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Designing a Microcontroller Based Basic Circuit of a Dual-Purpose Agricultural Vehicle

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Abstract: ***This paper develops a microcontroller based dual-purpose vehicle for agriculture. The vehicle is performed in such a way that it can executes numerous commands at any given time. The proposed vehicle is designed for cultivating the land. It can navigate through the crop lines by its flexibility of all-directional locomotion and perform (i) Ploughing the soil and (ii) Spreading seeds and fertilizers. All the tasks can be done by the user command. It is a hybrid powered user-driven vehicle as it is powered by portable DC voltage source and Renewable Solar technology.***

Keywords: Agricultural Vehicle, Switching Circuit, Control Logic, Microcontroller, Servo Motors.

1. Introduction

Agriculture has always become an essential part for the economy of each and every country. It not only provides foods for all the living being, but it also globally connects and interacts with all the related industries [1]. If the agricultural sector is very stable, a nation is believed technically to be stable in all the sectors including economically, politically and socially [1],[2]. Robotics and automation can play a significant role for satisfying the agricultural production needs. For past six decades, automated vehicles have played an important role in increasing the efficiency and reducing the cost of industrial production [3].

In the past few years, a strong aptitude is observed towards the development of farming vehicles which are able to perform a variety of agricultural tasks for accomplishing the basic needs for the increment of more than 2 billion people by 2050 [1]-[3]. Besides, researchers are trying to develop new robotic vehicle technology for increasing the efficiency of agricultural sector [3].

This research proposes the design and switching circuit of a farming automobile which can perform two different tasks. The system includes ploughing, seeding and fertilizing the land. It can move in every direction such as forward, backward, left and right. A microcontroller is used for controlling and generating all the required pulses for the switching signals. For performing the dual tasking cultivation process, different kinds of servo motors are used. Gear motors are used for movement of the proposed vehicle. All the gear motors are attached to DC-drivers to decrease the back emf effects [4].

The uniqueness of this research among other recent studies is such that it will be a less-expensive and energy-efficient agricultural automobile which is based on simple and cheap microcontroller instead of expensive PLC technology [5]. In this research, for reducing the cost of installations, solar technology is used as green energy. Necessary simulations are performed in Proteus Simulation tool.

2. Methodology

To make the system in the most convenient and user-responsive way, it should be designed by the following approach.

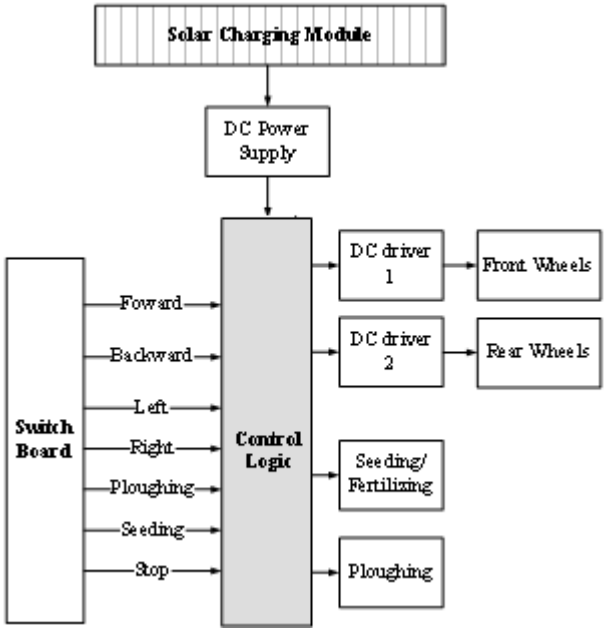

Figure 1: Block Diagram of Agricultural Vehicle

Figure 1 illustrates the basic operating methodology of the proposed automobile. The block diagram can be partitioned in two sides: input sides and output sides. The input commands are shown at the left-handside of the control logic whereas the output sides show the results which are at the right-hand side of the control logic block.

For the input side, the projected prototype of the vehicle will be using a solar charging module with DC power source to energize the vehicle. The switching board will have forward, backward, left-turn, right-turn, plowing, seeding

and stop operational switching commands. All these input pins of the microcontroller will get logical '1' when the user will command them to get activated.

The output terminals are combined with DC driver 1, DC driver 2, Seeding and Ploughing servo motors. DC driver 1 is employed for supplying enough DC voltage to the Front wheels of the vehicle whereas the DC driver 2 is employed for supplying enough DC voltage to the Rear wheels of the proposed vehicle.

3. Working Principle

The working principle of the proposed vehicle should be getting concerned after understanding the structural design of the block diagram. Although the proposed embedded system can do two main tasks, the principle of operating the system is divided in two different types of gage; Movements and Operations.

For the movement of the four-wheeler agricultural vehicle, one gear motor is attached in each wheel of the vehicle. They should be used for making the vehicle stable and flexible to move in any directions including forward, backward, left and right.

On the other hand, for the dual-purpose operations, different kinds of servo motors are connected for each of the operation. The vehicle can do plough, spread seeds and fertilizers on the soil. A powerful servo motor will be attached with an Agricola for the cultivation purpose of the land.Another servo motor will be attached with the container of seeds and fertilizer. This container can hold only seeds or only fertilizers at a time. The concept of this container is designed such like either holding seeds or fertilizers because, seeds and fertilizers aren't required at the same time for cultivation process. This technique helps to reduce the complexity of circuits and weights of one container instead of two.

Recalling the process of tree plantation, for planting a tree from a seed, at first, the soil should be ploughed properly. Secondly, the seed should be sowed. Then if the soil requires fertilizers, the fertilizer should be spread after the baby-tree grows a bit [6]. Therefore, the proposed dual-purpose agricultural vehicle is designed to perform the same task as discussed.

4. Analysis of Servo Motor by Accurate Timing

Apart from DC motor, the servo motor can hold its shaft at a precise angular position by getting the accurate pulse from its control signal [7]. The motor shaft will be held at that specific position as long as the control signal remains unchanged. It is worth to discuss that a servo motor has 3 terminals; Ground (0V), Power (+5V) and Control signal (PWM) [8]. Controlling a servo motor is comparatively straight forward. A square wave is applied to the control signal of the servo motor. An approximate accuracy of timing vs servo angle for controlling the shaft position is discussed below. However, these values can be varied from unit to unit or by the type of servo motor [9], [10].

(1) 620 µs square signal can turn the servo 0^o
(2) 1000 µs square signal can turn the servo 45^o
(3) 1400 µs square signal can turn the servo 90^o
(4) 1900 µs square signal can turn the servo 135^o
(5) 2320 µs square signal can turn the servo 180^o

5. Simulation of Switching Operation

For the simulation of the vehicle, Proteus 8.1 software is used. PIC Microcontroller is used in this research. The input and output schematic circuit diagram is shown in the figure below.

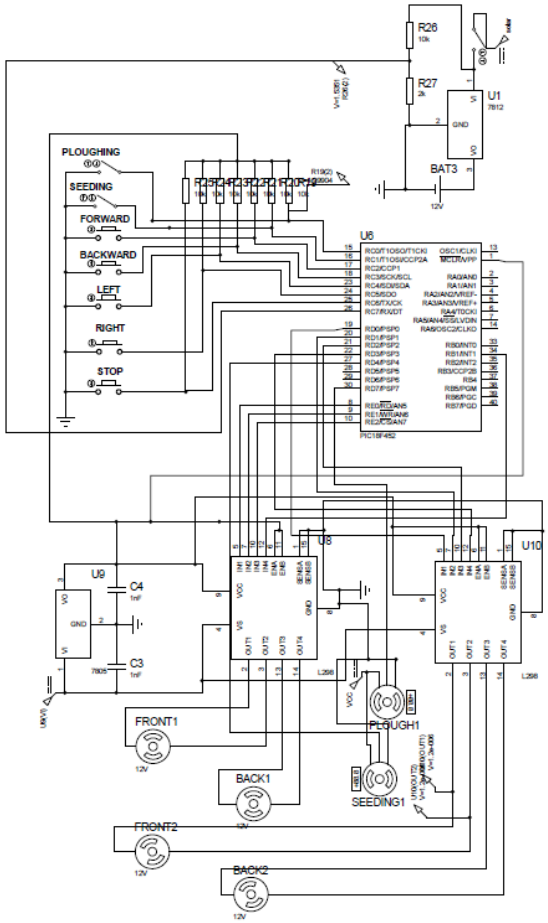

Figure 2: Schematic Circuit of the Proposed Vehicle

Figure2 shows the Proteus schematic simulation circuit of the proposed vehicle. All the components including switching circuit, servo motors, DC drivers, voltage regulator conversion, solar charging technology, 4x4 vehicle motion technology can be seen from the above Figure 2. As mentioned earlier, a single unit of PIC microcontroller is driving all the operations by performing series-parallel theory of the features.

For preparing the farmland, a strong metal gear servo motor will be used for performing the ploughing operation. Another same kind of servo motor will be used for seeding and fertilizing operation. Furthermore, for the movement of the vehicle, four wheels attached with four DC gear motors will be used. Two DC drivers are used to control the gear motors. A 12V battery is required to supply power to the

circuit. The microcontroller is energizedfrom a 5V voltage regulator which converts the 12V supply.A solar panel is also used for charging the battery.

6. Advantages over Other Researches

This proposed research has quite advantages over many other researches. The main advantage of this research is that it proposes to use a single unit of microcontroller instead of an expensive PLC. It can make the proposed vehicle with its full option comparatively cheaper. Secondly, this vehicle can perform the basic task of planting seedlings on seedbeds. Besides, it reduces the labor and hard-work which are required for tree plantation. So, it can make tree plantation cost-effective, easier and hassle-free.

7. Limitation of this Research

This proposed vehicle cannot sprinkle water which is very essential for the cultivation process of plants. If this vehicle can perform the watering task, this will fulfill all the basic requirements for agriculture.

8. Future Works

The prototype of the proposed vehicle will be implemented at first with the wireless controlling feature. The feature of automatically and manually spreading water with a portable pump should be added as well. One DC driver should be reduced for minimizing the powerconsumption.

9. Conclusion

In agriculture, the prospects for robot-enhanced productivity are immense. The automated vehicles are appearing on farms in various forms. The problems associated with farm equipment can probably be overcome with technology. The ideology of getting the proper pulse from the control circuit of this proposed vehicle is the most important concern in this research. Therefore, the entire focus is given to the design of the methodology of operating the vehicle as well as the controller. Although the vehicle can be successfully simulated by getting the desired output, some circuit modifications may be needed to the practical implementation. If the proposed research can be manufactured industrially, it will make a revolutionary change in today's work.

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Author Profile

Maisha Farzana received the Bachelor of Science in Electrical and Electronic Engineering from American International University-Bangladesh. She has performed several projects on Power Electronics and Robotics. She works asManaging Director at Trust Asset Limited- a private real-estate company in Bangladesh. She involved her research work in performing IOT based Home Automation with solar technology. Her research interest includes but not limited to analyzing and observing characteristics of CoAP and MQTT based IOT protocols.

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