# Accelerometer – Driven RC Car

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*Abstract* **- There has been recent growth in the use of accelerometers for sensory feedback. Modern day technology comes standard with accelerometers; often these accelerometers are used for intuitive control. Ideally, RC vehicles have been controlled by a set of one-axis joysticks or dials. To implement accelerometer control, we designed a circuit to convert the accelerometer's orientation data into information usable by our RC transmitter. The circuit starts with an RC filter connected to 2 comparators that control the steering and acceleration for the accelerometer. The accelerometer is used as an orientation sensor, rather than a true acceleration sensor. It outputs two pulse-width modulated signals based on its orientation. Thus the accelerometer makes the controls intuitive: lean left, and the vehicle turns left. After completion the finished device is simpler and more profound than the original. Clearly accelerometers have applications with RC vehicles.**
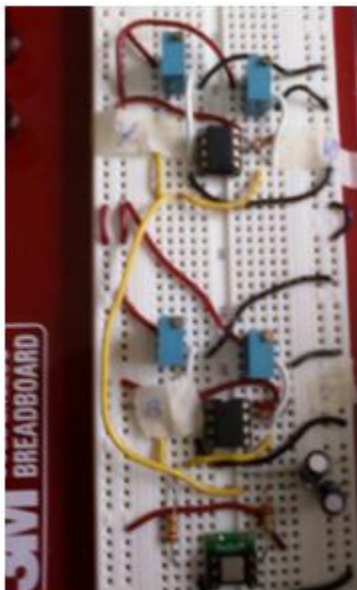
**Figure 1**

## Introduction:

Recently, accelerometers are being incorporated in everyday applications. Accelerometers have become relatively inexpensive and extremely durable. Laptops, cell phones, and video game controllers come standard with accelerometers; often these accelerometers are used for intuitive control to provide users with motion sensing and safety capabilities.

With the increasing use of accelerometers, this summer's engineering project was to use an accelerometer to drive an RC car. Instead of joysticks, triggers, or steering wheels, a user inputs commands by tilting and rolling a two-axis accelerometer.

## Background:

The use of accelerometers in RC vehicles is uncommon. Traditionally, RC vehicles have been controlled by a set of one-axis joysticks or dials. In RC cars, the two most common configurations are two joysticks (steering and acceleration) or a rotary wheel (steering) and a trigger (acceleration). By using an accelerometer, we simplify both the device and the control. The accelerometer makes the control intuitive: lean left, and the vehicle turns left. It also makes the control mechanism simpler by eliminating all moving parts.
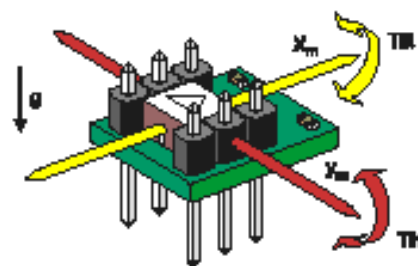


**Figure 2**

## Previous Design:

The device presented in this paper builds off from a previous design. Initially the design used an RC car with a wheel-trigger controller (transmitter), which had a

mechanical contact control mechanism. The contact control mechanism sends a control signal from the transmitter to the receiver. The receiver interprets the control signal to produce the desired response, by utilizing pulse width modulation (pwm). In order for the circuit to work, transistors were used emulate the mechanical contacts.

Essentially the transistors acted as a trigger or switch in this design. We used a NPN (collector, base, and emitter) transistor to achieve the simulation of the mechanical contacts (see figure 5 for schematic design). [4]

Four voltage dividers were used, that connected to two op-amp comparators and two transistors to determine if the signals would represent left versus right, and forward versus back. We found it easier to implement four potentiometers to achieve the same results.

**Design Description:**

Currently the device uses a two joystick controller, which had a contact control mechanism. Like the wheel-trigger controller; the joysticks acts as the transmitter when an action occurs. If you want to go forward push up on the joystick, vice versa for turning left or right. As the transmitter sends the radio signal, the receiver utilizes pwm to control the response of the RC car.

By using an accelerometer, the mechanical joysticks were replaced. While the receiver and transmitter stayed intact. The accelerometer makes the controller more intuitive. With a more intuitive controller, emulation of the mechanical joysticks becomes easier. After emulating the circuit, the output of the accelerometer is shown by the pwm.

The accelerometer used is a dual-axis memsic 2125 accelerometer from Parallax INC, [2] Figure 2 shows a picture and a sketch of the accelerometer and its axes. The accelerometer is used as an orientation sensor that measures tilt, rather than a true acceleration sensor. It outputs two pulse-width modulated signals based on its orientation. (see figure 4 for a schematic of the accelerometer's connections and table configuration) [1]
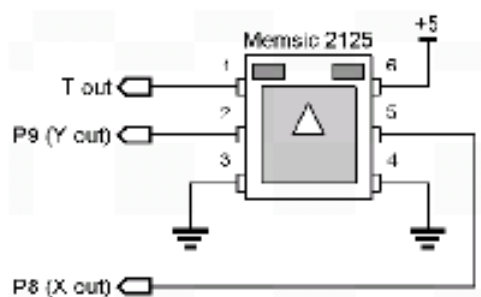
| Pin | Name | Function |
|-----|------|----------|
| 1 | Tout | Temperature Out |
| 2 | Yout | Y-axis PWM output |
| 3 | GND | Ground -> 0 V |
| 4 | GND | Ground -> 0 V |
| 5 | Xout | X-axis PWM output |
| 6 | VDD | Input voltage: +3.3 to +5 VDC |

**Figure 4**

The pulse width modulated signals are then used for commanding the RC car (see Figure 3, 4 for a full circuit flowchart and schematic).
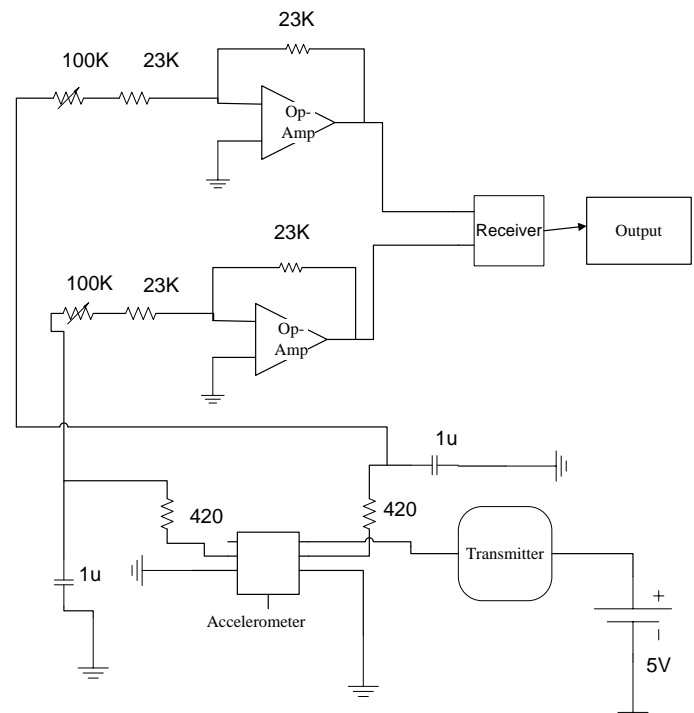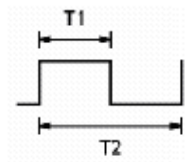


**Figure 5**

First, the modulated signals are converted to voltages by two resistor-capacitor filters with time constants of 0.023 seconds. The voltage signals are then sent to an op-amp comparator to determine if the signal represents left versus right, and forward versus back. The comparator uses reference voltages from four hand-tuned potentiometer voltage dividers.



**Figure 3**

Memsic 2125 Pulse Output

$$A(g) = ((T1 / T2) - 0.5) / 12.5\%$$

**Figure 6**

Finally, the comparator sends the two signals (forward versus backward and left versus right) into the RC controller, to emulate the mechanical joysticks. The final output for simulation of the mechanical joysticks depends on the users input command (forward versus backward and left versus right).

**Conclusion:**

Currently both the prototype and the final circuit are complete. Many steps were taken to get to this point. Trying to implement the accelerometer to the transmitter proved to be difficult. By adding RC filters I was able to control which frequencies were sent to the comparators. Through testing, the device correctly controls the RC car through tilt and roll motions of the controller.

This project shows what type of applications and capabilities lie within the accelerometer. The accelerometer provides intuitive control of the RC car. The finished device is simpler and more profound than the original. Clearly accelerometers have applications with RC vehicles.

After the completion of this project there is a better understanding of implementing an accelerometer to an RC car. Future ideas include using an accelerometer to determine if a digital output or analog output is easier and more efficient to use.

**Acknowledgements:**

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