

Software Requirements Specification for Self-defense Training using Augmented Reality (STAR)

Version 1.0

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1. The Purpose of the Project

a. Background of the Project Effort

The need for a tool to train people for self-defense has been identified in this world that has limited emergency helplines but rising number of life threatening events. Several tools based on augmented reality are available for rigorous training of military personnels. These tools are majorly focussed at training the personnels to function effectively in a group during emergency situations for evacuation, rescue and other services. However, a need has been identified for a tool, that can train civilians in basic self-defense using augmented reality to provide them with a real-life experience without causing any potential injury, called Self-defense Training Using Augmented Reality (STAR).

The relevance of the above-mentioned tool has been established and, there being no applicable tool available, a project to create such a tool was conceptualised.

b. Goals of the Project

The project is built with the goal to train the users in basic self-defense moves by allowing them to interact, via headset and wristbands, with a potential attacker, which is made available in the form of a virtual avatar augmented in a real-world setup.

2. The Stakeholders

a. The Client

The client for this product is Department of Public Safety, who would eventually make the product available to the society for their use and benefit. The client solely holds the responsibility for approving changes in the scope of the project.

b. The Customer

The customer for this product is any organization that is interested in training people in basic self-defense for promoting the cause of safety.

c. Other Stakeholders

- i. Architecture Team : To design the scope and structure of the product.
- ii. Development Team : To manage, develop and test the product end-to-end.
- iii. Marketing Team : To handle sales and distribution of the product.
- iv. Regulatory Board : To enforce safety and standards of product.
- v. Maintenance Team : To maintain the compatibility of the product with updated version of the auxiliary devices.

d. The Hands-On Users of the Product

- i. Anyone training for self-defense.
- ii. Anyone verifying the product for risk assessment.
- iii. Anyone verifying the product features.
- iv. Other user characteristics: For each user, the following characteristics are defined :
 - Age
 - Gender
 - Height
 - Weight

3. Mandated Constraints

a. Solution Constraints

Description : The product shall be deployable on smartphones and tablets.

Rationale : The product should be easy for people to access.

Fit criterion : The user shall be able to learn and use the product without technical assistance.

Description : The product shall be available on Android and iOS platforms.

Rationale : Android and iOS are most common operating systems on phones and tablets.

Fit criterion : The product shall be end-to-end compatible on Android and iOS based devices.

b. Partner or Collaborative Applications

Description : The product shall be compatible with Vuzix M100 smart glasses.

Rationale : Vuzix M100 smart glasses shall be integrated with the product for visualization purpose.

Fit criterion : Vuzix M100 smart glasses shall show the 3D augmentation at all times during a session.

Description : The product shall be compatible with 2.2.1 version of Myo Gesture Control Armband.

Rationale : Myo Gesture Control Armband shall be integrated with the product for motion tracking.

Fit criterion : Myo Gesture Control Armband shall correctly read wrist movements at all times during a session.

Description : The product shall be compatible with 1.1.0 version of Cartogram IPS.

Rationale : Cartogram IPS shall be integrated with the product for location detection.

Fit criterion : Cartogram IPS shall detect accurate location of user in the premise at all times during a session.

Description : The product shall be compatible with map-display Sony Single-Lens Display Module.

Rationale : Single-Lens Display Module shall be clipped onto the Vuzix M100 for user-guidance.

Fit criterion : Sony Single-Lens Display Module shall show position of user in the premise during a session via Vuzix M100.

Description : The product shall be compatible with Oracle Database 12c.

Rationale : Oracle Database 12c shall be used for back-end data storage and analysis of the product.

Fit criterion : Every movement and action of user shall be recorded in database during a session.

c. Off-the-Shelf Software

Description : The product shall use a transparent pair of smart glasses with in-built camera and display.

Rationale : The product shall use smart glasses to project the Avatar into the real world.

Fit criterion : The user shall be able to see the Avatar as soon as the training session starts.

Description : The product shall use a wearable smart band.

Rationale : The product shall use the smart band to detect the position and motion of wrist.

Fit criterion : The product shall be able to track user's hand motion to calculate the results.

d. Anticipated Workplace Environment

Description : The product shall have display visible in sunlight.

Rationale : The product is being used for self-defence training; the user might want to train outdoors.

Fit criterion : The user shall be able to see the Avatar in bright sunlight.

Description : The product shall not be hazardous to humans in any way.

Rationale : The workspace may be home, so children might come in contact with the product.

Fit criterion : The product shall not harm children, animals or adults.

e. Schedule Constraints

Description : The product shall be available by 4th July, 2018.

Rationale : The product requires an estimated development time of at least 5 months and shall be launched on Independence Day.

Fit criterion : The product will be available for public use in the form of mobile application on 4th July, 2018.

f. Budget Constraints

The product budget shall be \$2 million.

4. Naming Conventions and Terminology

Name	Description
AR	Augmented Reality
Avatar	A 3D virtual image that is augmented on the image of real world.
Headset	Transparent pair of smart glasses with in-built camera and display.
Stance	A posture or way a user/avatar stands.
Wristband	A wearable smart band to detect the position and motion of wrist. Interchangeably used with “armband”.
STAR	Stands for Self-defense Training using Augmented Reality
Spatial Data	Refers to the 3D coordinates of the user and avatar in the ongoing training session.

IPS	Refers to the Indoor Positioning System, similar to Global Positioning System but suitable for indoor locations.
Map-display	A small size head-up display (HUD) for augmented layout of the indoor location for user guidance.
Auxiliary Device	Refers to devices that aid in the functioning of STAR eg. headset, wristband, map-display, IPS and database.

5. Relevant Facts and Assumptions

a. Relevant Facts

Survey shows that one sexual assault occurs every two minutes. Local police reports reveal that in eight out of ten rape cases, the perpetrator is someone known to the victim. One in four women is a victim of domestic abuse in her lifetime.

Amber Alert statistics for the year 2015 reveal that 182 cases of missing children were filed out of which 121 were family abduction cases.

b. Assumptions

The user is assumed to be always connected to the internet while using the product. Realtime upgrade of auxiliary devices is not available. Any upgrade in the devices will not affect the interface of STAR and might be incompatible with STAR unless a version update of STAR is available for such a device upgrade. Any update to the interface will necessitate a reassessment of functionality, time and costs for STAR.

6. The Scope of the Work

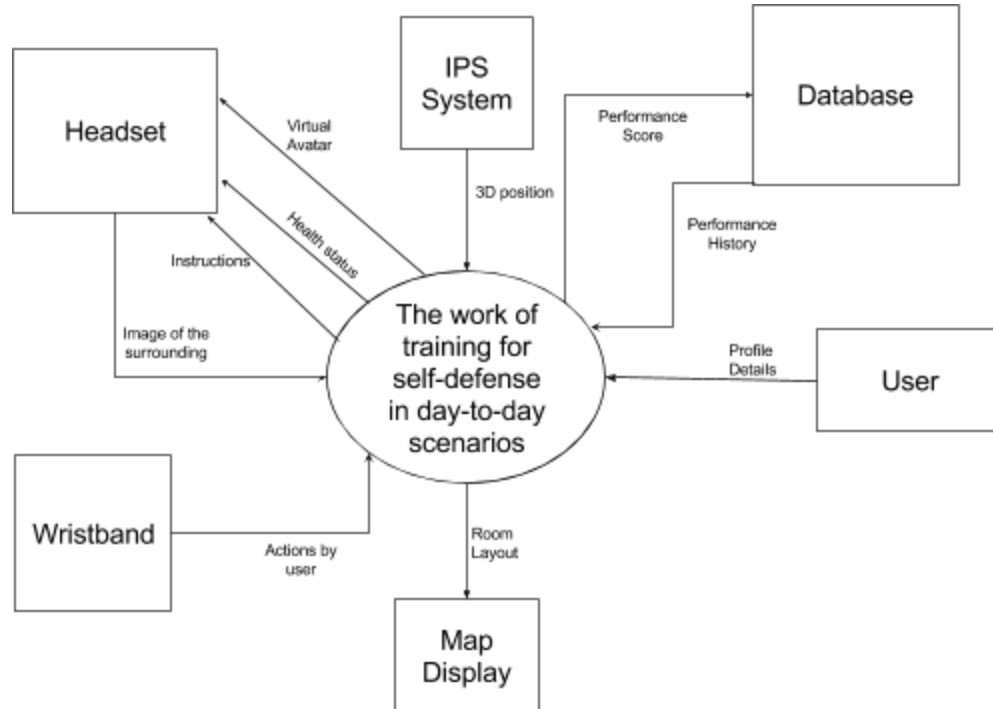
a. The Current Situation

Currently our target users engage in one-to-one training with trained personnels. This product enables user to instead train with a customized virtual avatar using augmented reality.

b. The Context of the Work

The context diagram describes the overall interaction of the product-work with

external systems. While the “User” is designated as a separate entity from “Headset” , “Map-Display” and “Wristband”, it is important to note that the user wears these devices during the use of the product. The data flows to and from these devices are dependent on the user activity.



c. Work Partitioning

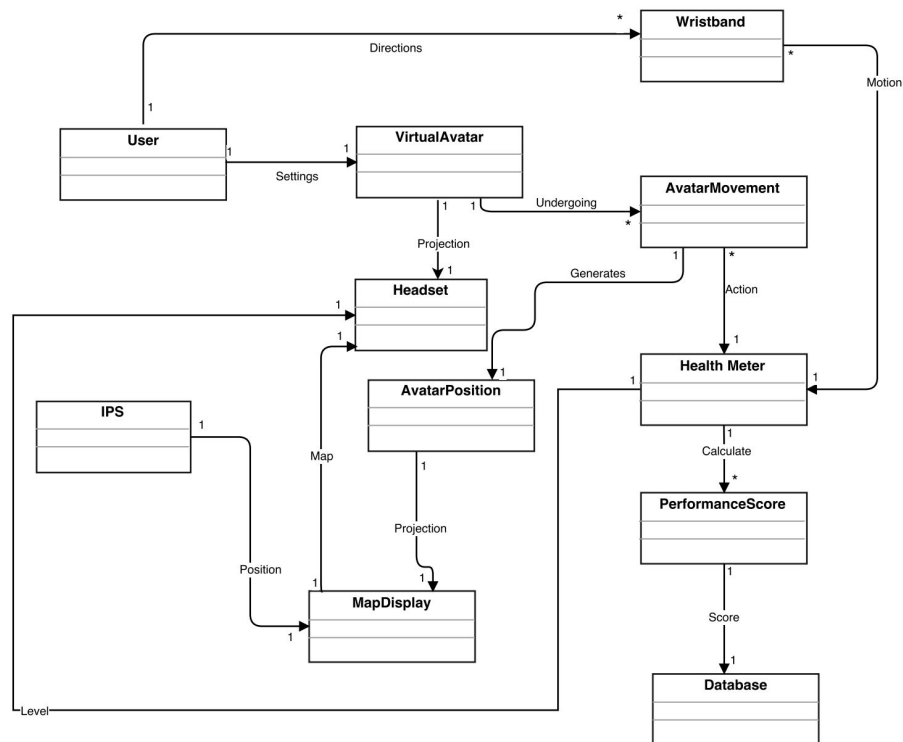
The entire work is partitioned into ten business events, each of which are separately investigated in the following sections.

#Business Event	Business Event Name	Input & Output	Summary
1	User enrolls in training	Enrollment information(in)	Authorize user to take part in the training
2	STAR verifies user information	Enrollment information(out)	Verifies the enrollment of user in the training.
3	User provides physique details	Physique Details(in)	Create a virtual avatar with stronger physique for the user to tackle.
4	Database sends performance history	Performance history(in)	Make the training more difficult/easy depending upon the history

5	Headset transmits the visual field it detects	View of real world captured by headset(in)	Allow user to see the avatar in the real surrounding
6	Time for the headset to project the virtual avatar	Superimposed 3D virtual avatar(out)	Allow user to train himself with different movements
7	Wristband transmits detected wrist movements	Hand movements(in)	Record hand movement of the user. Provide next stance of avatar for the user to tackle.
8	Database stores the performance score of ongoing session.	Performance score(out)	Record the successful hits made by the user on the avatar
9	IPS provides the location of ongoing session	Spatial data(in)	Record the spatial data for training session
10	Map-display shows the map of the area & position of the user and avatar	Map of the session (out)	Allow user to understand

7. Business Data Model and Data Dictionary

a. Business Data Model



b. Data Dictionary

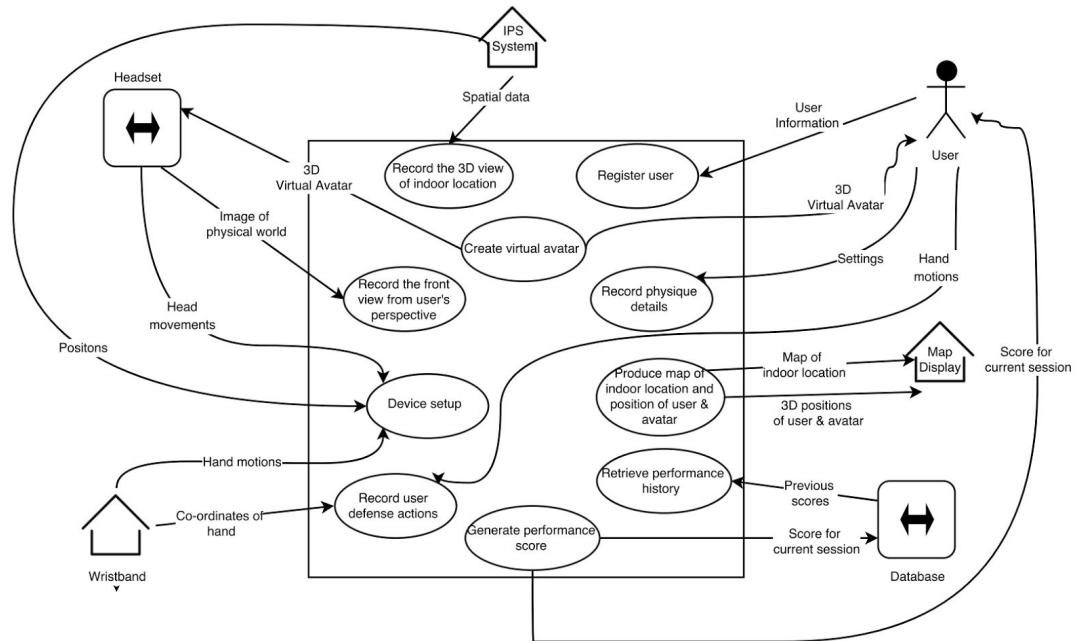
Data Name	Definition	Data Type
Headset	Map+Projection	Class
IPS	Position	Class
Wrist Band	Direction+Motion	Class
Map-display	Displayed using grid	Attribute/Element
User	Directions+Settings	Class
Database	Score	Class
Avatar	Setting+Projection+Motion	Class
Performance Score	Determined by an integer; performance is directly proportional with integer value; List of weak user actions.	Attribute/Element
Health Meter	Action+Calculation	Class
Avatar motion	Position + Action	Data Flow
Position	Determined using latitude and longitude coordinates	Data Flow
Settings	Physical details of the user, choice of avatar strength	Attribute/Element
Direction	Determined using angles of cardinal direction; North,East,South,West	Data Flow
Projection	High resolution display in the air	Data Flow
Action	Determined using wristband	Data Flow
Calculation	Evaluating user actions and updating the score	Attribute/Element

8. The Scope of the Product

a. Product Boundary

The product boundary diagram identifies the boundary between STAR and different adjacent systems classified as active actors (person icon), autonomous

actors (house icon) and co-operative actors (double-sided arrows). Autonomous actors are IPS System, Map-display and wristband that are involved in unidirectional dataflow. Co-operative actors are headset and database that continuously provide results and are updated in real-time based on user activity.



b. Individual Product Use Cases

1.

Product Use Case Name: Register new user.

Trigger: User uses the product

Precondition : The user is new on the system.

Stakeholder : User, Registration System

Actor : User

1. STAR asks for user's registration email-id.
2. The user provides the email-id.
3. STAR asks for user to choose a username and password.
4. The user provides username and password.

Outcome : The user is registered to use the product.

2.

Product Use Case Name: Initial software and device setup.

Trigger: User registers in the product

Precondition : The user is new on the system.

Stakeholder : User, IPS, Headset, Wristband

Actor : User

1. STAR verifies the connection with auxiliary devices.
2. STAR performs software setup with auxiliary device:
 - 2.1. STAR detects compatibility with devices.
 - 2.2. STAR updates software with recent modifications.
 - 2.3. STAR is incompatible with at least one auxiliary device. (!)
3. STAR asks for headset and wristband calibration.
4. The user calibrates headset and wristband.

Outcome : The auxiliary devices are setup successfully with the product.

3.

Product Use Case Name: Record physique details.

Trigger: User logs into the system.

Precondition : The user is registered on the system.

Stakeholder : User, Registration System

Actor : User

1. STAR asks for user's age, gender, height & weight.
2. The user provides the details :
 - 2.1. The user provides new input for the details.
 - 2.2. The user continues with stored details.
3. STAR suggests a physique data of avatar for training based on user input.
4. The user provides input :
 - 4.1. The user approves the suggested physique detail of the avatar
 - 4.2. The user customizes the physique of avatar

Outcome : The user is ready to start session and the dimension of the virtual avatar is set.

4.

Product Use Case Name: Retrieve performance history.

Trigger: User starts a session.

Precondition : Physique details are available.

Stakeholder : Database Management System, User

Actor : Database

1. STAR retrieves history from the database.
 - 1.1. The history is retrieved.
 - 1.2. The history is not retrieved. (!)
 - 1.3. STAR sends error report to the development team. (!)

- 1.4. STAR retrieves retrieval of history.(!)
2. STAR sets the difficulty level of the upcoming training session as per the history.
3. STAR suggests avatar physique based on the history.

Outcome : The difficulty level of training session is set.

5.

Product Use Case Name : Record the front-view from user's perspective and height from ground-level.

Trigger : User starts a session.

Precondition : Headset is connected

Stakeholder : User, Headset, IPS

Actor : Headset, User

1. STAR receives the front view of the surrounding from headset.
2. STAR records the height of headset from ground-level.
3. STAR determines the appropriate position in front of the user to place the virtual avatar.
4. The headset records the movement of the virtual avatar.
5. The headset provides guidance to the user
 - 5.1. The headset instructs to step back when avatar moves forward.
 - 5.2. The headset instructs to block and crouch when the avatar punches.
 - 5.3. The headset instructs to jump aside when the avatar kicks.

Outcome : The initial placement position of the avatar is determined. Instructions to tackle the avatar are provided.

6.

Product Use Case Name : Record 3D view of the indoor location.

Trigger : User starts a session.

Precondition : IPS is turned on and connected.

Stakeholder : IPS, User

Actor : IPS

1. STAR receives the 3D position of user in the location from the IPS.
2. STAR receives the location of the nearby objects from the IPS.
3. The IPS generates the indoor map and feeds STAR to display a map.

Outcome : The spatial data of the training location is generated and recorded by STAR.

7.

Product Use Case Name : Create a virtual avatar

Trigger : User starts a session.

Precondition : Details of virtual avatar and performance history is available.

Stakeholder : Headset, IPS, User

Actor : Headset

1. STAR creates a virtual avatar of specified details.
2. STAR places the avatar in the indoor location virtually.
3. STAR embeds the avatar with certain difficulty level as per performance history.

Outcome : The virtual avatar is placed in front of the user to train for self-defense.

8.

Product Use Case Name : Produce map of indoor location and position of user & avatar

Trigger : The session is started.

Precondition : Headset is connected. IPS is active.

Stakeholder : Map-display, IPS, User

Actor : Map-display, Headset

1. The map-display informs user about real-time relative position of the avatar.
2. The map-display shows the position of indoor objects to the user.
3. The map-display provides visual aid to user about movement of avatar.
 - 3.1. The headset instructs to move away when the avatar moves closer.
 - 3.2. The headset instructs to crouch when the avatar punches.
 - 3.3. The headset instructs to jump aside when the avatar kicks.

Outcome : Notification to user about position & actions of avatar. Guidance to user to tackle avatar.

9.

Product Use Case Name : Record user defense actions

Trigger : User moves his/her hands

Precondition : Wristband is worn and switched on.

Stakeholder : Wristband, Headset, User

Actor : User, Wristband

1. STAR receives the defense movements from wristband.
2. STAR records the precision of the movements w.r.t the virtual avatar.
 - 2.1. The wristband measures the movements incorrectly. (!)
 - 2.2. The wristband is calibrated and re-connected. (!)
3. STAR prescribes hand movements to users via headset.

Outcome : The movements made by user is tracked and accounted appropriately.

10.

Product Use Case Name : Generate performance score

Trigger : The user ends session or time-up.

Precondition : A session was ongoing for at least 5 minutes.

Stakeholder : Wristband, Database, User

Actor : Database

1. STAR tracks the successful actions of user.
2. STAR provides score to each action of user.
 - 2.1. STAR fails to generate score. (!)
 - 2.2. STAR sends error report to the development team. (!)
3. STAR provides informative remarks to user for future trainings.

Outcome : The overall performance result of the user for the session is obtained.

N.B: Exceptional scenarios are marked as (!)

9. Functional Requirements

a. Functional Requirements

Priority Key is 1 to 5 in decreasing order; 1 meaning highest priority.

Rqt #	Description	Rationale	Fit Criterion	Priority	PUC
1	The product shall allow an unregistered user to create an account.	To enable new customers to use the product.	A new customer shall be able to register with a valid email address.	1	8.b.1
2	The product shall allow an new user to choose username and password.	To enable user to access his/her account in the product with ease.	A new customer shall be able to choose a unique username. Password shall be	1	8.b.1

			minimum of 8 characters with at least one digit and one special character.		
3	The product shall perform initial software setup with auxiliary devices.	To abstract setup details from users for their ease.	The user shall not configure the software to use the product.	1	8.b.2
4	The product shall verify the connection status with the auxiliary devices.	To enable users to train in AR.	The user shall be able to check the connection status of various devices on the smartphone.	1	8.b.2
5	The auxiliary devices such as headset and wristband shall be calibrated after connecting with the product.	To get accurate readings from the devices for score generation.	The user shall do an initial calibration for the first time he uses the product.	1	8.b.2
6	When user logs into his account and while no prior settings are available, the product shall allow user to enter settings.	To allow user to choose the AR settings.	The newly registered user shall be able to enter settings for the first time compulsorily and optionally thereafter.	1	8.b.3
7	When user registers a new account, the performance score will be set to zero.	To allow user to be able to track his improvement from start.	The newly registered user shall see no performance history.	2	8.b.3
8	When an unregistered user creates an account for the first time, the health meter will show level 100%.	To allow user to be able to track his performance from start.	The newly registered user shall see no reduction in health.	2	8.b.3
9	When user logs into his account and while prior setting are available, the product shall allow user to choose existing settings or enter different settings.	To enable ease of use for user.	The user shall be able to continue with stored settings or change settings, if needed.	2	8.b.3
10	When user enters the settings, the product shall be able to store the details for the account.	To track different settings used for training.	The database shall be updated for every settings made by user.	2	8.b.3
11	When user enters the settings, the product shall set the physique parameters of the virtual avatar.	To allow user to customize the settings.	User shall be able to choose between lighter or heavier avatar.	1	8.b.3

12	When user is entering the setting, he/she can choose the level(beginner / easy / medium / difficult)	To allow user be able to choose the level of difficulty.	The user shall choose the level (beginner / easy / medium / difficult)	2	8.b.3
13	When the user is entering the settings, the product shall accordingly set the virtual avatar based on the user settings of difficulty level.	To allow user be able to experience the effect of settings chosen by him.	The physical details of the virtual avatar shall be in accordance with the settings chosen.	1	8.b.3
14	When user is entering the settings, he/she should have the option to enter any special medical condition. (ex. Heart disease)	To disallow users with certain disabilities from participating in intensive training..	The product shall keep the intensity of training low in case of user disability	3	8.b.3
15	While the database is connected and an user account is logged in, the product shall be able to retrieve performance history.	To allow users to browse their performance history on phone without requiring auxiliary devices.	No auxiliary devices shall need to be connected in order to only browse performance history.	1	8.b.4
16	When the user history is retrieved, the product shall embed the virtual avatar with strengths based on the history.	To make the training a continuous process.	The proficiency level of training at certain difficulty level shall continue from previous session of same difficulty level.	4	8.b.4
17	When the user history is retrieved, the performance bar will indicate the last level succeeded by the user.	To allow user to gauge his recent performance.	The user shall be able to see last level accomplished.	3	8.b.4
18	When the user history is retrieved, the product shall give an option to the user to continue on the same level or attempt a higher level.	To allow user to have an option to train at a more difficult level for scope of improvement.	Based on history, the user receives a suggested level to be trained in.	3	8.b.4
19	When user history is retrieved, the user shall have the option to replay the last training session.	To allow user to have an option to train at a same level for scope of improvement.	Based on history, the user receives a suggestion to re-train at same level.	3	8.b.4
20	While the headset is connected and an user account is logged in, the headset shall record the height from ground-level.	To place the avatar at the same ground level.	The user shall see the avatar standing on the ground level same as user.	1	8.b.5

21	While the headset is connected and an user account is logged in, the headset shall record the front-view from user's perspective.	To place the avatar initially in front of the user.	The user shall be able to see the avatar through the headset when the session begins.	1	8.b.5
22	When the height and the front-view is recorded, the headset shall send the information to the product.	To place the avatar initially in front of the user at an appropriate height.	The user shall be able to see the avatar placed at ground level.	1	8.b.5
23	When the front-view and height information is received, the product shall calculate the initial placement position of virtual avatar.	To make the avatar move around in the premise with initial point point being a reference point.	Initial position of the avatar would be marked as visited in the database.	1	8.b.5
24	While the IPS is connected and an user account is logged in, the IPS shall record the positions of objects in indoor location.	To allow accurate placement of avatar within the premise.	Positions of all objects in the indoor location would be marked in the database.	1	8.b.6
25	When the 3D view of indoor location is recorded, the IPS shall send the information to the product for processing to map-display.	To allow user to have a view of the premise layout.	The map-display shall show the layout of entire premise through the headset.	1	8.b.6
26	When the spatial information is received, the product shall calculate the trail to be followed by the virtual avatar during training session.	To allow avatar to move around the premise.	The user shall be able to tackle the avatar by moving around the premise.	1	8.b.6
27	When the IPS feeds the spatial data to the product then the user shall take decision on his actions by the guidance of the map-display.	To allow user to be guided by map-display for movement around the room.	The user shall be able to see the position of the avatar in the premise through the map-display.	1	8.b.6
28	While the IPS is connected and an user account is logged in, the user should have an option to select the distance he/she wants to cover. (may be the user wants to train in a confined area)	To allow user to be able to decide his level of comfort for movement for the specific training.	The user shall be able to choose the amount of training area to be covered.	2	8.b.6

29	When the area coverage is set, the user should have the option of enabling or disabling the instructions shown by the headset.	To enable user to train with or without instructions.	The user shall be able to disable/enable instructions before the session starts.	2	8.b.6
30	When the parameters of virtual avatar are set and all information is received, the product shall provide user with an option to start a session.	To allow user to begin training with suitable settings.	The user shall be able to choose different settings before beginning the training session.	1	8.b.7
31	While in a session, the product shall create the virtual avatar at different positions based on trail calculated.	To move the avatar around the premise.	The user shall be able to tackle the avatar by moving around the premise	1	8.b.7
32	While in a session, the headset shall project the avatar.	To allow user to have a perception of presence of a person-like figure in his/her vicinity.	The user shall be able to see the avatar via headset or map-display on headset at all times during session.	1	8.b.7
33	When the user has entered his/her physical details, the default virtual avatar can be created of stronger or equal physical dimensions than the user.	To allow user to continue with the suggested settings for ease of use.	The user shall be able to continue with the default choice of virtual avatar physique settings.	2	8.b.7
34	While in a session, the product shall communicate with the headset for avatar projection.	To allow user to experience continuous activity from avatar.	The user shall be able to see the avatar motion similar to human activity.	1	8.b.7
35	While in a session, the map-display shall show the positions of user in the training premise.	To inform user about the his/her location in the room for safety purpose.	The user shall be able to see his/her own position in the layout	1	8.b.8
36	While in a session, the map-display shall show the position of virtual avatar in the training premise.	To inform user about the avatar's location in the room for training purpose..	The user shall be able to see the avatar's position in the layout.	1	8.b.8
37	While in a session, the map-display shall receive feed from IPS for spatial data of the training room.	To allow real-time update of the map-display for accurate guidance to user.	The user shall be able to see the accurate position of the avatar and self on the map-display.	1	8.b.8
38	While in session when user makes a defense action,	To track user action and train	The wristband shall send information	1	8.b.9

	the wristband shall record the movement.	accordingly.	based on user hand movements.		
39	While in session when the wristband has recorded a movement, the product shall evaluate the accuracy of the movement.	To evaluate the accuracy of user action based on avatar position and action for feedback to user.	The product shall add points to health meter if wrist movement is appropriate and deduct points if not.	1	8.b.9
40	While in session when the avatar attacks, the product shall send instructions to headset.	To guide user during training.	The user shall see instructions for tackling on the headset based on avatar attacks.	1	8.b.9
41	While in session when the avatar is in front of user and punches, the product shall instruct to block and crouch.	To guide user to save him/herself when avatar punches standing in front of user.	The user shall see instruction to block/crouch when the avatar punches from front.	1	8.b.9
42	While in session when the avatar is in front of user and moves closer to user, the product shall instruct to move back.	To guide user to tackle when avatar approaches from front.	The user shall see instruction to move back when the avatar approaches from front.	1	8.b.9
43	While in session when the avatar is in front of user and kicks, the product shall instruct to jump.	To guide user to tackle when avatar kicks from standing in front of user.	The user shall see instruction to jump aside when the avatar kicks from front.	1	8.b.9
44	While in session when the avatar is behind user and punches, the product shall instruct to crouch.	To guide user to tackle when avatar punches from behind.	The user shall see instruction to crouch when the avatar punches from behind.	1	8.b.9
45	While in session when the avatar is behind user and moves closer to user, the product shall instruct to move forward.	To guide user to tackle when avatar approaches from front.	The user shall see instruction to move forward when the avatar approaches from behind.	1	8.b.9
46	While in session when the avatar is behind user and kicks, the product shall instruct to jump aside.	To guide user to tackle when avatar kicks from behind.	The user shall see instruction to jump aside when the avatar kicks from behind.	1	8.b.9
47	While in session when the headset receives instructions, it shall display the instructions.	To guide user during training.	The user shall see instructions for tackling on the headset based on avatar attacks.	1	8.b.9

48	While in session, product shall provide user with an option to stop the session.	To enable user ease of use.	The user shall be able to stop session at any point.	1	8.b.9
49	While in session, the product will display the health meter of the user which will fluctuate with the user's defensive movements against the avatar.	To enable user to experience real time effect on his/her health based on his/her actions.	The user shall be able to see the health meter change as the session proceeds.	1	8.b.9
50	While in session, the user should have an option to record the avatar's actions, to review it later.	To enable user to self-evaluate his/her performance.	The user shall be able to check history to review avatar actions.	2	8.b.9
51	While in session, the product shall train the user to call any emergency numbers in different scenarios. (ex. In case of a theft)	To train user to remember emergency numbers .	The user shall be able to see emergency numbers as part of instruction during training.	2	8.b.9
52	While in session, the wristband will record the user's elevation from the ground at the particular moment to determine if the user's defense action in response to the avatar is to bend down or jump etc.	To allow accurate measurements for suggesting instructions.	The points shall be added to the health meter if the instruction on the headset is followed.	1	8.b.9
53	While in session the product shall give points on the basis of accuracy of the defence action by user.	To allow user to gauge the consequences of his/her actions during training.	The user shall be able to see different sections of points gain/loss after session as part of performance score.	1	8.b.10
54	When session ends, the product shall generate a score by adding each point for the session.	To allow user to get an overview of his/her performance.	The user shall be able to see the overall points gained during the session.	1	8.b.10
55	When a new score is generated, the product shall save the score in performance history.	To be able to adjust the training based on history.	The user shall be able to retrieve past performance scores.	1	8.b.10
56	While in a training session and when the user wishes to pause the training session then the user shall be able to pause and resume it later.	To allow user ease of use.	The user shall be able to pause and resume the session from previous point.	2	8.b.10

57	While in a session and when the user pauses the training session, the product shall also record the level in the health meter of the user.	To allow user ease of use.	The user shall be able to pause and resume the session from the previous level on health meter.	2	8.b.10
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10. Look and Feel Requirements

Priority key is low / medium / high

a. Appearance Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall use company colors.	To market STAR as a product of the company developing it.	The colors used on the application should be the colors approved by the company.	high	UI
2	The product should have clear interface, to make it easy to use for all age groups.	To allow ease of use for user.	Texts should be non-overlapping and have minimum size of 11pt. Active buttons should look clickable and inactive should look disabled.	high	UI

b. Style Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall have brightness and contrast settings within 70-90, to ease the users for training at least an hour.	To prevent straining of eyes for long training session.	The comfortable brightness and contrast settings of the headset shall be pre-set.	high	Headset
2	The product shall automatically adjust the screen settings for devices such as ipad, database, iphone.	To allow readability and adjustable look for different devices.	The text, buttons, layout etc should re-arrange in different devices as per screen resolution.	high	UI

11. Usability and Humanity Requirements

Priority key is low / medium / high

a. Ease of Use Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall be easy to use for users who do not know English and/or who are non-software literate	To allow users, who do not know English, be able to use the product.	The product shall use relevant icons for all settings.	high	UI
2	The product shall project the map and adjust it according to the user view within 0.5% error	To allow the user to easily view the avatar and train with minimum projection error.	The user shall be able to train accurately with the virtual avatar.	high	UI

b. Personalization and Internationalization Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall allow each user to choose his/her profile settings and preferences.	To allow users be able to train with different physiques.	The user shall be able to choose AR settings at different granularity level.	high	UI

c. Learning Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The user shall have ease of learning i.e, learning period for a new user shall be about 3 minutes.	To let user experience AR based training quickly with minimum prerequisite settings.	A new user shall be able to start a session within 3 minutes of registration.	high	UI

d. Understandability and Politeness Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall use symbols and words that are naturally understandable by the users.	The user shall be able to easily interpret the product textual / picture information.	The product shall have minimal user training.	medium	UI

e. Accessibility Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
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f. Convenience Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall allow user to navigate between different tabs easily.	To allow user to update a change in previous tabs.	The user shall be able to switch the settings tabs without losing information .	high	UI
2	The map display shall guide user during training session.	To allow user to keep track of avatar motions for accurate defense action.	The map-display shall show exact position of avatar in the premise.	high	map-display

12. Performance Requirements

Priority key is low / medium / high

a. Speed and Latency Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall make the avatar respond within 0.15 seconds of user's reaction.	To allow user to be able to see immediate reaction in avatar due his/her action to give a real-world perception.	The time lag between user action and change in avatar reaction shall be at most 0.15 seconds.	high	Headset
2	The product shall send instructions to user within 0.15 seconds of avatar's movements.	To enable user to react quickly to avatar action and save health.	The time lag between change in avatar action and instruction update on headset shall be at most 0.15 seconds.	high	Headset

b. Safety-Critical Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	When the user moves out of training premise, the product shall stop the session.	To ensure that user disengages in training when not in premise.	Headset shall stop projecting the avatar when IPS detects user's position to be	high	IPS, Headset

			out of training premise .		
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c. Precision or Accuracy Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The IPS linked with the product shall accurately scan the 3D view of the room with allowed 0.3% error in measurement of positions.	To enable user to get an overview of the room layout.	The map-display shall be accurate replica of the training premise.	high	IPS
2	The wristband linked with the product shall accurately measure the hand movements with allowed 0.3% error in measurement.	To track hand movements accurately to train user efficiently.	The product shall add points to health meter if wrist movement is appropriate and deduct points if not.	high	Wristband

d. Reliability and Availability Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall update scores for the ongoing training session on the database.	To keep track of scores and provide current scores in case of interruption in training,	The points on health meter should update in real-time and not just at the end of session.	medium	UI, Headset

e. Robustness or Fault-Tolerance Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The headset shall be able to project the avatar.	To make sure of avatar simulation.	The headset shall project the avatar in the event of failure it shall continue the avatar simulation.	high	Headset

f. Capacity Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall be able to handle 5 hours training for a single session	To enable user to train uninterrupted for long sessions.	The user shall not face any interruption in training for duration less than 5 hours.	medium	UI, Headset, Wristband, IPS, Map-display

2	The product shall delete obsolete user session details.	To use recent user data for training purpose.	The database shall not contain training data that is more than 5 years old.	low	Database
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g. Scalability or Extensibility Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The IPS connected to the product shall automatically feed/ load training premise, user and avatar position to display map within 0.15 seconds	To allow user to be able to easily locate avatar movements in the premise on the map-display.	The time lag between change in real position of avatar/user and update of position on map shall be at most 0.15 seconds.	medium	IPS

h. Longevity Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	While in a training session and when the user wishes to pause the training session then the user shall be able to pause and resume it later.	To allow user ease of use.	The user shall be able to pause and resume a session.	high	Headset, wristband, map-display.

13. Operational and Environmental Requirements

Priority key is low / medium / high

a. Expected Physical Environment

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The training room shall have a minimum size.	To allow user and avatar to move while training.	The training room size should be minimum of 28 ft x 15 ft.	medium	Training premise
2	The training room shall not have any dangerous stuffs.	To prevent injuries to user during training.	The training room shall be clear of any obstacles.	high	Training premise

b. Wider Environment Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
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1	The product shall be used in an certified premise.	To allow supervision of training to prevent misuse or injury.	The product shall not be usable with AR features outside the certified premises.	high	Training premise
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c. Requirements for Interfacing with Adjacent Systems

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall be compatible with headset and wristband	To allow full AR experience.	The readings from headset and wristband shall update avatar via product.	high	Headset, Wristband, UI

d. Release Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall be fully functional and defect-free to be released.	To make sure the product meets the scope of user requirement, bug free or it has minimal errors to be released.	Each functionality shall be verified and rectified before release	high	Headset, IPS, Wristband, UI

14. Maintainability and Support Requirements

Priority key is low / medium / high

a. Maintenance Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	Full documentation of use of framework should be available for future developers to improve the product.	To allow developers to be able to modify the product in case of change in requirements.	The developers shall be able to understand and modify the code in case of bugs or requirement changes.	high	UI
2	Error reports shall be generated on monthly basis.	To allow analysis of product performance.	The product development team shall receive a monthly report of errors.	medium	UI, Headset, Wristband, IPS

b. Supportability Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
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1	Product manual shall be available to the users.	To inform users about the product, rules and regulations.	The product shall have a documentation tab with all rules & regulations; terms & conditions listed.	high	UI, User Manual
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c. Adaptability Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	Product code should be independent of database design.	To allow minimum modifications in case of change in database backend.	Developer shall be able to understand queries from documentation and translate to other query languages as per database.	medium	UI
2.	The product shall adapt to new information from a user in approximately 0.3 minute and create a new virtual avatar.	To allow the new user to set up the avatar according to his/her settings in minimum time.	The avatar should change within a minute when the setting is changed by the user.	high	UI
3.	The product shall need changes if the movements of the virtual avatar are not been handled by 80% and above users.	To ensure that maximum number of users are able to use the software for effective training.	Developer shall be able to make changes to the UI to allow easy use by the users.	medium	UI

15. Security Requirements

Priority key is low / medium / high

a. Access Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	Only development team shall have access to all error reports generated during product usage.	To allow developers to be able to fix the errors in the product.	Errors shall be registered as bug reports for developers to fix.	high	Database

b. Integrity Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
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1	Product shall not allow user to modify the functionality of the product.	To disallow user to access the product code.	The user shall not be able to see the code of the product.	high	Product
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c. Privacy Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall keep the personal information such as height, weight etc visible to only the corresponding user.	To disallow user to see other user's personal details..	User shall not be able to see the details entered by another user.	high	Database
2	The product shall only allow the user to access the details of his account authorized by his username and password.	To protect the details of a user identified by login credentials.	User shall be able to login for his data using credentials created at the time of registration.	high	Database
3	User details are kept confidential for any 3rd party enquires.	To disallow any outsider to see user details	Data sent for third party enquires shall not include identity of user.	high	Database

d. Audit Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	A backup operation shall be performed once in every 7 days for all the user information and user progress.	To store repository of information for training during data server downtime.	User shall be able to start a training incase of database server downtime	medium	Database

e. Immunity Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	Product shall not allow user to integrate any external device.	To prevent information leak or virus injection.	The product shall disregard connection of unauthorized devices.	high	UI
2	The product shall be hosted from a secure server.	To prevent third party from stealing user information.	The product firewall shall detect and prevent unauthorized access of data.	high	Database

16. Cultural Requirements

Priority key is low / medium / high

a. Cultural Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall comply with the cultural traditions of the country of the product deployment.	To not offend any culture / race / ethnicity.	The product shall not design avatar to represent any specific community.	medium	UI
2	The product shall only support the idea of self-defense.	To not promote idea of violence	The product shall enlist its goal in the terms and conditions section.	high	UI
3	The product shall be used by users within the defined age range (13-40 years).	To allow different range of users learn basic self-defense tactics.	The product shall only allow users with date of birth after 1st January 2006 as per 2019 standards.	medium	UI
4	The product shall be accessible for any race, gender or cultural background.	To not to discriminate any community.	The product shall not restrict its usage based on the community the user belongs to.	high	UI

17. Compliance Requirements

Priority key is low / medium / high

a. Legal Compliance Requirements

Rqt#	Description	Rationale	Fit Criterion	Priority	Sub-System
1	The product shall comply with the legal regulations of the region in which it is used.	To prevent violations of local laws.	The product shall be verified with local law policies before marketing.	medium	UI
2	The product shall display statutory warning of not to unnecessarily use the training to disrupt peace in the society.	To prevent misinterpretation of intention of the product.	The product shall clearly state its intention and purpose of development.	high	UI
3	The user shall comply to the training procedure	To prevent user from misusing the	The product shall be returned undamaged	high	Wristband, Headset, IPS ,

	and shall not continue further for any misdemeanour.	product.	at the end of a session.		Map-display, Health meter.
4	The product shall maintain its originality and does not allow any organization for distribution to comply with the copyright law.	To comply with copyright law	The product shall not be copied and reproduced result of an existing product.	high	Wristband, Headset, IPS, Map-display, Health meter.
5	The user shall not be reimbursed for the training fee once registered for session and shall co-operate with the training procedure.	To comply with the user training session.	The user shall make an agreement with the product owner.	medium	User profile
6	The user shall be held for fine or penalty in case of damage to the training devices.	To comply with penalty law for misuse.	The user shall make payments arrangements for replace of an item.	medium	Wristband, Headset, IPS, Map-display, Health meter.
7	User shall not be covered for any accidents or change of behaviour caused during the training and shall comply with the rules, standards and regulation of the product.	To comply with the liability between the user and the product owner.	The user shall comply with the training policy.	medium	UI

18. Open Issues

Issue No.	Cross-Reference	Summary	Stakeholder	Action Taken
1	Business Event : 6.c.7, 6.c.10 PUC : 8.c.9	Ability to detect unspecified user action like kicking is not available.	User, Headset, IPS	Updating IPS to detect all user actions
2	Business Event : 6.c.2 PUC : 8.c.2	Identification of updated version of auxiliary device is unavailable.	Headset Wristband, IPS, Map Display	-
3	Business Event : 6.c.2 PUC : 8.c.2	Ability to detect multiple user sessions for security purpose is unavailable.	User	Detecting database logs for multiple active sessions.

19. Risks

Risk	Description	Probability	Impact
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No.			
1.	Halt in production or marketing of one or more auxiliary devices.	Low	Medium
2.	The hardware of the wristband can not very accurately measure the very minute movements which may vary from manufacturer to manufacturer which may result in dissatisfaction among the users.	Medium	High
3.	The avatar can delay in response due to weak connectivity or low connection strength between the auxiliary devices.	Low	Medium
4.	The users of the product do not belong to the intended age bracket of the product and are hence unable to respond or understand the instructions.	Medium	High

N.B:

Probability key : Low (<40%); Medium(40%-70%); High(>70%)	Impact key : Low (Minor code modifications + Cost <\$10k); Medium (Changes in device-specific code + Cost:\$10-30k); High(Complete restructuring of development code+ Cost > \$30k)
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20. Costs

Based on the data flows in context of the work and data model designed, a estimated amount of effort is calculated in terms of function points.

Context Flows / Business Events	Type	No. of Attributes	No. of Classes	Function Points
Virtual Avatar	Output	8 : Height, Physique, Set of positions (xyz coordinates), Set of actions/reactions (Sequence of xyz coordinates)	3 : VirtualAvatar, AvatarMovement, AvatarPosition	5
Health status	Output	1 : Percentage of health remaining	2 : Health meter, Headset	4
Instructions	Output	1 : Clue for user action	1 : Headset	4
Image of surrounding	Input	1 : Image	2 : Headset, IPS	3
Actions by user	Input	4 : x,y,z coordinates of hand positions, speed of action	2 : User, Wristband	3
3D position	Input	5: x,y, z coordinates of the room, avatar position, objects in the room.	1 : IPS	3
Performance History	Input	2 : score , user's weakest move	1 : Database	3

Performance Score	Output	1 : percentage of health left, list of user's weak moves, level*	2 : PerformanceScore, HealthMeter	4
Profile settings	Stored	7 : name, age, height, weight, date of birth, level, avatar's strength	1 : Database	7
Room Layout	Output	5 : x,y, z coordinates of the room, avatar position, objects in the room.	2 : AvatarPosition, MapDisplay	4
User information verification	Time triggered	2:Name,Email	1 : User	3
Total				106

The total number of function points is estimated to be 106. The effort in terms of time is given as :

$$\text{Time effort} = \frac{FP^{1.4}}{150} = \frac{106^{1.4}}{150} = 4.56 \approx 5 \text{ person months.}$$

A person month refers to the effort of a person working 8 hours a day for 20 days in a month. Based on the fact that \$50 (in USD) is the average pay on hourly basis, the monetary cost for a person to develop the product is \$40,000 approximately.

Apart from the costs to the development team, costs to acquire the auxiliary devices for testing purpose and license to use development software amounts to \$5000.

Hence, the total cost involved in the development of a robust working product amounts to \$50,000 based on the constraint that one person works towards project completion for 5 months with mentioned wage rate.