**SoutheastCon Hardware Design Competition- Team 1B**

**Needs and Requirements Analysis**

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Authors: Lorenzo Smith, Louis Cooper, Chelsea Ogle, Ivan Vargas, Evan Marshall**

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7. **Design Team Introduction**

**Lorenzo Smith- Project Manager**  
*Technical Specialty: Robot Mechanics and Design*

The Project Manager creates the project plan, assigns tasks with deadlines, sets meetings and plans timelines. The Project manager is also responsible for communication between external sponsors, as well as risk management, and resolution of issues within the team.

**Louis Cooper- Treasurer***Technical Specialty: Communication, Power, and Motors*

The Treasurer has the primary responsibility of overseeing the management and reporting of the team’s finances. The Treasurer should be knowledgeable about all financial events regarding the project. All financial documents will be properly stored and readily available for review.

**Chelsea Ogle- Secretary***Technical Specialty: Power and Design*

The secretary’s main responsibility is to keep a record of the meetings for the project, including their duration and the attendance of each member. Additionally, the Secretary is responsible for recording the contents of the meetings, including the information discussed and various goals achieved. This record will be made available online, for all team members.

**Ivan Vargas- Equipment Technician**  
*Technical Specialty:* *Microcontroller Programming*

The equipment tech will focus on overall assembly of the robot. There will be an emphasis on creating a robot that is easy to maintain repair while still looking professional. The equipment tech will also be one of the main programmers for the project.

**Evan Marshall- Assistant Equipment Technician***Technical Specialty:* *Microcontroller Programming*

The assistant equipment tech works closely with the equipment tech to ensure the efficient development of the robot. Programming and testing are the focal points of the assistant equipment tech, while creating and meeting technical deadlines for the project.

1. **Needs Analysis**
   1. **Project Overview**  
        
      SoutheastCon is an annual Technical, Professional and Student Conference held by IEEE. The convention features several competitions, including a hardware competition in which teams build robots that autonomously perform the tasks required in the competition rules. The goal of this project is to design and build a robot capable of competing in the 2015 SoutheastCon Hardware competition.  
        
      The rules for the hardware competition have not yet been finalized, but as of now there is a general idea of the requirements each competing robot must meet. The robot must be able to navigate a plywood (painted black) course by following a white line (course will vary), stopping along the way to play three games (Etch a Sketch, Simon Says Carabiner, Rubik’s Cube) and to pick a playing card from a deck. The robot must complete the course, bringing the playing card over the finish line, in five minutes or less. Teams earn points for each task completed, and the time it takes for the robot to finish the course. There are three rounds in which teams can gain points, and the team with the highest point total wins
   2. **Required Capabilities**

* **CAP-1**: The robot must be able to move about the course and handle the toys autonomously
* **CAP-2**: The robot must remain operational for the five minute duration of the course
* **CAP-3**: The robot must begin to move with the proper cue (the red LED being shut off)
* **CAP-4**: The robot must be able to execute turns
* **CAP-5**: The robot must be capable of following the white line of the course autonomously
* **CAP-6** : The robot must be able to be turned off/on via a user interface
* **CAP-7**: The robot must be able to locate and secure the three toys in place
* **CAP-8**: The robot must have components capable of gripping and turning the knobs of the Etch- A-Sketch and the top layer of the Rubik’s Cube, and pushing buttons.
* **CAP-9**: The robot must be able to recognize the pattern played by the Simon Says Carabiner (which colored buttons were pushed, and in what order)
* **CAP-10**: The robot must be able to pick a card from a deck, and hold onto it
  1. **Desired Capabilities**
* **DCAP-1**: The robot should be able to hold all of the toys in place using the same apparatus
* **DCAP-2**: The robot should be able to manipulate the Etch-A-Sketch knobs and the top layer of the Rubik’s cube using the same apparatus
* **DCAP-3**: The robot should be able to pick up the playing card without knocking over the deck, and leave the car in a useable state (bends and creases are acceptable)

* 1. **Operational Description**The robot will placed at the starting position and turned on by a user. When the red LED signal is powered off, the robot will begin following the white line that dictates the course, and stop to play the games in white boxes along the way (not necessarily in the following order). The robot will stop at the Simon Says toy, secure it in place, and power it on. The robot will recognize the pattern displayed by the toy, and execute it by detecting the colors of the buttons, and pressing them appropriately**.** At the Etch-A-Sketch, the robot will secure the toy in place, and turn the knobs on the device in a predetermined manner to write the word “IEEE”. When the robot reaches the Rubik’s cube, it will hold the bottom of the cube in place, and twist the top layer 180 degrees. Finally, the robot will take the top card from a deck without damaging it beyond playable condition, and carry it to the finish line. The robot will have the power supply and operational life to make it through the three five minute rounds of the competition, in which the process just described is repeated each time.

1. **Requirements Specifications**
   1. **Functional Requirements**

* **FREQ-1**: The robot must be capable of moving by some means (wheels, tracks) that allow for turns of at least 90 degrees.
* **FREQ-2**: The robot must be capable of operating for the three five minute rounds.
* **FREQ-3**: The robot must be able to distinguish the white line from the black course, and follow it.
* **FREQ-4:** The robot must be able to properly navigate the course, going to each toy zone in a specified manner, and finding the finish line. It must be able to navigate the course in under 5 minutes.
* **FREQ-5**: The robot must have a microcontroller unit(s) capable of interpreting audio and visual data collected from its sensors, in order to navigate the course and complete the required tasks without user interference
* **FREQ-6**: The robot must be able to detect the red LED switching off, and begin completing the course on this cue.
* **FREQ-7**: The robot must be able to determine the position of the toys in their white squares, and process their distance away, position itself to secure the toys in place, and then do so
* **FREQ**-**8**: The robot must have a gripping apparatus capable of holding all three toys in place.
* **FREQ-9**: The robot must be capable of locating and gripping the knobs of the Etch-A-Sketch, and the top of the Rubik’s Cube. The apparatus must be able open at least wide enough to grip the cube (preferably around 2.5”), and close completely.
* **FREQ-10**: The robot must be capable of locating and pressing buttons (the on button for the Simon Carabiner, and the different large colored buttons for playing the game)
* **FREQ-11**: The robot must be capable of distinguishing between at least the four colors of the Simon Carabiner.
* **FREQ-12**: The robot must be capable of distinguishing the different pitches of the four tones of the Simon Carabiner, and determine the corresponding order for pushing the colored buttons before the game times out.
* **FREQ-13**: The robot must be able to locate and grip the bottom of the Rubik’s cube, while simultaneously turning only the top layer around 180 degrees.
* **FREQ-14**: The robot must be able to locate and grip the Etch-A-Sketch, the robot arm must turn the knobs in a pre-programmed pattern in order to display the word “IEEE”.
* **FREQ-15**: The robot must have a means of picking up a playing card without damaging it beyond playable condition.

* 1. **Non-Functional Requirements**
* **NREQ-1**: Design should allow easy individual component testing (modular assembly).
* **NREQ-2**: The robot must use an easy to replace and easily implantable power source.
* **NREQ-3:** The robot must be easy to maintain and service.
  1. **Constraints**
* **CONS-1**: The robot must be no larger than a volume of 1 ft x 1 ft x 1ft, with all moving parts retracted as much as possible
* **CONS-2**: The prototype design must be completed before competing with the other potential SoutheastCon team at the FAMU-FSU College of Engineering, most likely one month before the day of the actual SoutheastCon Hardware Competition on April 9th, 2015.
* **CONS-3**: The cost of producing the robot may not exceed the budget, currently $750 (subject to change).

1. **Preliminary Test Plan**
   1. **Capabilities Test Plan**

* **CTEST-1 Movement Test:** The robot must power on and a simple program should control the robot’s movements and expected functionality should be verified. Successful movements in the four cardinal directions are the primary objective. (CAP-1, CAP-4)
* **CTEST-2 Software Test:** A software and hardware combination is chosen to execute programs that will control the robot. The microcontroller and associated software must interface between the different sensors and motors to execute different instructions. Basic functionality is tested to certify the correct operation of the pair. (CAP-1)
* **CTEST-3 Operating Life Test:** The robot should operate continuously for long periods of time. Power consumption will be observed over time to optimize the robot’s power supply. Heat dissipation will also be observed to prevent damage to electronics and hardware. While this capability is higher up in importance, it will not be possible to test the full power consumption of the robot until other features have been added and tested. (CAP-2)
* **CTEST-4 LED Response Test:** A selected light sensor should detect the on/off operation of a red LED light and interact accordingly. The red LED will be toggled on and off. The robot’s microcontroller should process the LED turning off as the signal to start, and respond accordingly. (CAP-3, FREQ-5)
* **CTEST-5 Line Following Test:** Mounted light sensors will detect different colors (between the white line and the black course) and adjust the robot’s motion to follow straight paths and small turns. The robot will be placed on a sample course in order to determine if it can perform line following successfully. (CAP-5)
* **CTEST-6 On/Off Test:** A robot on/off interface should control the power supplied to the components of the robot. The interface will be switched between the two positions (off/on), and whether or not the interface works correctly will be observed. Power should be correctly partitioned to meet the operating conditions of all electronics. (CAP-6)
* **CTEST-7 Distance Test/Toy Holding Test:** Through the use of infrared or sound sensors, the robot should be able to maintain a certain distance from the games to ensure proper execution. The robot will be placed in front of the toys, and after the distance is recognized, the robot should position itself properly, and be able to properly secure the toy in place. (CAP-7, DCAP-1)
* **CTEST-8 Robot Arm Test:** The robot should have an apparatus capable of gripping and turning objects with dimensions similar to that of the toys used. It also must move as desired for pushing buttons/picking up the playing cards. A test will be performed in which the robot arm(s) must perform these simple movements. (CAP-8, CAP-10, DCAP-2, DCAP-3)
* **CTEST-9 Sound Response Test:** The robot must demonstrate the ability to respond to the Simon Carabiner’s tones in a designed manner. Several different audio samples (corresponding to the ones needed) will be played for the sound sensor. The microcontroller should be able to register the different sound frequency levels and respond accordingly. (CAP-9)

* 1. **Requirements Test Plan\*\*\***
* **RTEST-1 Line Following/Mobility Test 2:** The robot must use mounted light sensors to detect the position of the white line on a black surface, and adjust its motion accordingly to follow it. The robot will be placed on a test course to see if it is capable of following the line. An emphasis will be placed on speed, accuracy, and the turning radius. (FREQ-1, FREQ-3)
* **RTEST-2 Power test:** With all of the necessary features completed on the robot, it, and its power source, should be capable of operating for at least fifteen minutes. (The total time of the three rounds) This is a minimum requirement, ideally it will last longer. In order to test this, the robot will be put through three rounds on a test course. The power source used should also be easily implemented and replaced (FREQ-2, NREQ-2)
* **RTEST-3 Game Zone Navigation Test:** The robot should be able to navigate a test course and correctly distinguish between the track and a game zone. Certain protocols should take place if the track splits. Also it must cross the finish line in under 5 minutes. Additionally, it will be tested that the robot begins the navigation of the course when the red LED turns off. (FREQ-4, FREQ-6)
* **RTEST-4 Toy Securing Test 2:** The robot must be able to interact with the toys in the correct order. This includes being capable of approaching their white boxes, positioning itself the correct distance from the toy, and closing the gripping apparatus enough to fit around the different dimensions of each toy, in the correct order. The robot will be placed on a test course to make sure it is capable of executing this. (FREQ-7, FREQ-8)
* **RTEST-5 LED Response Test 2:** The robot must detect different colored LED lights using mounted light sensors and respond in a designed manner. The microcontroller must accept the different inputs and control the mechanical arm in response. All movements should meet a certain timing condition within a certain degree of accuracy. The four different colors from *Simon* will be flashed (red, yellow, blue, green). (FREQ-11)
* **RTEST-6 Simon Carabiner Test:** The robot should correctly identify “Simon” and position itself to play the game. An initial program will activate Simon by having the robot arm press the on button. The next program will recognize the pattern Simon executed, from the frequency of the sounds. The robot must then press the correctly colored buttons in the same pattern, before the game times out. The robot will be tested against Simon for fifteen seconds, the amount of time necessary to achieve the most points. (FREQ-9, FREQ-10, FREQ-11, FREQ-12)
* **RTEST-7 Rubik’s Cube Test**: The robot should correctly identify the Rubik’s cube and position itself. First, the robot should firmly grip the entire bottom two layers of Rubik’s cube. Next, the mechanical arm should precisely grab one row or column of the cube and rotate it 180˚. Finally, the robot should release the cube and proceed to the next game zone. (FREQ-9, FREQ-13)
* **RTEST-8 Pocket Etch-A-Sketch Test:** The robot should correctly identify Etch-a-Sketch and position itself to firmly grip the toy in place. The robot should be able to grip each of the two knobs. A certain sequence of twists will be performed, using both knobs, to spell “IEEE” on the Etch-A-Sketch. Block and stick letters should be considered for diversity. All letters must be legible for maximum points. (FREQ-9, FREQ-14)
* **RTEST-9 Card Test:** The robot should correctly identify the deck of cards and position itself appropriately. It should be able to carefully separate one card from the deck, without knocking it over, and secure it for future travel. This could perhaps be achieved by something sticky attached to the robotic arm.  
  (FREQ-9, FREQ-15)
* **RTEST-10 Design Tests:** Throughout the process of designing and building the prototype, there will periodically be checks that the design remains modular for testing, and easy to maintain/service. (NREQ-1, NREQ-2)

**\*\*\*All Functional Requirement Tests check the Functional Requirement FREQ-5.**

* 1. **Constraints Test Plan**
* **ConsTEST-1 Size Test:** Periodic measurements will be taken throughout development to maintain and produce a robot under 1’x1’x1’ (with all moving parts retracted) constraint. (CONS-1)
* **ConsTEST-2 Deadline Test:** Weekly deadlines and goals will be placed to ensure efficient development of the robot. These objectives, which will include capabilities and requirement tests, will be met punctually (CONS-2)
* **ConsTEST-3 Budget Test**: In the beginning of the project, rough estimates will be made for the amount of money spent on supplies for the robot. As the project progresses, the budget will be watched carefully in order to ensure that there is enough money to accomplish all of the project’s goals. (CONS-3)

1. **Deliverables**The final project will be an autonomous robot that meets all needs and requirements set forth by Southeast Con 2015 Hardware Competition. The robot parts and equipment will meet the budget requirement, the hardware and software combine will fulfill the design objective.

The group is required to complete the project before the competition in April 2015. The proper documentation and project reports will make up the essentials of what will be delivered by the design team. The goal of the design group is to deliver a robot that will receive maximum points in the competition.

1. **References**

IEEE (2014, September 15). *SoutheastCon 2015 Hardware Competition Rules (DRAFT)*Retrieved from IEEE Web Site: http://www.ewh.ieee.org/reg/3/southeastcon2015/