FLORIDA INTERNATIONAL UNIVERSITY
SCHOOL OF COMPUTING AND INFORMATION SCIENCES

SOFTWARE ENGINEERING FOCUS

FINAL DELIVERABLE

PROJECT TITLE: *LEARNING WITH AUGMENTED REALITY*

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ABSTRACT

HOW TO REAP THE BENEFITS OF NEW TECHNOLOGY FOR LEARNING AND EDUCATION PURPOSE AND MAKE THE NEW MOBILE DEVICES NOT ONLY AN ENTERTAINMENT TOOL BUT ALSO A JOYFUL LEARNING ENGINE?

LEARNING WITH AUGMENTED REALITY (AR) HAS THE POTENTIAL FOR ACHIEVING THESE GOALS. WITH THE HELP OF THIS TECHNOLOGY, ARCHITECTURAL STUDENTS WILL LEARN ABOUT BUILDING INFORMATION MODELING (BIM) PASSIVELY WHILE THEY ARE PLAYING WITH THEIR MOBILE DEVICES.

THE PROPOSED MOBILE APPLICATION ENHANCES THE LEARNING PROCESS WITH PROVIDING A BUILDING SYSTEM ASSEMBLY AND INFRASTRUCTURE THROUGH AUGMENTED REALITY.

IN THE CURRENT APPLICATION WHEN THE USER OPENS THE APPLICATION AND POINT TOWARD SIPA BUILDING 3D BIM MODEL IS OVERPLAYED ON TOP OF THE BUILDING. IT WORKS BASED ON THE GPS COORDINATE OF THE USER AND HIS POSITION TOWARDS THE BUILDING WHICH IS DETECTED BY DEVICE SENSORS.

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INTRODUCTION

BUILDING INFORMATION MODELING (BIM) ARE DIGITAL REPRESENTATIONS OF BUILDINGS THAT SERVE TO PLAN, DESIGN, LEARN AND CONSTRUCT INFRASTRUCTURES. OUR CURRENT FOCUS IS FACILITY INFRASTRUCTURES. FOR THOSE LEARNING ABOUT BIM FOR THE FIRST TIME, IT CAN BE DIFFICULT TO GRASP ITS COMPLEXITY.

HOW CAN WE REAP THE BENEFITS OF NEW TECHNOLOGY FOR LEARNING AND EDUCATION PURPOSE? LEARNING WITH AUGMENTED REALITY (AR) HAS THE POTENTIAL FOR ACHIEVING THE THOSE GOALS. WITH THE HELP OF THIS TECHNOLOGY, ARCHITECTURAL STUDENTS WILL LEARN ABOUT BUILDING INFORMATION MODELING (BIM) PASSIVELY WHILE THEY ARE PLAYING WITH THEIR MOBILE DEVICES. THE PROPOSED MOBILE APPLICATION ENHANCES THE LEARNING PROCESS WITH PROVIDING A BUILDING SYSTEM ASSEMBLY AND INFRASTRUCTURE THROUGH AUGMENTED REALITY. WITH AR, STUDENTS CAN MOVE AROUND PHYSICAL BUILDINGS IN THE REAL WORLD AND OBTAIN FROM THE APP AN X-RAY VISION OF THE INNER STRUCTURE OF THE BUILDING.

CURRENT SYSTEM

IN THE CURRENT APPLICATION WHEN THE USER OPENS THE APPLICATION AND POINT TOWARD SIPA BUILDING 3D BIM MODEL IS OVERPLAYED ON TOP OF THE BUILDING. IT WORKS BASED ON THE GPS COORDINATE OF THE USER AND HIS/HER POSITION TOWARDS THE BUILDING WHICH IS DETECTED BY DEVICE'S SENSORS. THE MODEL PERSPECTIVE AND ORIENTATION CHANGES SMOOTHLY WITH THE USER'S MOTION. TO THIS POINT MODEL ONLY WORKS ON SOME SPECIFIC PREDEFINED LOCATIONS.

PURPOSE OF NEW SYSTEM

OUR CONTRIBUTION IS A TESTBED WHICH HELPS THE DEVELOPMENT TEAMS TO EXPLORE OTHER ALTERNATIVES FOR FURTHER REFINEMENT OF THE CURRENT SYSTEM.WE HAVE TESTED SEVERAL TECHNIQUES AND PROPOSED THEM IN A SINGLE APPLICATION. THE TESTBED THAT CAN BE USED BY MANY DEVELOPERS TO STUDY THE POWER OF THE ANDROID DEVICE AND THEN BE ABLE TO USE IT TOGETHER WITH UNITY FOR A 3D AR EXPERIENCE. CURRENTLY THE APP CAN BE INSTALLED IN A HANDHELD DEVICE OR EMULATOR WITH ANDROID 5.0 OR HIGHER.

USER STORIES

THE FOLLOWING SECTION PROVIDES THE DETAILED USER STORIES THAT WERE IMPLEMENTED IN THIS ITERATION OF THE LEARNING WITH AUGMENTED REALITY PROJECT. THESE USER STORIES SERVED AS THE BASIS FOR THE IMPLEMENTATION OF THE PROJECT'S FEATURES. THIS SECTION ALSO SHOWS THE USER STORIES THAT ARE TO BE CONSIDERED FOR FUTURE DEVELOPMENT.

IMPLEMENTED USER STORIES

- #108 PREPARE PREREQUISITE (MARIA)
- #117 PREPARE PREREQUISITE (MARYAM)
- #97 ANALYZE PHONE SENSOR DATA
- #96 ANALYZE THE VISUALIZATION OF THE DATA
- #128 GETTING GPS COORDINATES USING GOOGLE API
- #142 ANALYZE AND CREATING 3D MODEL
- #155 USE THE PHONE TO MAP DIRECTION OF THE BUILDING
- #162 INTEGRATE IMAGE PROCESSING MODULE
- #154 INTEGRATE 3D MODEL WITH PHONE SENSORS
- #163 CONNECT THE SENSOR READINGS TO THE CAMERA
- #164 INTEGRATION - AR CAMERA WITH SENSORS AND ROTATION VECTOR REAL TIME GRAPH
- #166 INTEGRATION - GPS, ACCELEROMETER AND GYROSCOPE GRAPH AND UNITY AR CAMERA

#108 PREPARE PREREQUISITE

DESCRIPTION:

AS A DEVELOPER, I NEED TO INSTALL THE REQUIRED PLATFORMS AND READ ON RELATED MATERIALS SO THAT I CAN HAVE A GOOD PREPARATION TO WORK ON ASSIGNED TASKS.

ACCEPTANCE CRITERIA:

MUST INSTALL AND BE FAMILIAR ANDROID STUDIO AND ANDROID DEVICE EMULATOR

MUST READ ABOUT ANDROID SENSORS AND THE RETRIEVING OF SENSOR DATA IN REAL TIME.

#117 PREPARE PREREQUISITE

DESCRIPTION:

AS A DEVELOPER, I NEED TO INSTALL ALL THE PLATFORM AND ENVIRONMENTS IN ORDER TO START CODING PART.

AS A DEVELOPER, I NEED TO INSTALL ALL THE EMULATOR TO HAVE THE CHANCE TO TEST MY CODE WHILE THERE IS NO ACCESS TO THE ACTUAL DEVICE.

AS A DEVELOPER, I NEED TO INSTALL AND INTEGRATE A PACKAGE FOR SENSOR SIMULATION BECAUSE I WILL WORK WITH THE EMULATOR NOT ACTUAL DEVICE THAT HAS BUIT-IN SENSORS.

ACCEPTANCE CRITERIA:

INSTALLED ANDROID STUDIO SOFTWARE

INSTALLED EMULATOR

INSTALLED SENSOR SIMULATOR

#97 ANALYZE PHONE SENSOR DATA

DESCRIPTION:

AS A USER, I SHOULD BE ABLE TO GET MULTIPLE SENSOR DATA FROM THE PHONE, SUCH AS ROTATION VECTOR SENSOR FOR THE PHONE TO BE ABLE TO TRACK THE PHONE'S POSITION AND MOVEMENTS.

ACCEPTANCE CRITERIA:

GET MULTIPLE SENSOR DATA IN REAL TIME.

#96 ANALYZE THE VISUALIZATION OF THE DATA

DESCRIPTION:

AS A USER, I WOULD LIKE TO VISUALIZE THE PHONE'S SENSOR DATA AS A GRAPH IN A REAL TIME TO BE ABLE TO STUDY HOW THE PHONE TRACK MY MOVEMENTS.

ACCEPTANCE CRITERIA:

THE VISUAL SHOULD BE A GRAPH SHOWING THE DATA SMOOTHLY IN REAL-TIME WITH NO INTERRUPTION AND DELAY.

#128 GETTING GPS COORDINATES USING GOOGLE API

DESCRIPTION:

AS A DEVELOPER I WISH TO GET THE GPS COORDINATES FROM MY CURRENT LOCATION SO THAT I CAN TRACK MY POSITION SO THAT I CAN CORRECTLY LAY OVER THE 3D MODEL ON THE BUILDING I'M CLOSEST TO.

ACCEPTANCE CRITERIA:

USING THE GOOGLE API, DISPLAY THE LONGITUDE AND LATITUDE OF THE USER'S CURRENT LOCATION.

#142 ANALYZE AND CREATING 3D MODEL

DESCRIPTION:

AS A DEVELOPER, I WANT TO BE ABLE TO MOVE 3D MODEL IN THE 3D SPACE SUCH THAT I CAN LEARN HOW THE FINAL MODEL SHOULD BE CHANGED BASED ON THE SENSOR DATA.

ACCEPTANCE CRITERIA:

THE MODEL CAN MOVE IN THE DIRECTION OF THE USER'S DRAGGING GESTURE.

#155 USE THE PHONE TO MAP DIRECTION OF THE BUILDING

DESCRIPTION:

AS A DEVELOPER, MY MOBILE DEVICE SHOULD BE ABLE TO TELL WHAT IS THE DIRECTION OF THE BUILDING FROM MY LOCATION, SUCH THAT I CAN OVERLAY THE 3D MODEL OVER THE BUILDING.

ACCEPTANCE CRITERIA:

USE THE PHONE'S GPS TO KNOW ABOUT THE DIRECTION OF THE BUILDING.

USE THE PHONE'S ROTATION SENSOR IN ORDER TO MAP THE DIRECTION AS I MOVE THE PHONE

#162 INTEGRATE IMAGE PROCESSING MODULE

DESCRIPTION:

AS A DEVELOPER I WANT TO, INSTEAD OF POSITION DETECTION BY SENSORS WE APPROACH THE PROBLEM WITH IMAGE PROCESSING TECHNIQUES , SUCH THAT FIRST TO DETECT THE BUILDING AND OVERLAY THE MODEL ON TOP OF IT AND CHANGE THE POSITION OF IT WITH THE POSITION CHANGE.

ACCEPTANCE CRITERIA:

THE MODEL SHOULD ADJUST BASED ON THE ACTUAL BUILDING CORRECTLY

THE SIZE OF THE MODEL SHOULD CHANGE BASED ON THE DISTANCE TO THE BUILDING

THE MOVEMENT OF THE MODEL SHOULD NOT BE TOO FAST AND SHOULD BE SMOOTH INORDER TO BE PLEASANT FOR USER NOT DISTURBING(NOT SHAKING TOO MUCH)

#154 INTEGRATE 3D MODEL WITH PHONE SENSORS

DESCRIPTION:

AS A DEVELOPER I WANT TO GET THE ANDROID SENSOR INFORMATION FROM THE UNITY MODEL SUCH THAT I CAN SHOW THE EFFECTS OF THE UNITY MODEL TO THE

#163 CONNECT THE SENSOR READINGS TO THE CAMERA

DESCRIPTION:

AS A DEVELOPER, I WANT TO CONNECT THE PHONE'S CAMERA TO PHONE SENSORS, SO THAT I CAN OVERLAY THE BUILDING INFORMATION OVER THE CAMERA VIEW.

#164 INTEGRATION - AR CAMERA WITH SENSORS AND ROTATION VECTOR REAL TIME GRAPH

DESCRIPTION:

AS A DEVELOPER I WANT ALL THE WORK DONE SO FAR INTEGRATED WITHIN ONE APP FOR AN EASIER ACCESS.

ACCEPTANCE CRITERIA:

THE AR CAMERA THAT WORKS WITH SENSORS MUST BE INCLUDED

THE ROTATION VECTOR REAL TIME GRAPH MUST BE INCLUDED

#166 INTEGRATION - GPS, ACCELEROMETER AND GYROSCOPE GRAPH AND UNITY AR CAMERA

DESCRIPTION:

AS A DEVELOPER I WANT ALL THE WORK DONE SO FAR INTEGRATED WITHIN ONE APP FOR AN EASIER ACCESS.

ACCEPTANCE CRITERIA:

GPS TEST MUST BE INCLUDED

ACCELEROMETER AND GYROSCOPE GRAPH MUST BE INCLUDED

UNITY AR CAMERA USING ARTOOLKIT MUST BE INCLUDED

PENDING USER STORIES

- **#140 WORK WITH UNITY VIRTUAL REALITY**
- **#165 DEFINE CHECKPOINTS AROUND THE BUILDING**
- **#172 USE OPENCV**
- **#173 SHOW USER IN THE MAP**

PROJECT PLAN

THIS SECTION DESCRIBES THE PLANNING THAT WENT INTO THE REALIZATION OF THIS PROJECT. THIS PROJECT INCORPORATED THE AGILE DEVELOPMENT TECHNIQUES AND AS SUCH REQUIRED THE SPRINTS TO BE PLANNED. THESE SPRINT PLANNINGS ARE DETAILED IN THE SECTION. THIS SECTION ALSO DESCRIBES THE COMPONENTS, BOTH SOFTWARE AND HARDWARE, CHOSEN FOR THIS PROJECT.

HARDWARE AND SOFTWARE RESOURCES

THE FOLLOWING IS A LIST OF ALL HARDWARE AND SOFTWARE RESOURCES THAT WERE USED IN THIS PROJECT:

HARDWARE

- **SAMSUNG GALAXY ANDROID SMARTPHONE**
- **SAMSUNG GALAXY TAB 2**
- **LENOVO LAPTOP WITH WINDOWS 10**
- **MACBOOK PRO WITH MACOS SIERRA**

SOFTWARE

- **ANDROID STUDIO 2.2**
- **UNITY 3D 5.4.1**
- **MINGLE**
- **GOOGLE DRIVE**

SPRINTS PLAN

SPRINT 1

- **USER STORIES #108 AND #117**
- **FRAMEWORK AND SOFTWARE INSTALLATION**
- **PREPARE THE PREREQUISITES TO START WORKING ON THE PROJECT**
- **ANDROID STUDIO INSTALLATION**
- **INSTALLING EMULATOR OR LINK TO ACTUAL DEVICE FOR TESTING**

SPRINT 2

- **USER STORIES #97 AND #96**
- **ANALYZE PHONE SENSOR DATA**
- **ANALYZE VISUALIZATION OF THE DATA AND DRAW A REAL TIME GRAPH BASED ON ONLINE STREAM OF SENSORS DATA**
- **READING ACCELEROMETER AND GYROSCOPE SENSORS SEPARATELY**

SPRINT 3

- **USER STORIES #128 AND #142**
- **GPS SENSOR DATA READING**
- **IMPLEMENT A 3D MODEL WHICH IS ROTATED BY THE PHONE MOVEMENT.**
- **INTEGRATING THE UNITY MODEL WITH ANDROID STUDIO AND CURRENT APPLICATION TO LEARN HOW TO REFLECT THE SENSOR CHANGES ON ACTUAL UNITY MODEL**
- **EXPLORE WIFI FINGERPRINTING TO CHECK THE INTEGRATION FEASIBILITY TO THE CURRENT SYSTEM.**
-

SPRINT 4

- **USE STORIES #155 AND #162**
- **USE THE PHONE'S GPS TO KNOW ABOUT THE RELATIVE DIRECTION OF THE BUILDING TOWARDS PHONE FOR BETTER OVERLAY OF THE MODEL .**

- USE THE PHONE'S ROTATION SENSOR IN ORDER TO MAP THE DIRECTION , SO WITH THE PHONE MOVEMENT, MODEL WILL ROTATE AND ADJUST ON THE DEVICE SCREEN TO MATCH WITH THE NEW PERSPECTIVE.
- USE IMAGE PROCESSING LIBRARIES TO DETECT THE BUILDING DIRECTLY WITH THE IMAGES THAT ARE CAPTURED BY THE DEVICE CAMERA IN REAL TIME.

SPRINT 5

- USER STORIES #154 AND #163
- CONNECT THE SENSORY DATA TO THE CAMERA
- CONNECT ANDROID STUDIO TO THE UNITY AND GET THE ANDROID SENSOR INFORMATION FROM THE UNITY MODEL
- ADJUST THE UNITY MODEL BASED ON THE SENSORY DATA AND DISPLAY IT IN THE DEVICE SCREEN

SPRINT 6

- USER STORIES #164 AND #166
- INTEGRATE AR CAMERA WITH THE SENSORS AND FINALIZE IT.
- INTEGRATE ALL THE BENEFICIAL STUDIED PART IN THE SYSTEM
- UNIT TEST AND INTEGRATION TEST
- COMPLETE THE DOCUMENTATION

SYSTEM DESIGN

THIS SECTION CONTAINS INFORMATION ON THE DESIGN DECISIONS THAT WENT INTO THIS PROJECT. THE ARCHITECTURE PATTERNS ARE OUTLINED AND EXPLAINED. THE ENTIRE SYSTEM IS SHOWN IN A PACKAGE DIAGRAM AND THE SUBSYSTEMS ARE EXPLAINED. FINALLY, THE DESIGN PATTERNS USED IN THE PROJECT ARE DISCUSSED.

ARCHITECTURAL PATTERNS

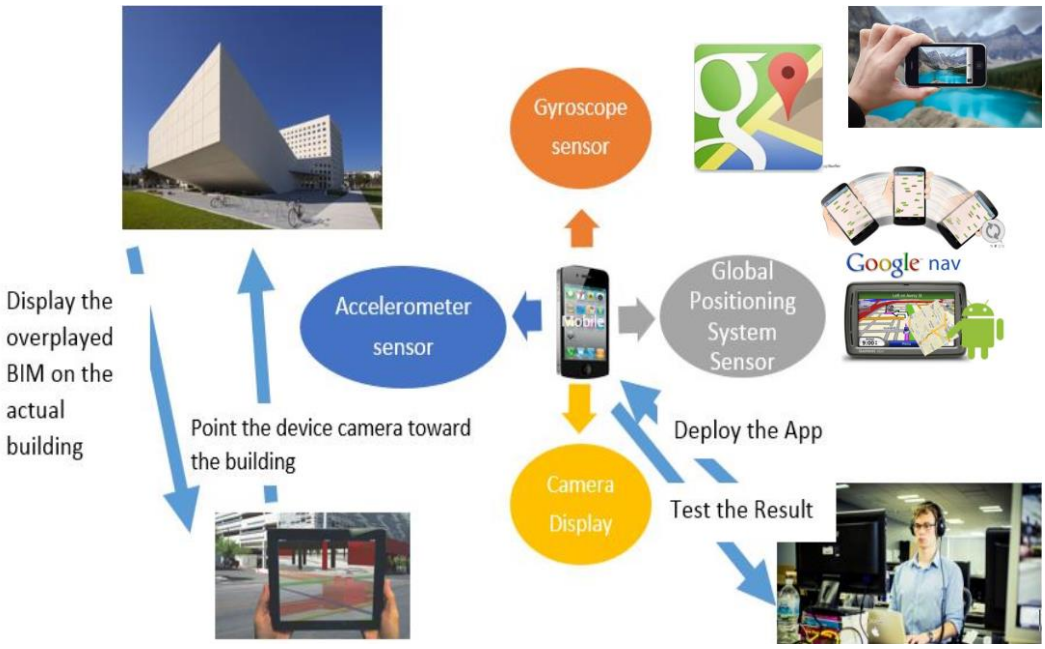
MODEL-VIEW-CONTROLLER: THESE PATTERN WAS SELECTED TO MAINTAIN AN ORGANIZED STRUCTURE OF THE APPLICATION AND TO REDUCE DEPENDENCIES WITHIN THE CODING STRUCTURE OF THE MOBILE APP. IN ANDROID THE VIEW IS DEFINED BY AN XML FILE THAT IS THEN MODIFIED AND/OR MAINTAINED BY THE CONTROLLER. THE MODEL IN OUR SYSTEM IS THE DATA ACCESS CLASS THAT GET NECESSARY SENSOR READINGS FROM THE ANDROID'S BUILT-IN SENSORS AND GPS LOCATION. OUR SYSTEM DOES NOT STORE ANY DATA IN ANY FORM.

SYSTEM AND SUBSYSTEM DECOMPOSITION

THIS SECTION CONTAINS INFORMATION ON THE MINIMAL CLASS DIAGRAM WHICH CAN BE FOUND IN APPENDIX A, FIGURE 3. LISTED BELOW IS A BRIEF EXPLANATION OF THE FUNCTIONALITY OF EACH SUBSYSTEM.

- **MAINACTIVITYVIEW AND MAINACTIVITYCONTROLLER: PRESENT THE A MENU VIEW WITH THE OPTIONS: ACCELEROMETER AND GYROSCOPE GRAPH, ROTATION VECTOR GRAPH, AR CAMERA WITH SENSORS, GPS, AR CAMERA WITH MARKER, FOR THE DEVELOPER TO CHOOSE WHICH COMPONENT TO TEST.**
- **GPSTESTVIEW AND GPSTESTCONTROLLER: USE GEOLOCATION TO LOCATE THE CURRENT POSITION OF THE HANDHELD DEVICE. IT USES GPS AND NETWORK AND CAN TELL WHICH ONE PROVIDES THE MOST ACCURATE READING.**
- **CAMERAARSENSORVIEW AND CAMERAARSENSORCONTROLLER: USE THE DEVICE'S HARDWARE CAMERA AND OVERLAYS A VIEW WITH THE INFORMATION OF THE BUILDING.**
- **ROTATIONVECTORSENSORVIEW AND ROTATIONVECTORSENSORCONTROLLER: USES THE PHONE'S ROTATION VECTOR SENSOR AND THE MPANDROIDGRAPH TO SHOW THE REAL TIME READINGS AS THE DEVELOPER MOVES THE PHONE.**
- **ACCELGYROSENSORVIEW AND ACCELGYROSENSORCONTROLLER: USES THE PHONE'S ACCELEROMETER, GYROSCOPE SENSORS AND SHOW REAL TIME READINGS USING THE MPANDROIDGRAPH. ACCELEROMETER SHOWS THE SPEED THE USER MOVES THE PHONE THROUGH A SPECIFIC AXIS OF THE PHONE. GYROSCOPE SHOWS THE ROTATION OF THE PHONE IN THE DIFFERENT AXIS.**
- **CAMERAARMARKERVIEW AND CAMERAARMARKERCONTROLLER: USES UNITY AND ARTOOLKIT TO OVERLAY THE 3D MODEL USING A MARKER.**

DEPLOYMENT DIAGRAM



SYSTEM VALIDATION

THE LEARNING WITH AR APPLICATION WAS VERIFIED USING UNIT TESTING, RAINY DAY AND SUNNY DAY. THE APP WAS TESTED IN AN ANDROID EMULATOR PROVIDED BY ANDROID STUDIO AND ALSO IN A HARDWARE DEVICE WITH ANDROID INSTALLED. WITH THE EMULATOR, WE TESTED THE

COMPONENTS BY FEEDING IT SIMULATED DATA. THEN WE TESTED WITH REAL DATA BY USING THE APP IN OUR DEVICES.

GLOSSARY

- **ANDROID (OPERATING SYSTEM): A MOBILE OPERATING SYSTEM DEVELOPED BY GOOGLE.**
- **ANDROID STUDIO: IS THE OFFICIAL IDE THAT IT IS USED BY ANDROID APPLICATION DEVELOPMENT BASED ON INTELLIJ IDEA.**
- **AUGMENTED REALITY (AR): A VIEW OF A REAL-WORLD ENVIRONMENT WITH AUGMENTED COMPONENTS PROVIDED BY COMPUTER SENSORY INPUT SUCH AS CAMERA, MOVEMENT SENSOR AND/OR GPS DATA.**
- **BUILDING INFORMATION MODELING (BIM): DIGITAL REPRESENTATIONS OF BUILDINGS THAT SERVE TO PLAN, DESIGN, LEARN AND CONSTRUCT INFRASTRUCTURES.**
- **CLASS DIAGRAM: AN ILLUSTRATION OF ALL THE CLASSES IN THE SYSTEM.**
- **GLOBAL POSITIONING SYSTEM (GPS): A NAVIGATION SYSTEM THAT PROVIDES GEOLOCATION TO A RECEIVER.**
- **MPANDROIDCHART:A POWERFUL ANDROID CHART VIEW THAT CAN SHOW READINGS OF THE DATA IN REAL TIME.**

UNITY 3D: A GAME ENGINE VERY USEFUL TO CREATED CROSS-PLATFORM 3D EXPERIENCES.

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APPENDIX

APPENDIX A - UML DIAGRAMS

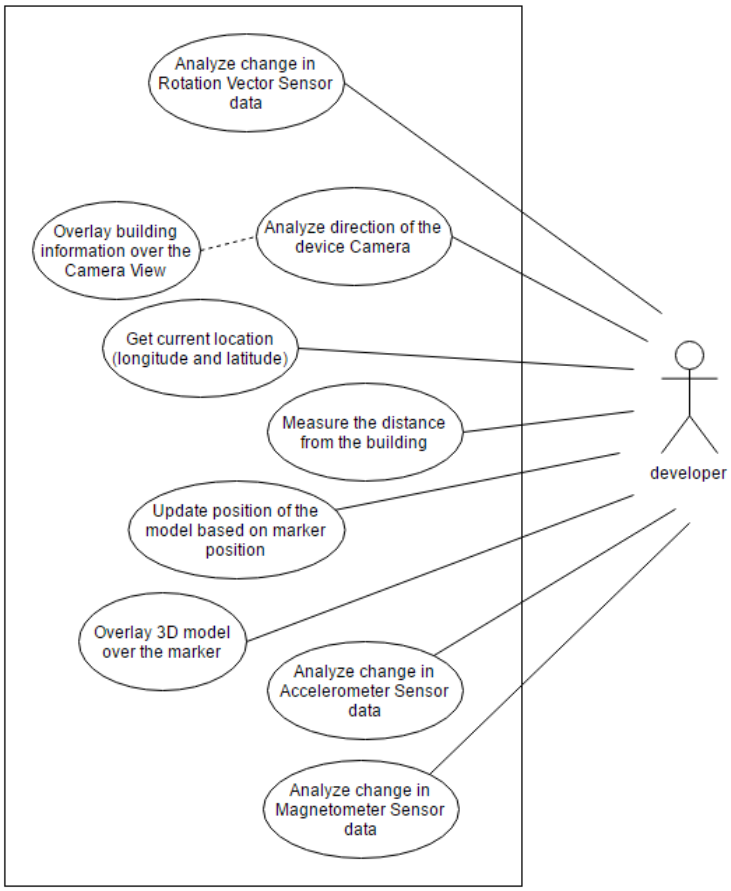

FIGURE 1: USE CASE DIAGRAM

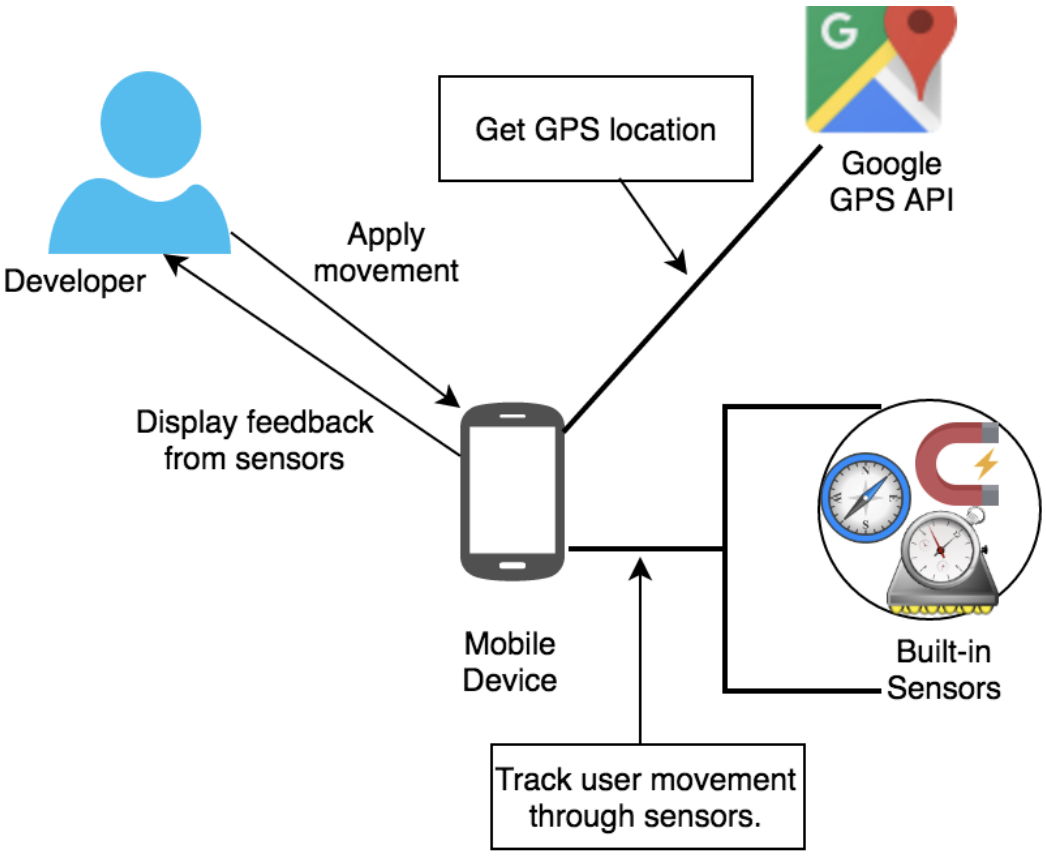

FIGURE 2: SYSTEM DESIGN ARCHITECTURE

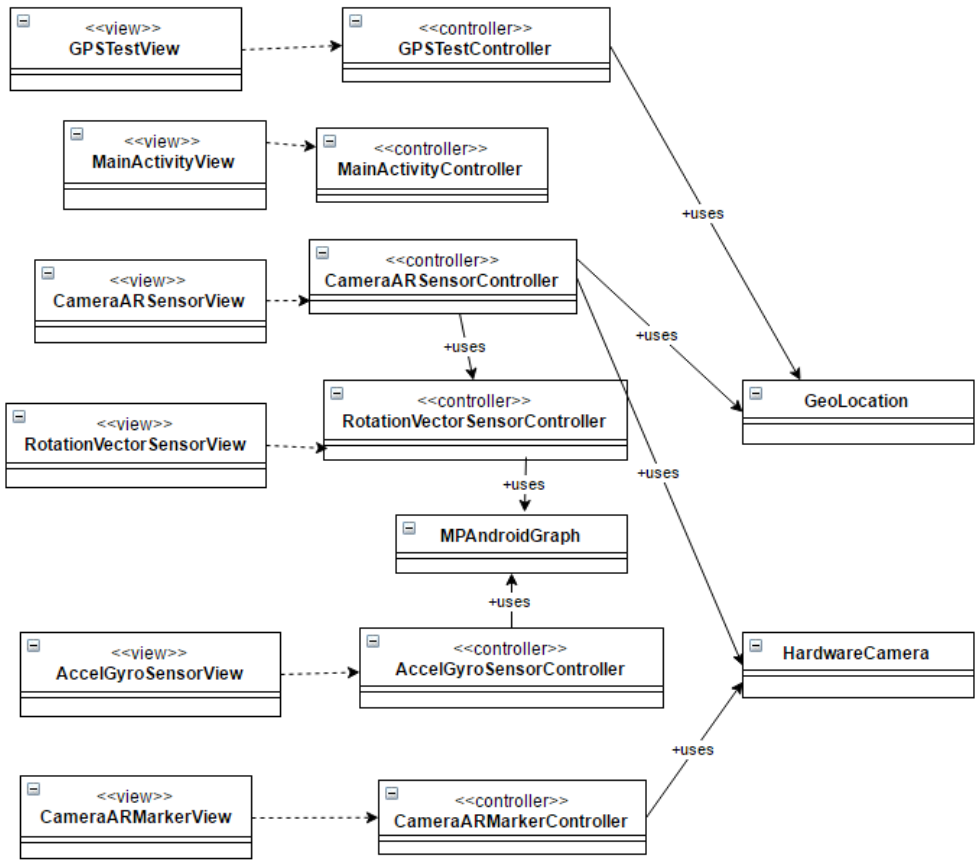

FIGURE 3: MINIMAL CLASS DIAGRAM

APPENDIX B - USER INTERFACE DESIGN

Menu View | Rotation Vector Sensor Graph | AR Camera pointing to the direction of ECS building | AR Camera pointing to the direction of Green Library

FIGURE 4 PART 1

Menu View

GPS Location and Network Location Readings and Comparison

Accelerometer and Gyroscope Sensor Graph

AR Camera using marker to overlay 3D Model

FIGURE 4 PART 2

APPENDIX C - SPRINT REVIEW REPORTS

DATE: 9/9/2016

ATTENDEES: MARYAM, MARIA, LUKAS AND FRANCISCO

START TIME: 3:00PM

END TIME: 4:00PM

AFTER A SHOW AND TELL PRESENTATION, THE IMPLEMENTATION OF THE FOLLOWING USER STORIES WERE ACCEPTED BY THE PRODUCT OWNERS:

- **U**

SER STORY #108 & #117

THE FOLLOWING ONES WERE REJECTED AND MOVED BACK TO THE PRODUCT BACKLOG TO BE ASSIGNED TO A FUTURE SPRINT AT A FUTURE SPRING PLANNING MEETING.

- **NO USER STORY WAS REJECTED**

DATE: 9/23/2016

ATTENDEES: MARYAM, MARIA, LUKAS AND FRANCISCO

START TIME: 3:00PM

END TIME: 4:00PM

AFTER A SHOW AND TELL PRESENTATION, THE IMPLEMENTATION OF THE FOLLOWING USER STORIES WERE ACCEPTED BY THE PRODUCT OWNERS:

- **U**

  SER STORY #97 & #96

THE FOLLOWING ONES WERE REJECTED AND MOVED BACK TO THE PRODUCT BACKLOG TO BE ASSIGNED TO A FUTURE SPRINT AT A FUTURE SPRING PLANNING MEETING.

- **NO USER STORY WAS REJECTED**

DATE: 10/7/2016

ATTENDEES: MARYAM, MARIA, LUKAS AND FRANCISCO

START TIME: 3:00PM

NOT HOLD

WE COULD NOT MAKE A MEETING DUE TO THE HURRICANE YET

DATE: 10/21/2016

ATTENDEES: MARYAM, MARIA, LUKAS AND FRANCISCO

START TIME: 3:00PM

END TIME: 4:00PM

AFTER A SHOW AND TELL PRESENTATION, THE IMPLEMENTATION OF THE FOLLOWING USER STORIES WERE ACCEPTED BY THE PRODUCT OWNERS:

- **U**

SER STORY #155 & #162

THE FOLLOWING ONES WERE REJECTED AND MOVED BACK TO THE PRODUCT BACKLOG TO BE ASSIGNED TO A FUTURE SPRINT AT A FUTURE SPRING PLANNING MEETING.

- **NO USER STORY WAS REJECTED**

DATE: 11/4/2016

ATTENDEES: MARYAM, MARIA, LUKAS AND FRANCISCO

START TIME: 3:00PM

END TIME: 4:00PM

AFTER A SHOW AND TELL PRESENTATION, THE IMPLEMENTATION OF THE FOLLOWING USER STORIES WERE ACCEPTED BY THE PRODUCT OWNERS:

- **U**

SER STORY #154 & #163

THE FOLLOWING ONES WERE REJECTED AND MOVED BACK TO THE PRODUCT BACKLOG TO BE ASSIGNED TO A FUTURE SPRINT AT A FUTURE SPRING PLANNING MEETING.

- **NO USER STORY WAS REJECTED**

DATE: 11/18/2016

ATTENDEES: MARYAM, MARIA, LUKAS AND FRANCISCO

START TIME: 3:00PM

END TIME: 4:00PM

AFTER A SHOW AND TELL PRESENTATION, THE IMPLEMENTATION OF THE FOLLOWING USER STORIES WERE ACCEPTED BY THE PRODUCT OWNERS:

- **U**

SER STORY #164 & #165

THE FOLLOWING ONES WERE REJECTED AND MOVED BACK TO THE PRODUCT BACKLOG TO BE ASSIGNED TO A FUTURE SPRINT AT A FUTURE SPRING PLANNING MEETING.

- **NO USER STORY WAS REJECTED**

APPENDIX D - USER MANUALS, INSTALLATION/MAINTENANCE DOCUMENT, SHORTCOMINGS/WISHLIST DOCUMENT AND OTHER DOCUMENTS

THIS PROJECT HAS MULTIPLE PARTS, WE HAVE PROVIDED AN APPLICATION AS A TESTBED THAT CAN BE INSTALLED IN THE ANDROID DEVICES SIMPLY LIKE THE OTHER APPLICATION WHICH IS INSTALLED BY THE APK FILE.

USING THE RESULT FROM THE PROVIDED TESTBED AND CORRESPONDING RESEARCH, A FUNCTIONAL APPLICATION OF LEARNING BY AUGMENTED REALITY IS IMPLEMENTED AND SAME AS THE TESTBED IT CAN BE INSTALLED SAME AS OTHER ORDINARY APPLICATION BY APK FILE.

FOR DEVELOPMENT PART THE ANDROID STUDIO AND ALL THE CORRESPONDING SDK AND EMULATOR SHOULD BE INSTALLED. INSTALLATION IS EASY AND EXECUTION FILE IS PROVIDED BY THE ANDROID STUDIO OFFICIAL WEBSITE. BY FOLLOWING THE STRAIGHTFORWARD WELL DEFINED STEPS. HTTPS://DEVELOPER.ANDROID.COM/STUDIO/INDEX.HTML

UNITY, THE 3D GAME ENGINE ALSO INSTALLED IN THE SAME WAY.HTTPS://UNITY3D.COM/

OTHER SENSORS AND SERVICES WHICH ARE USED IN THIS APPLICATION ARE INTEGRATED IN THE MOBILE DEVICES AND NO INSTALLATION AND PREPARATION IS NEEDED EXPECT SOME CASES THAT PERMISSION MAYBE NEEDED.

BY EACH SDK UPDATE SOME UPGRADING IN THE SYSTEM IS NEEDED TO KEEP IT COMPATIBLE WITH NEW RELEASE.

WE WISH TO ADD FOLLOWING FEATURE TO THE SYSTEM:

- IMPLEMENT SIMILAR APPLICATION FOR OS DEVICE PHONES .
- INTEGRATE MULTIPLE BUILDING MODEL RATHER THAN SIPA BUILDING INTO THE SYSTEM AND PROVIDES THE USER THE OPPORTUNITY TO SELECT BETWEEN DIFFERENT BUILDING MODELS.
- INTEGRATE DIFFERENT BUILDING ARCHITECTURE AND AND PROVIDES THE USER THE OPPORTUNITY TO SELECT BETWEEN DIFFERENT ARCHITECTURE MODELS.

REFERENCES

HTTPS://UNITY3D.COM/

HTTPS://DEVELOPER.ANDROID.COM/STUDIO/INDEX.HTML

HTTP://ARTOOLKIT.ORG/

HTTPS://WWW.YOUTUBE.COM/WATCH?V=QFXQFDTXYVA