# ECE 411 Industry Design Processes
# Homework 7:
# Test Plan on Hand Motion Controlled Robot

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Ver. 1

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https://github.com/GomathyVenkat/411Practicum

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# 1. Introduction

- The objective of the product test plan is to measure the overall performance of the product, detect any faults, and fix or improve the outcome. By establishing a test plan, the final product becomes traceable, repeatable, durable, and reliable.
    - **Hardware**
        - Each hardware component or module must function correctly for coherent with software modules.
    - **Software**
        - High and low level algorithm shall be set and documented.
        - Code must be capable of translating x & y values from accelerometer output pins into 4-bit output values that control 2 motors' operations.

# 2. Reference Documents

- Each document provides the detail information used in establishing testing guidelines and plan.

### 2.1 Industry Standards

- A guide to United States Electrical and Electronic equipment Compliance Requirements
    - 47CFR15-Radio Frequency Device

### 2.2 Design Documentation

- Product Design Specification - Hand Motion Controlled Robot
- Block Diagram
- EagleCAD Transmitter Schematic
- EagleCAD Receiver Schematic
- Transmitter PCB Layout
- Receiver PCB Layout
- Ohs Park 2 layers Design Rules

### 2.3 Datasheets

- Atmega328 - Microcontroller
- HT12E - Encoder
- LM7805 - 5V Voltage Regulator
- AVR910 - In System Programming
- ADXL335 - Accelerometer
- REG1117 - 3.3V Voltage Regulator
- HT12D - Decoder
- L293D - Driver IC
- Robot Chassis
- Receiver/Transmitter
    - Testing Receiver and Transmitter
    - Specification

### 2.4 Other Documentation

- Project Plan
- Bill of Material

# 3. Overview of Testing Approach and Objectives

- Levels of testing are implemented to observe the functionality of individual modules and detect any faults in the early stages so that the overall product is made up of well-functioning hardware and software modules. The plan is to start with testing each individual module to detect and identify any faults and to note its behavior and functionality. Next, these tested modules are integrated and tested together to see if they are working. At this level of testing, we will be able to identify interconnection problems if any exists. Lastly, all of the modules are connected and measure the output value when the input signal is on. This level of testing illustrates whether the testing is repeatable. It also validates the product's overall functionality, stability, traceability, and durability.

**3.1 Levels of Testing**

3.1.1 Level 1: Unit Testing

Unit testing is to verify the functionality of individual module.

- Objective
  - Perform detailed test of all functional requirements
  - Perform Black Box testing
  - Perform White Box testing
  - Detect and fix any errors

3.1.2 Level 2: Integrated Testing

Integrated testing is to verify the function of combined modules.

- Objective
  - Verify the performance of multiple modules operating together
  - Detect and fix any errors

3.1.3 Level 3: System Testing

System testing is to determine if the overall product functions as expected.

- Objective
  - Confirm the expected and measured input and output
  - Ensure the final product functions as it is designed
  - Detect and fix errors

**3.2 Operational Description**

- Accelerometer output gets encoded and transmitted wirelessly to the receiver where the received signal gets decoded and gives the direction and movement of motors.

**3.3 Terminology**

- TX: transmitter
- RX: receiver

# 4. Resources & Pretest Preparation

- We will rely on devices which provide consistent values to the testing.

**4.1 Personnel Involvement**

  - Mark/Yebin:
    - Testing Tx to Rx wireless communication
    - Supply voltages
  - Gomathy/Tapas:
    - Robot chassis functionality

- Accelerometer functionality with tested code.

**4.2 Test Equipment**

- Function generator
- Ammeter
- Voltmeter
- Arduino Uno
- Solder Station
- PC running Windows 10
- Arduino IDE

**4.3. Test Setup and Calibration**

- Main test setup consists of a PC connected to an Arduino Uno (functioning as a programmer) connected via ISP to microcontroller (Atmega328p) on TX PCB.
- Accelerometer is calibrated by placing accelerometer module parallel to ground and setting that position as the origin.

**4.4 Level of Skill**

- Hardware
  - Personnel has some knowledge on electronics or electrical components.
  - Personnel knows how to solder**.**
- Software
  - Personnel has some knowledge on C and ARM assembly programming language (know how to develop high and low level algorithms).

# 5. System Tests Outline

- The test ID format will be Level# - Type ## - Rev. no.
  - Ex)**L1-F01-A** → Level 1 - Functional Testing 01 - Rev no. A

| **Testing Levels** | | **Testing Types** | |
|---|---|---|---|
| 1 | Unit testing | F | Functional Testing |
| 2 | Integration testing | P | Parametric Testing |
| 3 | System testing | R | Reliability Testing |
| 4 | | U | Use Testing |

- **Level 1: Unit Testing**
  - Functional Testing
    - L1-F01-A: Transmitter module test
    - L1-F02-A: Receiver module test
    - L1-F03-A: Voltage regulator test
    - L1-F04-A: Accelerometer test
    - L1-F05-A: ISP and microcontroller
  - Parametric Testing
    - L1-P01-A: X and Y from accelerometer
    - L1-P02-A: Input and output voltage
    - L1-P03-A: RF communication distance testing

- Reliability Testing
  - L1-R01-A: Circuit Connection test
  - L1-R02-A: Hand motion test
  - L1-R03-A: RF communication

- **Level 2: Integrated Testing**
  - Functional Testing
    - L2-F01-A: Transmitter and receiver communication test
    - L2-F02-A: Data transfer indicator
    - L2-F03-A: Accelerometer reaction indicator - LED
    - L2-F04-A: Accelerometer reaction indicator - Robot chassis
  - Parametric Testing
    - L2-P01-A: Power efficiency test
    - L2-P02-A: X and Y coordinates test
    - L2-P03-A: Test point (current and voltage)
- **Level 3: System Testing**
  - Functional Testing
    - L3-F01-A: Usability test
    - L3-F02-A: End to end hardware
    - L3-F03-A: Input to output test
    - L3-F04-A: Antenna test
  - Use Testing
    - L3-U01-A: Ease of use test
    - L3-U02-A: Accelerometer input test
  - Reliability Testing
    - L3-R01-A: Repeatability test
    - L3-R02-A: Battery lifetime

# 6. Test Cases

- **L2-F03-A: Accelerometer reaction indicator - LED**

| Test Writer: Gomathy Venkata Krishnan | | | |
|---|---|---|---|
| Test Case Name: | Accelerometer reaction indicator: Rx LED response | Test ID#: | L2-F03-A |
| Description: | Exhaustive testing of all possible hand tilts of user and Rx chip antenna response check. | Type: | Integrated Testing<br>Functional testing |
| Tester Information: Electronics technician skills and basic understanding of accelerometer required | | | |
| Tester Name/Sig: | Tapas Sastry | Date: | 11/27/2017 |
| Hardware Version: | Rev. A | Time: | 10:00 am |
| Setup: | Rev. A: code loaded onto the Atmel chip on transmitter side. Transmitter and Receiver side powered by battery and power sources. Turn on switch on receiver board. Tie the glove that holds on to the receiver board. Tilt hand forward, backward, left and right and observe lighting up of LEDs on Rx board. | | |

| Step | Action | Expected Result | Pass | Fail | Comments |
|---|---|---|---|---|---|
| 1 | Turn hand upwards | LED A is on. | ✓ | | |
| 2 | Turn hand right | LED B is on. | ✓ | | |
| 3 | Turn hand left | LED C is on. | ✓ | | |
| 4 | Turn hand backwards | LED D is on. | ✓ | | |
| 5 | Keep hand parallel to earth. | No LEDs are on. | ✓ | | |
| Overall test results: Good | | | | | |

- **L2-F04-A: Accelerometer reaction indicator - Robot chassis**

| | | | |
|---|---|---|---|
| Test Writer: Gomathy Venkata Krishnan | | | |
| Test Case Name: | Accelerometer reaction indicator: Rx robot chassis movement. | Test ID#: | L2-F04-A |
| Description: | Exhaustive testing of all possible hand tilts of user and robot chassis response check. | Type: | Integrated Testing<br>Functional testing |
| Tester Information: Electronics technician skills | | | |
| Tester Name/Sig: | Tapas Sastry | Date: | 11/27/2017 |
| Hardware Version: | Rev. A | Time: | 1:00 pm |
| Setup: | Rev. A: code loaded onto the Atmel chip on transmitter side. Transmitter and Receiver side powered by battery and power sources. Turn on switch on receiver board. Tie the glove that holds on to the receiver board. Place transmitter board on a robot chassis which is connected to the battery. Tilt hand forward, backward, left and right and observe movement of the vehicle. | | |

| Step | Action | Expected Result | Pass | Fail | Comments |
|---|---|---|---|---|---|
| 1 | Turn hand upwards | Robotic vehicle paces forward. | ✓ | | |
| 2 | Turn hand right | Robotic vehicle turns right and moves in the same direction. | ✓ | | |
| 3 | Turn hand left | Robotic vehicle turns left and moves in the same direction. | ✓ | | |
| 4 | Turn hand backwards | Robotic vehicle paces backward. | ✓ | | |

| | | | | | |
|---|---|---|---|---|---|
| 5 | Keep hand parallel to earth. | Robotic vehicle stops. | ✓ | | |
| Overall test results: Good | | | | | |

- **L2-F01-A: Transmitter and receiver communication test**

| Test Writer: Yebin Woo | | | |
|---|---|---|---|
| Test Case Name | Transmitter and receiver communication test | Test ID#: | L2-F01-A |
| Description | Make sure two modules are communicating with or without antennas | Type: | Integration test<br>Functional test |

| Tester Information | | | |
|---|---|---|---|
| Tester Name/Sig: | Yebin Woo/Mark Kaldas | Date: | 11/20/17 |
| Hardware Ver.: | 1.0 | Time: | 1:00 pm |
| Setup: | Connect a switch to a data pin on the transmitter module and a LED to a data pin on the receiver side. 5V to the data pin means on (=1) and ground to the data pin means off (=0). When switch is pushed, the transmitter would transmit “1” to the receiver, then the LED flashes. | | |

| Test | Expected Result | Pass | Fail | Comment |
|---|---|---|---|---|
| Switch pushed | LED turns on when button is pushed<br>LED turns off when button is released | ✓ | | |
| Overall test result: Good | | | | |

- **L1-F02-A: Receiver module test**

| Test Writer: Yebin Woo | | | |
|---|---|---|---|
| Test Case Name | Receiver module test | Test ID#: | L1-F02-A |
| Description | Test if the receiver circuit is outputting enough voltage and current to drive motors. | Type: | Unit test<br>Functional test |

| Tester Information | | | |
|---|---|---|---|
| Tester Name/Sig: | Yebin Woo/Mark Kaldas | Date: | 11/18/17 |
| Hardware Ver.: | 1.0 | Time: | 4:00 pm |
| Setup: | Set and connect components as the receiver schematic shows. Receiver circuit consists of a voltage regulator, a decoder, a driver IC, and a receiver module. Check the output voltage coming out of voltage regulator. Check the output current and voltage at the Driver IC. Test the receiver; check if the receiver and transmitter communicate by using an indicator, such as LED. | | |

| Test | Action | Expected Result | Pass | Fail | Comment |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Voltage regulator | Measure the output voltage from the L7805 | Expected voltage, 5V is measured. | ✓ | | |
| Driver IC | Measure the output voltage and current from each output pin | $V_{out}$ = 5V (Motor ON)<br>$I_{out}$ = 100mA (Motor ON) | ✓ | | |
| Overall test result: Good | | | | | |