

1- frame:
- Cut 2 pieces of wood with dimensions 30*30 cm.
- Make holes in order to allow the wires and jumpers to path.

2- Servo motors:
- Put the motor shield at the top of the arduino board.
- Connect the servo motors (robot wheels) with the motor shield using the jumpers as shown in fig (1).
- At the 90 degree turn to the left the two wheels from the left side of the robot moves backward and the two wheels from the right side moves forward.
- At the 90 degree turn to the right the two wheels from the right side of the robot moves backward and the two wheels from the left side moves forward.
- Otherwise the robot keeps moving forward .

3- Camera:
- Connect the camera with the Arduino as shown in fig(2).
- Install the camera code on Arduino (the code have the access to picture files of the eggs and spider mite).

4- Pump:
- Connect the pump with Arduino.
- Install the pump code on Arduino which allows it to spray pesticide any time when a mite or egg is detected

5- Stick the wooden frame to the servo motor as shown.

6- Connect the solar cell to be the power source of Arduino.

Figure 1 wheels and frame)

Test plan:

1- Move the robot in a real agriculture field.
2- Apply the robot to a spider mite to test the camera and code, if it sprays the pesticide then the camera and pump codes are free of errors (to make sure of the efficiency).
3- Fix any coding errors if there are some.
4- Measure the amount of pesticides sprayed using the volume of pesticide in the container before and after then compare it with the usually sprayed amount if it's less than usual and less than the allowed amount then toxicity and cost are decreased.
5- Test the wheels by moving the robot in various parts of the field to achieve applicability.

Figure 2 (camera connection)

Results

Testing has always been an important step in doing any project, in our project we focused on testing the camera and pesticide sprayed, and we got pretty impressing results.

Trial	Success or fail	reason	Amount of pesticide used (relative to the usual sprayed amount)	Pump spraying
1	fail	Problems with the code as the camera wasn't able to detect most of the spider or eggs	11%	Sprayed
2	Partial success	The camera was able to detect only the eggs because the images installed on the camera were more clear	35%	Sprayed
3	success	The spider and eggs were all detected after updating new images with different perspectives	48%	Sprayed

Table 2(results)

And to make sure the prototype was successful we also had to test the design requirements.

Results related to design requirements:

Design requirement	Whether it was accomplished or not	why
Money saving	Yes	As the prototype consumes less amount of pesticides than usually sprayed
Environmental friendly	Yes	As it reduces the amount of pesticides used which reduces air pollution
Energy saving	Yes	As it works with a solar cell
Efficient	Yes	As it produces the same quality of crops with less amounts of pesticides

Table 3 (results elated to design requirements)

Analysis

According to 2017 statistics, the income per an Egyptian family per year is about 3000 dollars. While the average income per capita in a developed country is 12056 dollars per year. So it is obvious that we need to focus more on industry in order to increase the individual's income. Which is one of the main sources of income in addition to agriculture which represents about 17% of the Egyptian GDP as shown in chart 1.

One of the main crops grown in Egypt is tomatoes, they can be sold or entered to a lot of industries, but it is threatened by many pests one of them is the spider mite, which harms the crop and make it useless, pests are easily killed using pesticides but the main problem is that farmers use pesticides more than that is allowed which toxics the crops and gives the negative feedback to the consumer. A pesticide used against spider mite is solfan which is allowed to be sprayed with a percentage of 200 cm cube per a hundred liter of irrigation water but it is actually sprayed with a much higher rate. Now imagine an organism which senses the enemy then sprays it with poison; that's how rattlesnakes defense themselves in order to live in peace, crops don't have the ability to do the same as rattlesnake except by GMO which costs a lot and take a huge amount of time, but a pesticides robot can do the same function and be the guard of crops without the need of wasting large amounts of pesticides, it sees the mite with the camera and sprays the specific area. But it had to face some problems in the early beginning as the results were going a little negative as the robot didn't locate all the mites. In another try it was able to locate them successfully but updating the code and robot system, pesticides spraying results were very pleasing as they were much less than normal spraying. To construct such a successful robot some requirements had to be put, Recall that even though the pesticide kills the pest but it toxics the whole field and causes a lot of diseases to the consumer, It also costs a lot to manufacture these pesticides and consumes time, energy and have negative effects on human and environment, so these problems became the design requirements of a prior solution and a useful prototype, there are always different ways to measure each design requirements for example something like the cost can be measured by comparing the robot cost to salary of the spraying worker and see if the robot will cost you less money. The robot costs about 500 pounds in manufacturing in addition to that the energy source for the robot isn't something to worry about as it works with a solar cell that supports all the electricity it needs for movement, on the other hand the worker costs about 70 pounds per day and works 3 days a week and takes less time with the same or better efficiency, efficiency can be measured using how much pesticides sprayed by the robot and how much pesticides sprayed by the worker with the same number of spider kills, which turned out to be about 48% of the worker usage and finally the negative effect on the environment can be measured by whether the amount of pesticides meets the allowed amount or exceeds it and to measure the success of the robot we divide the efficiency by the cost of the robot and of the worker, since the same number of spider mites and eggs (represented in figure 3) dies and the same number of crops are saved, therefor the efficiency is the same between the robot and the worker but annually the robot only costs 500 pound and the worker costs about 10080 pound in addition to that the robot uses approximately half amount of the fertilizers. Let the efficiency be a 100%:

- For the robot 100%/500 + 0.5*pesticides price.
- For the worker 100%/10080+ pesticides price.

That illustrates how the robot is much more successful than the spraying worker in addition to that it decreases the toxicity with a 3% Error percentage. To make sure things are going fine graphs and charts can be used to measure the rate of change, which is something that can be easily measured using the derivative, for example if we have a cost efficiency graph with a function f(x)= x^2 +8, we will find the function of rate of change using the derivative so rate of change will be equal to 2x. Physics also is very helpful when it comes to robots as we can use it in understanding the mechanism of a solar cell to support energy, and in the movement of the servo motor. As shown in fig 4 Information technology is very useful in writing the code as it tells you everything about the coding. language to use which is c++.

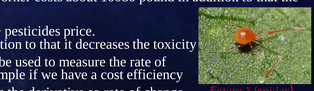

Figure 3 (spider)

Figure 4 (connection mechanism)

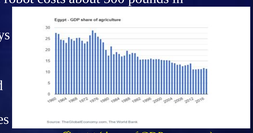

Chart 1 (share of GDP over years)

Conclusions

Using pesticides without restrictions been always a threat for human being as it is considered a waste of money, raw material and a main cause of many diseases;
during this project it was concluded that:

1- detecting the pest and spraying it gives the same efficiency of killing pests and saving crops in addition to that it costs less money as much less amounts of pesticides are used.
2- camera detection is more useful than sensors as it can perform more functions.
3- solar cells are very practical in agriculture fields as it is totally exposed to sunlight.
4- spider mite cannot be seen using naked eye but can do huge damage.
5- spider mite eggs can be easier to detect after detecting the parent as they are often very close to each other.

Recommendations

Knowledge never stops at a certain point, every minute there is a new discovery, maybe we are not lucky enough to see where it will be years from now but to anyone of would take the same path we took we recommend:

1- Using more than one camera in the robot to be able to use the robot in fields whose leaves varies in height.
2- Increasing the area of the body of the robot in order to carry more than 1 type of pesticides so that the robot can kill more pests in more crops.
3- Developing the structure of the body of the robot for example using better wheels to allow the robot to move much easier in fields pecifically in the wet soil.

Literature cited

1- Baraniuk, C. (2018, August 03). The crop-spraying drones that go where tractors can't. Retrieved from https://www.bbc.com/news/business-45020853
2- Blum, J. (2018). *Exploring Arduino: Tools and Techniques for Engineering Wizardry*. Wiley & Sons Canada, Limited, John.
3- Brooks, G. T., & Roberts, T. R. (1999). *Pesticide chemistry and bioscience: The food-environment challenge*. Cambridge, UK: Royal Society of Chemistry.
4- BuiltInExamples. (2017, January 12). Retrieved from https://www.arduino.cc/en/Tutorial/BuiltInExamples
5- Professional societies and ecologically based pest management: Proceedings of a workshop. (2000). Washington, D.C.: National Academy Press.
6- Spider mites. (2017, March 23). Retrieved from https://www.infonet-biovision.org/PlantHealth/Pests/Spider-mites
7- Tukey, P., Tukey, P., Plymale, B., Plymale, B., Plymale, B., Rhys, T., . . . Drown, J. D. (Writers). (n.d.). A Chemical Reaction: The Story of a True Green Revolution [Video file].

For further information

Alaa.22524@stemassiut.moe.edu.eg Radwa.22381@stemassiut.moe.edu.eg Sara.22537@stemassiut.moe.edu.eg