Project Title

Software Requirements Specification

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Date	Revision #	Comments	Authors
03/06/2016	0	- Initial document creation	Eric Le Fort Max Moore Guy Meyer Ernest Selman Andrew Danha Derek Savery

Table 1: Revision History

1 Introduction

1.1 Project Overview

The purpose of this project is to provide the client with an autonomous solution for a pool playing partner. The system will utilize Visual Recognition (VR) to make its own decisions regarding shot selection and then move accordingly to take that shot.

1.2 Product Perspective

This section will outline various interfacing requirements as well as memory constraints of the system.

1.2.1 System Interfaces

The only system level interface in this project will be a simple user-facing one for obtaining commands such as: take a shot, move out of the way, or stop motion.

1.2.2 Hardware Interfaces

The user will have the ability to interface with the system using hardware either through buttons, sensors or other hardware solutions. This functionality will allow the user to give the system trivial commands relating to the status of the game.

1.2.3 Software Interfaces

The software will have two major interfacing requirements. The first will be in the formatting of the table state data that will be passed from MATLAB to the core programming language. The second will be in the formatting of instruction sets to be used by the μC. These formats must be designed to be syntactically consistent so that they can be understood by both subsystems.

1.2.4 Communications Interfaces

This system will have two inter-system communication interfaces:

1. VR to PC

   The communication between the VR and the PC will require the system to output the image takes by the VR to the PC for further computation.

2. PC to μC

   This method of communications defines the method of transferring information from the PC to the μC that will control the hardware.

3. μC to PC

   The μC will communicate a response back to the PC so that the PC can be sure that the message was both received and that the command is valid.

1.2.5 Memory Constraints

The PC will not be very limited in terms of memory since it will have large memory storage. The limitations of the PC will arise from its RAM memory which may cause the computations to take time.

The μC is more heavily constrained by its memory since most μC use chip memory that is generally in the order of Kilobytes.

1.3 Naming Conventions & Definitions

This section outlines the various definitions, acronyms and abbreviations that will be used throughout this document in order to familiarize the reader prior to reading.

1.3.1 Definitions

Table 2 lists the definitions used in this document. The definitions given below are specific to this document and may not be identical to definitions of these terms in common use. The purpose of this section is to assist the user in understanding the requirements for the system.

Table 2: Definitions

Term	**Meaning**
X-axis	Distance along length of pool table
Y-axis	Distance across width of pool table
Z-axis	Height above pool table
End-effector	The end of the arm that will strike the cue ball.
θ	Rotational angle of end-effector
Cue	End-effector
Direct shot	No obstacles between cue ball and target ball
Straight shot	A direct shot in which the cue ball, target ball, and target hole form a straight line
Break	This refers to the first shot at the beginning of a game of pool when the cue ball is used to strike and separate the rest of the arranged balls
Jump	In reference to a pool ball, this means that the ball loses contact with the table surface
Personal Computer	A laptop that will be used to run the more involved computational tasks such as visual recognition and the shot selection algorithm.
Camera	Some form of image capture device (e.g. a digital camera, smartphone with a camera, etc.)
Table State	The current positions of all the balls on the table.
Standard Shot	A shot that does not involve backspin, jumps, curving, etc. (i.e. trick shots)

1.3.2 Acronyms & Abbreviations

Table 3 lists the acronyms and abbreviations used in this document.

Table 3: Acronyms and Abbreviations

Acronym/Abbreviation	**Meaning**
VR	Visual Recognition
PC	Personal Computer
μC	Micro-Controller

2 Project Drivers

2.1 The Purpose of the Project

The purpose of this project is to provide pool players with an automated system that they can play against.

2.2 The Clients, the Customers, and Other Stakeholders

2.2.1 The Clients

- Dr. Wassyng

2.2.2 The Customers

- Professional pool players
- Amateur pool players
- Pool hall owners

2.2.3 Other Stakeholders

- Team Members
- Pool Table Manufacturers

2.3 Users of the Product

- Control test group
- Professional pool players
- Amateur pool players
- Demonstrators

3 Project Constraints

3.1 Mandated Constraints

These are the constraints that are outside of the control of the development team:

- 750 dollars investment limit
- Must create a functional prototype
- The group will be required to complete the entirety of this project by April 2017

3.2 Other Constraints

Other constraints that the development team decided would be necessary:

- System will be customized for a specific table
- The system should not be required to break the balls
- The system shall only perform standard shots
- No motion further than 2ft away from table (in the plane of the table surface)
- No motion/components further than 4ft above the table surface
- Cannot move at a dangerous speed other than striking the pool ball
- The system shall adhere to the rules of pool (e.g. only moving balls by taking shots with a cue, only striking the cue ball, etc.)
- Application of chalk to the cue will be handled manually
- The system will only operate in regular pool playing environments (i.e. indoors at room temperature with sufficient space and lighting)

3.3 Scope

The scope of the project includes only the components of pool that require the player to attempt and take a shot. In other words, the system will not handle freely placing a ball on the table, breaking at the beginning of the game, or automatically knowing when it should take its shot.

3.4 Relevant Facts & Assumptions

This section will outline various facts and assumptions that will be leveraged in the design of this system.

3.4.1 Facts

- Weight, size, and colour of the balls
- Table dimensions
- Table-ball static and dynamic coefficients of friction
- Ball-ball static coefficient of friction
- The spring constant of the table wall

3.4.2 Assumptions

- Table surface and walls are uniform
- Table plane is completely perpendicular to the force of gravity
- Balls are uniform in shape and density
- No interference will occur mid-shot (e.g. user moves a ball, stops a balls motion, etc.)
- Balls never jump

4 Requirements

The following section outlines the various requirements of this system. For each requirement, a description of the requirement, the rationale behind the requirement, and a fit criterion for when the requirement is satisfied are provided. The values given for customer satisfaction and dissatisfaction are from 0-5. The values for requirement priority are either high, medium or low.

Requirement types will correspond to the following table:

Requirement Type	**Description**
1	Software Capability
2	Software Communication
3	Mechanical
4	Electrical
LF	Look & Feel
UH	Usability & Humanity
P	Performance
OE	Operation & Environmental
MS	Maintainability & Support
SA	Safety
SE	Security
CP	Cultural & Political
L	Legal

Table 4: Requirement Types

4.1 Functional Requirements

The following is a collection of the functional requirements of this system:

Requirement #: 1 **Requirement Type**: 1

Description: Obtain visual data of the table.
Rationale: The system must be able to take in data to be used in the VR algorithm.
Fit Criterion: This requirement will be considered satisfied if the data obtained is of sufficient quality to be successfully used by the VR algorithm.

Originator: Eric Le Fort

Customer Satisfaction: 0 **Customer Dissatisfaction**: 0
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 2 **Requirement Type**: 2

Description: Communicate image data from camera to PC.
Rationale: The system will have a separate device for image capture. It is imperative that that device can communicate its data to the PC in order to be used in the VR algorithm.
Fit Criterion: This requirement will be considered satisfied if the data received by the PC is identical to the data transmitted by the camera 99.9%.

Originator: Eric Le Fort

Customer Satisfaction: 0 **Customer Dissatisfaction**: 0
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 3 **Requirement Type**: 1

Description: Create model of table state in software using VR.
Rationale: The table must be modelled such that the shot selection algorithm has information to work off of.
Fit Criterion: This requirement will be considered satisfied if the modelling of each ball on the table is accurate to within 1 centimeter of their actual position.

Originator: Eric Le Fort

Customer Satisfaction: 0 **Customer Dissatisfaction**: 0
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 4 **Requirement Type**: 1

Description: Select an optimal shot based off a series of simulations using the table state.
Rationale: The system must be able to come up with a shot to make given the table state.
Fit Criterion: This requirement will have various degrees of success. It will be considered satisfied on its simplest level if the system comes up with a shot that makes objective rational sense according to the user.

Originator: Eric Le Fort

Customer Satisfaction: 2 **Customer Dissatisfaction**: 4
Priority: Medium **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 5 **Requirement Type**: 2

Description: Communicate the model of the table state from MATLAB to the system's core programming language.
Rationale: MATLAB will only be used to compute VR calculations and a more suitable language will be utilized to handle the rest of the program's functionality. Therefore, the results that MATLAB arrives at must be passed to the other language.
Fit Criterion: This requirement will be considered satisfied if the data received by the core programming language is identical to that computed in MATLAB.

Originator: Eric Le Fort

Customer Satisfaction: 0 **Customer Dissatisfaction**: 0
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 6 **Requirement Type**: 1

Description: Create an instruction set for the embedded system based on the selected shot.
Rationale: Once a shot is selected, the system must then determine the necessary steps to take in order for the machine to be able to make the shot. This will include motion of all elements to position the end-effector at a suitable location from machine's current location as well as how the end-effector should strike the cue ball.
Fit Criterion: This requirement will be considered satisfied if the instruction set provided contains all necessary information and that information does in fact instruct the embedded system on how to go about making the selected shot.

Originator: Eric Le Fort

Customer Satisfaction: 0 **Customer Dissatisfaction**: 0
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 7 **Requirement Type**: 2

Description: Communicate the instruction set to the μC.
Rationale: The system must be able to communicate the instruction set generated on the more computationally powerful PC to the μC in order to operate the machine.
Fit Criterion: This requirement will be considered satisfied if the data received by the μC is identical to that computed in the PC 99.9% of the time.

Originator: Eric Le Fort

Customer Satisfaction: 0 **Customer Dissatisfaction**: 0
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 8 **Requirement Type**: 2

Description: μC should communicate a simple response back to the PC indicating receipt of the message.
Rationale: The PC should be able to verify that the μC received the message.
Fit Criterion: This requirement will be considered satisfied if the response received is identical to the response sent and if the response is correct given the current state of the system 99.9% of the time.

Originator: Eric Le Fort

Customer Satisfaction: 0 **Customer Dissatisfaction**: 2
Priority: Low **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 9 **Requirement Type**: 1

Description: The μC must be able to interpret the instruction to real-world controls.
Rationale: The instruction will be just tell the μC where to move. The embedded system must encode these instructions to the equivalent electrical signals.
Fit Criterion: This requirement will be considered satisfied if the control signals generated from the instruction set are correct.

Originator: Eric Le Fort

Customer Satisfaction: 0 **Customer Dissatisfaction**: 0
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 10 **Requirement Type**: 4

Description: The system should be able to detect the machine's current physical state at certain location.
Rationale: If the system has a way of verifying the machine's current physical state, it will be able to detect unexpected disturbances. This will lead to higher accuracy of instructions being generated in certain cases as well as enabling the machine to self-correct as necessary.
Fit Criterion: This requirement will have various degrees of success. It will be considered satisfied on its simplest level if it can be used to calibrate the system within negligible error (i.e. a default starting point to return to when in doubt). Other levels of success would include more set points that can be used as reference.

Originator: Eric Le Fort

Customer Satisfaction: 0 **Customer Dissatisfaction**: 0
Priority: Low **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 11 **Requirement Type**: 1

Description: The system must keep track of the machine's current physical state.
Rationale: In order to determine how to move the machine to take its next shot, the system must know the starting physical state of the machine.
Fit Criterion: This requirement will be considered satisfied if the physical state of the machine is updated correctly as expected movements are made by the machine.

Originator: Eric Le Fort

Customer Satisfaction: 0 **Customer Dissatisfaction**: 0
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 12 **Requirement Type**: 3

Description: The machine must be able to move the end-effector to the determined location and orientation.
Rationale: The system must be able to relocate the end-effector in order to make a shot.
Fit Criterion: This requirement will be considered satisfied if the machine moves close enough to the location specified by the system such that the shot can be made successfully 95% of the time.

Originator: Eric Le Fort

Customer Satisfaction: 5 **Customer Dissatisfaction**: 5
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 13 **Requirement Type**: 3

Description: The machine must be able to move the end-effector to strike the cue ball, taking a shot.
Rationale: The system must be able to strike the cue ball in order to actually take a shot. The force required will likely vary and therefore the system must be able to adjust accordingly.
Fit Criterion: This requirement will be considered satisfied if the machine actuates the end-effector within 5% of the specified speed.

Originator: Eric Le Fort

Customer Satisfaction: 5 **Customer Dissatisfaction**: 5
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 14 **Requirement Type**: 3

Description: The machine must be able to take user input to indicate options such as: take a shot, move out of the way or stop operation.
Rationale: The user will need to indicate to the system what it needs it to do. Automatically knowing what the user would desire from the machine is outside of the scope of this project.
Fit Criterion: This requirement will be considered satisfied if the embedded system can react to signals from the user signifying the specified functionalities within 5 seconds 90% of the time.

Originator: Eric Le Fort

Customer Satisfaction: 2 **Customer Dissatisfaction**: 5
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 15 **Requirement Type**: 3

Description: The machine must be capable of moving out of the way to pre-determined locations upon user request.
Rationale: The system must be able to move the machine out of the way if the machine is in the user's way while they are attempting to make a shot.
Fit Criterion: This requirement will be considered satisfied if after the machine is instructed to move out of the user's way it moves to a pre-determined location.

Originator: Eric Le Fort

Customer Satisfaction: 4 **Customer Dissatisfaction**: 3
Priority: Low **Conflicts**: None
Supporting Material: None

History: Created 01-NOV-2016

Requirement #: 16 **Requirement Type**: 3

Description: The system must be able to move the machine around the table as necessary.
Rationale: In order to make shots, the machine must first be able to move into place.
Fit Criterion: This requirement is satisfied if the system is able to move into any position required to take a shot.

Originator: Ernest Selman

Customer Satisfaction: 0 **Customer Dissatisfaction**: 0
Priority: Medium **Conflicts**: None
Supporting Material: None

History: Created 03-NOV-2016

Requirement #: 17 **Requirement Type**: 3

Description: The machine should be able to take a shot regardless of the table state.
Rationale: The machine needs to hit the cue ball without moving the other balls even if the cue ball is on the edge of the table or surrounded by other balls.
Fit Criterion: This requirement is satisfied if the machine is able to hit the cue ball in 99% of situations while adhering to the rules of the game.

Originator: Ernest Selman

Customer Satisfaction: 3 **Customer Dissatisfaction**: 4
Priority: Medium **Conflicts**: None
Supporting Material: None

History: Created 03-NOV-2016

Requirement #: 18 **Requirement Type**: 4

Description: Power supply for system must be transformed from AC to DC as necessary.
Rationale: Certain components will rely on DC power and the power source will only provide AC current.
Fit Criterion: This requirement will be considered satisfied if the necessary components can be successfully powered using an AC to DC converter.

Originator: Andrew Danha

Customer Satisfaction: 0 **Customer Dissatisfaction**: 0
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 02-NOV-2016

4.2 Non-Functional Requirements

The following is a collection of the non-functional requirements of this system:

4.2.1 Look & Feel Requirements

Requirement #: 2 **Requirement Type**: LF

Description: The general look and feel of the setup must sufficiently resemble a standard pool table.
Rationale: The setup must be familiar to the player such that they feel comfortable playing against the robot.
Fit Criterion: 90% of users should conclude that the look and feel of the setup sufficiently resembles a standard pool table.

Originator: Derek Savery

Customer Satisfaction: 1 **Customer Dissatisfaction**: 4
Priority: Low **Conflicts**: None
Supporting Material: None

History: Created 04-NOV-2016

4.2.2 Usability & Humanity Requirements

Requirement #: 1 **Requirement Type**: UH

Description: Players must be able to see the table setup upon their turn.
Rationale: The users must be able to see the table in order to make decisions about future shots.
Fit Criterion: 90% of users should conclude that the position of the machine does not inhibit their ability to see the game-state when it is their turn.

Originator: Maxwell Moore

Customer Satisfaction: 2 **Customer Dissatisfaction**: 4
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 03-NOV-2016

Requirement #: 2 **Requirement Type**: UH

Description: The design of the machine shall not greatly inhibit a players ability to make a shot.
Rationale: The users must be able to play alongside the machine.
Fit Criterion: 90% of users should conclude that the position of the machine does not inhibit their ability to make shots as well as they would be able to on a regular pool table.

Originator: Maxwell Moore

Customer Satisfaction: 1 **Customer Dissatisfaction**: 5
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 03-NOV-2016

Requirement #: 3 **Requirement Type**: UH

Description: The robot should not interrupt the player's turn.
Rationale: If the user chooses to stop the robot, the robot should remain stopped until activated by the user.
Fit Criterion: The robot shall not interrupt the player's turn 99.9% of the time.

Originator: Derek Savery

Customer Satisfaction: 1 **Customer Dissatisfaction**: 3
Priority: Medium **Conflicts**: Possibly with enforcing rules of game
Supporting Material: None

History: Created 04-NOV-2016

4.2.3 Performance Requirements

Requirement #: 1 **Requirement Type**: P

Description: The system will take shots within a reasonable amount of time.
Rationale: The user should not have to wait too long to play their turn.
Fit Criterion: The machine will make a shot in under 90 seconds after being instructed to 90% of the time.

Originator: Maxwell Moore

Customer Satisfaction: 1 **Customer Dissatisfaction**: 4
Priority: Medium **Conflicts**: None
Supporting Material: None

History: Created 03-NOV-2016

Requirement #: 2 **Requirement Type**: P

Description: The system will take shots precisely.
Rationale: The user should feel challenged by the system.
Fit Criterion: This requirement will be considered satisfied if the system performs to the minimum standards in terms of successful shots as set forth in the *Summary and Goals* document associated with this project.

Originator: Maxwell Moore

Customer Satisfaction: 4 **Customer Dissatisfaction**: 3
Priority: Low **Conflicts**: None
Supporting Material: Summary and Goals document.

History: Created 03-NOV-2016

Requirement #: 3 **Requirement Type**: P

Description: The machine should be light.
Rationale: If the machine is light it will be easier to relocate, be handled by the user, and it will require less power to move components.
Fit Criterion: This requirement is satisfied if the components are light enough to be moved by the system.

Originator: Ernest Selman

Customer Satisfaction: 0 **Customer Dissatisfaction**: 5
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 03-NOV-2016

Requirement #: 4 **Requirement Type**: P

Description: The body of the machine needs to be rigid.
Rationale: The body of the machine must be rigid in order to support the components necessary for taking shots.
Fit Criterion: This requirement is satisfied if the machine is rigid enough not to buckle excessively and to not be displaced by taking a shot.

Originator: Ernest Selman

Customer Satisfaction: 0 **Customer Dissatisfaction**: 4
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 03-NOV-2016

4.2.4 Operational & Environmental Requirements

Requirement #: 1 **Requirement Type**: OE

Description: The system should be able to be powered by a standard 120V AC 60Hz outlet.
Rationale: The system should be simple to power.
Fit Criterion: This requirement will be considered satisfied if all components of the system can be powered using a standard outlet.

Originator: Andrew Danha

Customer Satisfaction: 4 **Customer Dissatisfaction**: 5
Priority: Medium **Conflicts**: None
Supporting Material: None

History: Created 02-NOV-2016

4.2.5 Maintainability & Support Requirements

No support will be provided.

4.2.6 Security & Safety Requirements

Requirement #: 1 **Requirement Type**: S

Description: High voltage components should be safely secured from users.
Rationale: The system should not present electrical hazards.
Fit Criterion: This requirement will be considered satisfied if all high voltage components are not readily accessible to users without tampering.

Originator: Andrew Danha

Customer Satisfaction: 0 **Customer Dissatisfaction**: 5
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 02-NOV-2016

Requirement #: 2 **Requirement Type**: S

Description: Users should not be able to modify system to perform unsafe actions such as setting the power of a shot beyond a certain safe value.
Rationale: The machine will not be able to be used in a dangerous fashion.
Fit Criterion: This requirement is satisfied if 99.9% of users must not be able to figure out a way of making the system perform an unsafe action.

Originator: Maxwell Moore

Customer Satisfaction: 0 **Customer Dissatisfaction**: 0
Priority: Low **Conflicts**: none
Supporting Material: None

History: Created 03-NOV-2016

Requirement #: 3 **Requirement Type**: S

Description: Sensitive electrical equipment needs to be isolated from high voltage.
Rationale: Certain equipment like the μC and sensors can be damaged if connected to high voltage sources.
Fit Criterion: This requirement is satisfied if sensitive electrical equipment is not connected to high voltage sources that would cause damage.

Originator: Ernest Selman

Customer Satisfaction: 0 **Customer Dissatisfaction**: 0
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 03-NOV-2016

Requirement #: 4 **Requirement Type**: S

Description: All high voltage components should have circuit breakers.
Rationale: The system should be safe to use.
Fit Criterion: This requirement will be considered satisfied if the power supply is cut to all high voltage components of the system when the circuit is overloaded.

Originator: Andrew Danha

Customer Satisfaction: 0 **Customer Dissatisfaction**: 3
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 02-NOV-2016

Requirement #: 5 **Requirement Type**: S

Description:The μC must have a voltage regulator.
Rationale: The μC requires sufficient voltage/current to operate but may be damaged if too much voltage or current is supplied.
Fit Criterion: This requirement will be considered satisfied if the μC is provided with a regulated amount of voltage and current to operate.

Originator: Andrew Danha

Customer Satisfaction: 0 **Customer Dissatisfaction**: 5
Priority: High **Conflicts**: None
Supporting Material: None

History: Created 02-NOV-2016

Requirement #: 6 **Requirement Type**: S

Description: Users standing at least 2ft outside the perimeter of the setup will be in no danger of being harmed by any action taken by the mechanism.
Rationale: The robot shall not be able to harm users.
Fit Criterion: No user standing at least 2ft outside of the perimeter of the setup shall come to harm by any action taken by the mechanism.

Originator: Derek Savery

Customer Satisfaction: 1 **Customer Dissatisfaction**: 5
Priority: High **Conflicts**: none
Supporting Material: None

History: Created 04-NOV-2016

Requirement #: 7 **Requirement Type**: S

Description: There will be shutdown buttons located near any moving parts.
Rationale: Users should be able to signal the system to stop if they feel they are in danger.
Fit Criterion: Shutdown switches are located within reach of any possible dangerous location.

Originator: Derek Savery

Customer Satisfaction: 1 **Customer Dissatisfaction**: 4
Priority: High **Conflicts**: none
Supporting Material: None

History: Created 04-NOV-2016

4.2.7 Cultural & Political Requirements

Requirement #: 1 **Requirement Type**: CP

Description: There will be no direct references to any political or religious groups.
Rationale: This will avoid accidentally offending certain members of society.
Fit Criterion: This requirement will be considered satisfied if 99% of users say there is no noticeable political or cultural relevance.

Originator: Maxwell Moore

Customer Satisfaction: 0 **Customer Dissatisfaction**: 2
Priority: low **Conflicts**: none
Supporting Material: None

History: Created 03-NOV-2016

4.2.8 Legal Requirements

Requirement #: 1 **Requirement Type**: L

Description: There will be no copyright infringement, unlicensed usage of software, or services that have not been properly licensed.
Rationale: This will avoid academic dishonesty and maintain the moral integrity of the group.
Fit Criterion: An outside consultant will verify that there has been no copyright infringement, unlicensed usage of software, or services that have not been properly licensed.

Originator: Maxwell Moore

Customer Satisfaction: 1 **Customer Dissatisfaction**: 1
Priority: low **Conflicts**: none
Supporting Material: None

History: Created 03-NOV-2016

5 Project Issues

The issues to be addressed consider marketability, competition, safety, liabilities, or any other noticeable concerns. Furthermore, visual recognition, creating a pool table and the structural stability of the machine will be major challenges that must be overcome.

5.1 Existing Products

All known existing products are not publicly available. Nevertheless, these projects may affect the clients' view of the product and the overall marketability of the product.

5.2 Off-the-Shelf Solutions

Certain concerns involved in the development of this project can be addressed by using what has been created by others. There are various MATLAB libraries that can be leveraged in order to aid in the visual recognition segment of this project. A pool table can be purchased to avoid difficulties in creating a high quality table environment. The structure of the system can be optimized by purchasing high quality metals that are already machined in the appropriate fashion.

5.3 Risks

The risks found in this project generally describe the safety considerations found with both the creation and operation of the product. This machine may have quite strong motor and actuators that may be high current or high voltage devices. It is imperative that the user's safety is taken into account and that even a player without any electrical experience will be able to at least be around the table. Another risk is achieving high enough precision to actually make successful shots.

5.4 User Documentation & Training

In order to market the product the user will need to be provided with documentation regarding the operation, safety, and maintenance of the system. Although the product should be designed in a way that promotes ease of use, there must be some form of training required before the user can comfortably use the product. This may include a user manual or videos.