EE214 Electronic Circuits Laboratory
Term Project
Remote Controlled Vehicle

April 8, 2016

1 Introduction

Remote controlled vehicles, such as cars, ships, helicopters or quadcopters, have been very common not only among kids but also among adults or hobbyists. There are very different remote controlled vehicles that appeal to different expectations, and such a variety also exist for the structure of vehicles and the transmission of the control information.

Figure 1: Different remote controlled vehicles

These devices can be investigated under two main parts: controller and vehicle. Controller takes the input from the user for the direction and the speed of the movement, generates a control signal accordingly and transmits this signal to the vehicle. On the other side, there is a receiver on the vehicle that receives and interprets the control signal transmitted by the controller and an actuating mechanism that control the motors on the vehicle.

In this project, you are supposed to make a very simple example of a remote controlled vehicle on the ground. The transmission of the control signal is supposed to be through a wire.

2 Project Description

In this project, you are required to design the remote controller (transmitter) and the actuating mechanism (receiver) of a remote controlled vehicle. The vehicle is supposed to move on the ground and contain two motors.

2.1 Remote Controller

There must be at least three push buttons/switches that correspond to right, left and straight movement, on the controller. Once a button/switch is activated, it should generate a sinusoidal waveform of a certain amplitude. The frequencies of the waveforms corresponding to different buttons will be different and the transmission signal will be composed of all three sinusoids.

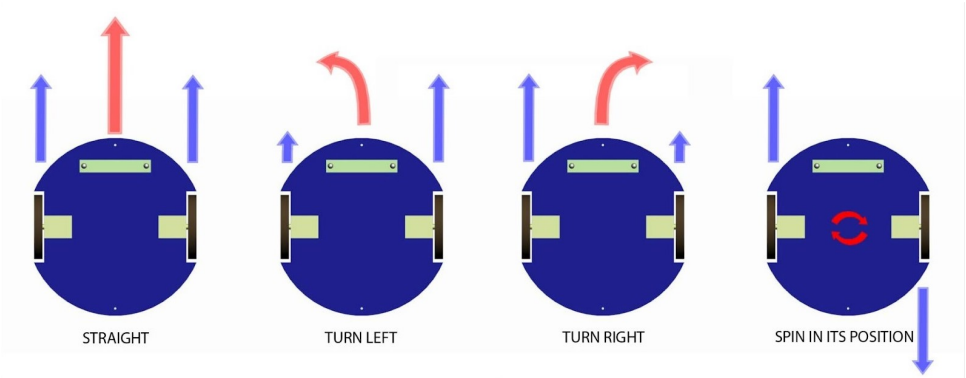

Figure 2: Differential Drive [image taken from https://www.robotix.in/tutorial/mechanical/drivemechtut]

2.2 Vehicle

The vehicle will have a receiver part that receives the signal transmitted by the controller and interprets it in order to activate the designed actuating mechanism.

For the actuating mechanism, you may make use of differential drive that is based on two separately driven wheels by DC motors and an optional free turning wheel for the balance of the vehicle. Differential drive system is very simple and illustrated in Figure 2. Blue arrows in the figure represents the individual movement of motors controlling the active wheels whereas the red arrow indicates the movement of the vehicle. As you can observe, there are different ways for a left turn: if the motor controlling the right wheel moves in forward direction faster than the motor controlling the left wheel, vehicle is supposed to turn to left very slowly. One way to accelerate the turn is when the right motor is active whereas the left motor is not. If the left motor moves in backward direction when the right motor moves in forward direction, left turn is realized on the vertical axis of the vehicle, which is named as a "spin" in the corresponding figure.

Notice that a spin-like turn is not recommended if you use a chassis with four wheels, only two of which are supposed to be active.

2.3 Allowed Components

You are allowed to use DC power supply and you may use any types of resistors, capacitors, inductors, diodes, LEDs, LDRs, op-amps, transistors, DC motors, push-buttons, switches.

2.4 Design Specifications

First of all, you may use any type of chassis for your remote-controlled vehicle: you are allowed to make use of the bodies of your old toys or you may prefer building a chassis from scratch, even by using some Lego blocks. It is also possible to use the chassis of ready-to-use car kits that are sold for students or DIY hobbyists. Hence, the body of your vehicle is limited by your creativity.

There must be three push-buttons or switches on the remote controller that allow user to choose the direction as right, left or straight. Backward movement is not a must. Only one of the buttons/switches is supposed to be active at a time, hence, only one sinusoid will be transmitted at that time. There will be a single transmission signal for the movement control, which will be composed of all three waveforms. The receiver on the vehicle is supposed to take a single input, differentiate its components and generate the movement accordingly.

The frequencies of sinusoids that will be used for different movements will be determined in the following way: Suppose that X_1X_2 and Y_1Y_2 are two-digit numbers that correspond to the

last two digits of group members' ID numbers. Find Z_1Z_2 by averaging X_1X_2 and Y_1Y_2. Then, calculate the frequencies of sinusoids according to Equations 1-3.

$$f_1 = 20 * Z_1Z_2 + 10000\ (Hz) \tag{1}$$
$$f_2 = 40 * Z_1Z_2 + 30000\ (Hz) \tag{2}$$
$$f_3 = 60 * Z_1Z_2 + 50000\ (Hz) \tag{3}$$

The deviation of generated frequencies from the calculated ones must be lower than 10%. The amplitude of all three sinusoids must be the same.

You must use at least one transistor in your overall design.

There should be three LEDs on the vehicles, one of which emits light at a time, indicating the direction of movement. When the vehicle is not moving, i.e., there is no user input, none of LEDs emits light.

2.5 Bonus

The bonus points will be given to the groups whose design gets full credit from design tests. Following implementations that succeeds will get the corresponding extra credits:

- Neatness of the implementation (5 points)
- Wireless transmission of the control signal (10 points)
- Speed control of the remote controlled vehicle (speed control of DC motors) (15 points)

3 Rules and Regulations

3.1 Groups

The project will be carried out in groups of two students, who are supposed to be in the same laboratory session.

3.2 Documentation

For this term project, you must submit two reports, one as preliminary report and the other as final report. In addition, you are expected to a submit a video for the presentation of your project.

3.2.1 Reports

The preliminary report is supposed to present your conceptual design for the project, which should be accompanied by background information and simulation results for the validation.

On the other hand, final report is where you will explain the construction of your design, the validation tests and conclusion. Minor revisions to your conceptual design is possible as long as you justify the need for them. Please notice that the final report should reflect what you learned from the term project.

As indicated in the report guideline, both of the reports should include:

- A cover page
- Table of contents
- Introduction
- Overall block diagram

- Description of circuit operation that covers circuit schematics, related theory and basic formulations
- Simulation results
- Selection of equipment
- Conclusion
- References

For the final report, you are also supposed to provide

- A cost analysis
- A power analysis and
- Illustrations of the finalized project

For EE214 projects, if you use a filter circuit in your project design, in addition to simulation results, HPVEE analysis of the filter circuits are also required for the final report.

Please notice that all requirements stated here does not necessarily mean a long report, but definitely a well-organized one. Refer to report guideline for further details.

Late submission for both reports will lower your reports your grades according to the following policy:

- %20 off for one-day late submission
- %50 off for two-day late submission
- %90 off for three-day late submission
- zero credit for more than three-day late submission. However, please notice that, even if you will get zero-credit for late submission, you must submit a preliminary report in order to be eligible for the project demonstrations.

3.2.2 Demonstration Video

You should prepare a 6-8 minute video where partners of each group present the project in a collaborative manner. The video should include the explanation of main blocks, why they are used and how they are designed. This video should be regarded as a formal presentation to the related assistant. Note that you should always appear in the video together with your presentation material.

3.3 Important Dates

- April 8 : Project announcement
- May 13 : Submission of the pre-report (till 17:00)
- May 16-20 : First project session
- May 23-27 : Second project session
- May 26-27 : Submission of demo-video (two days before demonstrations, till 17:00)
- May 28-29 : Demonstrations
- June 3 : Submission of the final report (till 17:00)

3.4 Grading

- Pre-report : %15
- Final Report : %20
- Presentation Video : %10
- Design and Performance : %55 (partial credits are possible)
- Bonus : up to %30

3.5 Important Rules

- Both members of the group are responsible for every single detail of their circuit.
- Attending to at least one project session and demonstration is a must for both team members, otherwise, you will fail the course.
- Cheating is strongly forbidden and any indication of cheating will cause you to get zero credit from the project and you will fail the course due to your attempt. You can collaborate with your friends by exchanging ideas, not copying the design details or the reports. Using the design of another group with slightly modified component values will also be regarded as cheating.