Final Project II

SE6361.001: Advanced Requirements Engineering

04/19/2022

Comet-Vision

Jyothise Johny

Pragya Karki

Abishek Kumar

Jun Li

Miao Miao

Jeongwon Seo

Vishakha Singh

Team URL: https://kumarabd.github.io/SE6361-project/

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Revision History

Date	Version	Changes	Editor
03/08/2022	Version 1.0	Edited a few functional requirements by removing non-functional keywords	Comet-Vision Team
03/22/2022	Version 1.1	Edited a few minor details	Comet-Vision Team
04/05/2022	Version 2.0	Started editing the preliminary issues for the second phase	Comet-Vision Team
04/18/2022	Version 2.1	Added roles of the team members for interim 2	Jeongwon Seo

Process

Project Description:

The course project is to develop a smartphone application to help blind people navigate indoors.

Project Schedule:

Deliverable	Date Due	Team Leader(s)	Tools
Preliminary Project Plan	January 27, 2022	Vishakha Singh	MS Word, OneDrive
Interim Project I	March 8, 2022 / March 10, 2022	Jeongwon Seo	MS Word & Powerpoint, Figma
Final Project I Submission	March 25, 2022	Jyothise Johny, Jun Li	MS Word & Powerpoint, Figma
Interim Project II	April 19, 2022	Pragya Karki	MS Word & PowerPoint, Android Studios, Java, RE Tools, Draw.io
Final Project II Submission	April 26, 2022 / April 28, 2022	Miao Miao, Abishek Kumar	MS Word & PowerPoint, Android Studios, Java, RE Tools, Draw.io

Roles in Interim II & Final Project II:

Name	Role
Vishakha Singh	Use Case Diagram & Section 9 of Vision Document
Jeongwon Seo	Process Specifications, Class Diagram & Vision Document
Jyothise Johny	Section 6, 8 of Vision Document, PIG & SIG
Jun Li	Sequence Diagram
Pragya Karki	Prototype & Sections 5, 10 of Vision Document
Miao Miao	Sections 1-3 of Vision Document, PIG & SIG
Abishek Kumar	Prototype & Sections 5, 10 of Vision Document

Introduction

Navigating around an indoor space can be difficult for anyone for various reasons. This is especially difficult for a visually impaired person, because they cannot accurately see where they are going, nor can they detect all obstacles that could appear in a split second. In order to help them with this problem, many people use a dog, a cane, or an assistant to help them reach their desired destination. Some people additionally use the help of braille indicators next to the classroom numbers to make sure they are at the correct location. However, those tools all cause an inconvenience as they are an additional load they have to carry around. To solve this issue, our team will be creating a smartphone application called "Comet-Vision". This smartphone application will be a portable tool that can help them navigate through classrooms, labs, offices, etc,. located in the Erik Jonsson School of Engineering & Computer Science (ECSS for short), here at the University of Texas at Dallas (UTD) easily and safely.

Preliminary Definition

Preliminary Definition of Domain

For this smartphone application, the purpose is to help visually impaired people to navigate around an indoor space, which can consist of multiple floors, each floor possibly hosting classrooms, offices, restrooms, lounges, elevators, etc... The application allows its user to input the destination location and will provide the most desirable route from the user's current location to the respective destination. The application can play audio instructions to help with guiding the user to his destination. Moreover, the application can intelligently detect potential dangers to protect its user from being hurt. If any accidents should happen to the user, the application will dial the emergency call immediately.

Preliminary Definition of Stakeholders

The stakeholders of this application can be divided into three sections: For, Of, and By.

The first division of the stakeholders refers to the end-users: people who will actively use the application. The primary stakeholder would be a blind person who needs to navigate indoors. Secondary stakeholders might involve a caretaker (an assistive person) - e.g., a family member or a friend – who sets the configuration of the smartphone app and come to aid the blind person in case the blind person is lost or injured. Secondary stakeholders might also include people in the Office of Student Accessability as well as the student health center at the University of Texas at Dallas, and the police, especially in an urgent situation that needs immediate attention.

The second division of stakeholders refers to the owners: people who own this smartphone application. Since this application is a market-driven project and not a customer-driven project, the stakeholders would be the Comet-Vision team of UTD who managed and organized the overall production process.

The third division of stakeholders refers to the developers: people who created and developed the application. The stakeholders can be partitioned into three different groups: Requirements Engineers, Test Engineers, and Software Engineers. The requirements engineers create and oversee the requirements to fulfill the end-user's needs and desires of this application. The test engineers thoroughly test the product by managing the procedures to make sure a high-quality

application is delivered to the users. Finally, the software engineers make the documentation into a fully functioning application on a smartphone device. For this application, the requirements engineers are Vishakha Singh, Jun Li, and Jeongwon Seo, test engineers are Jyothise Johny and Miao Miao, and software engineers are Abishek Kumar and Pragya Karki.

Preliminary Definition of Functional Objectives

Functional objectives would include foremost navigating indoors, primarily going from one location to another location in the same or different buildings that are connected to each other. In addition, the app shall be able to detect obstacles and avoid collisions to ensure the safety of the unsighted user. If any emergencies occur, the app shall contact the user's emergency contact immediately. Moreover, the app shall be able to recommend the most optimal route based on the preset user preference.

Preliminary Definition of Non-Functional Objectives

Non-functional objectives would include safe navigation, fast navigation, and comfortable navigation. Since the app is for unsighted people, usability or user-friendliness would also be an important objective. Since an unsighted person cannot read the screen of a smartphone app, the capabilities of voice recognition would as well be one of the top objectives. Finally, the system should be customizable for different users to set their personal preferences and should be easily extensible to accommodate typical variations.

Issues with Preliminary Definition Given

Issues with the Domain

Domain Issue ID	**Domain Issue Description**	
DI_01	How to define "visually impaired" people? There are many categories of visual impairments with varying levels of impairment or impact.	
	Option 1	This application is designed to help all types of visually impaired people.
	Option 2	This application is designed to help mainly blind people.
	Choice	**Option 2**

	Rationale	There are some visual impairments, such as color blindness, that cannot be assisted by this smart phone app.

Domain Issue ID	Domain Issue Description	
DI_02	How to define "indoor"? In which building and on which floor of the building should the application be able to work?	
	Option 1	This application should be able to work in any building of the UT-Dallas campus.
	Option 2	This application should be able to work in ECSS (Engineering & Computer Science South) building and on any floor of the building.
	Option 3	This application should be able to work in ECSS (Engineering & Computer Science South) building and only the 2nd floor of the building
	Choice	**Option 3**
	Rationale	Due to the limited access to UT-Dallas campus geographic information, this application can only support the navigation on the 2nd floor of the ECSS (Engineering & Computer Science South) building.

Domain Issue ID	Domain Issue Description
DI_03	How does the user input the destination location into the application? The domain description is ambiguous regarding the input methods the application supports.

	Option 1	This application only allows its user to type in the destination location via a keyboard.
	Option 2	This application only allows its user to set the destination location via voice input.
	Option 3	This application allows its user to set the destination location via both a keyboard and voice input.
	Choice	**Option 3**
	Rationale	According to the definition of stakeholders of this application, the user may be a blind person or his/her caretaker. Therefore, this application should support both the traditional way of input and the voice input.

Domain Issue ID	**Domain Issue Description**	
DI_04	How to define "the most desirable route"? The definition of desirable is vague. Is the level of desirability based on the time cost, the length of the route, the crowdedness, or the user's preference?	
	Option 1	This application will provide the user with the shortest path to the destination.
	Option 2	This application will provide the user with multiple paths each with respect to least time cost, shortest length, or least crowdedness.
	Option 3	This application will provide the user with multiple paths each with respect to least time cost, shortest length, or least crowdedness. If the user has saved a preferred path before, the application will provide the user with his/her favorite path.
	Choice	**Option 3**

	Rationale	The definition of the most desirable may vary from one user to another. Users might not always deem the shortest path as the most desirable path. The application should allow the user to have multiple options.

Domain Issue ID	Domain Issue Description	
DI_05	How to define "intelligently detect potential dangers"? What are the potential dangers? How will these potential dangers be captured?	
	Option 1	The application will detect the obstacles in front of the blind person within one meter using its camera and send a voice alert to help the blind person avoid the obstacles.
	Option 2	The application will detect the obstacles in front of the blind person within one meter or the fast-moving objects using its camera and send a voice alert to help the blind person avoid the obstacles or dangers.
	Choice	**Option 2**
	Rationale	Option 2 has dealt with more types of dangerous scenarios which might be faced by the blind people in their daily life.

Domain Issue ID	Domain Issue Description	
DI_06	"If any accidents should happen to the user, the application will dial the emergency call immediately." Should the decision to dial the emergency call be made by the user or by the system? Should the application ask for the user's permission before making an emergency call?	
	Option 1	The application will dial the emergency call immediately if there is a potential fall being detected.

	Option 2	The application will ask the blind person for their permission with the help of voice assistance to make sure there is an actual emergency happening and an emergency call is necessary, then the system will perform the action of calling.
	Choice	**Option 2**
	Rationale	Option 2 makes sure that the application will not make wrong emergency calls to cause unnecessary trouble for the blind people.

Issues with Functional Objectives

Functional Objectives Issue ID	**Functional Objective Issue Description**	
FOI_01	The primary person using the application will be visually impaired, so it is particularly important to make sure the interface of application is catered to their needs as someone without sight.	
	Option 1	The system shall provide interfaces that have large, tappable regions for the users.
	Option 2	The system shall play pre-recorded audible introduction sound on each app page to the user.
	Choice	**Options 1 & 2**
	Rationale	Options 1 & 2 makes sure blind people can interact with the application better.

Functional Objectives Issue ID	**Functional Objective Issue Description**	
FOI_02	When the system has received the user's destination, the system shall produce a route to get to the destination. What if there is no possible route from the user's current location and their destination? Or, what if the user has given an invalid destination?	
	Option 1	Tell the user that route could not be calculated and try another destination.

	Option 2	Call a live assistant or a nearby person to take them to their destination/help with input.
	Choice	**Option 1**
	Rationale	Option 1 responds immediately to the user and asks them to enter a legitimate destination. Considering the absence of people around, Option 2 is not appropriate and is not reasonable.

Functional Objectives Issue ID	**Functional Objective Issue Description**	
FOI_03	The system shall play pre-recorded introduction sound on each app page to the user. What if the volume is down on the phone?	
	Option 1	Force phone volume to be at an audible level.
	Option 2	Make a noise to nearby people to assist the user.
	Option 3	Vibrate the phone to alert the user to turn up the volume and use morse code to provide instructions.
	Choice	**Options 1 & 2**
	Rationale	Options 1 & 2 automatically assist users interact with application instead of asking users to operate on their phones. Also, morse code asks too much for users to use.

Functional Objectives Issue ID	**Functional Objective Issue Description**	
FOI_04	The system should be able to tell users which direction they should go to reach their destination. What if the user takes the wrong turn or steps too many/too little number of times leading them to the wrong destination?	
	Option 1	Have the application alert the user when they have messed up so they can retrace their steps.
	Option 2	Have the application adapt to the user's current location, so it will recalculate the best route based on where they currently are if they go off course.
	Choice	**Option 2**

	Rationale	Option 2 relocates the location of users synchronously and recalculates the optimal routes to the destination when they fail to reach their destination.

Functional Objectives Issue ID	Functional Objective Issue Description	
FOI_05	The system shall be able to transform users' speaking into text input. What if the host phone does not have the right hardware to do this?	
	Option 1	Make sure that before installing the app, the phone has the bare minimum hardware to meet this requirement.
	Option 2	Require text input from the keyboard.
	Choice	**Option 1**
	Rationale	Option 1 ensures the availability of the function of transforming users' speaking into text input. Text input will always be available regardless of this issue for secondary stakeholders who do not need this feature to access the application.

Functional Objectives Issue ID	Functional Objective Issue Description	
FOI_06	If any emergencies occur, the app shall contact the user's emergency contact immediately. What if users are not familiar with this feature?	
	Option 1	Notify the user about it when providing instructions.
	Option 2	Provide emergency detection (i.e., when the user falls, or they are screaming in pain) to automatically make an emergency call.
	Choice	**Option 1**
	Rationale	Option 1 makes sure users understand how to use emergency call (i.e., long-press the button).

Issues with Non-Functional Objectives

Non-Functional Objectives Issue ID	Non-Functional Objective Issue Description	
NFOI_01	The system shall be able to open the homepage within 5 seconds. What if the host phone does not have the right hardware to do this?	
	Option 1	Make sure that before installing the app, the phone has the bare minimum hardware to meet this requirement.
	Choice	**Option 1**
	Rationale	Option 1 ensures that the application responds instantly.

Non-Functional Objectives Issue ID	Non-Functional Objective Issue Description	
NFOI_02	The system shall calculate the best route within 1 minute. What does “best route” mean?	
	Option 1	The route with the shortest ETA.
	Option 2	The route that suits the user’s preferences
	Option 3	The route with the least number of turns.
	Choice	**Options 1 & 2**
	Rationale	Options 1 & 2 ensures that the application will provide the best route that the users may already be familiar and comfortable with.

Non-Functional Objectives Issue ID	Non-Functional Objective Issue Description	
NFOI_03	Audible introduction sound shall be put in the system. What happens when the files get deleted and no sound is available?	
	Option 1	Every time the application is started up, retrieve from the cloud the most up to date introduction to play.
	Option 2	Call for help from nearby people.
	Choice	**Option 1**
	Rationale	Option 1 ensures the availability of all audible functions before the application starts.

Non-Functional Objectives Issue ID	Non-Functional Objective Issue Description	
NFOI_04	The system shall avoid navigate the user into an area that is marked as dangerous. What if the user proceeds into the dangerous area, beyond the application's instructions?	
	Option 1	Alert the user that they are heading into the dangerous area
	Option 2	If the user is deep into the dangerous area, alert safety officials.
	Choice	**Options 1 & 2**
	Rationale	Both options ensure maximum security for those using the application to prevent any emergency occurring.

Non-Functional Objectives Issue ID	Non-Functional Objective Issue Description
NFOI_05	The system shall be able to guide the users to safely reach their destination in 15 minutes. What does "safe" mean?

	Option 1	Make sure that the user of the application is unharmed during their trip to the destination.
	Option 2	Make sure nobody else is harmed during the blind person's trip.
	Choice	**Options 1 & 2**
	Rationale	People related to the user - loved ones, caretakers, and the police want to ensure the utmost safety for the person using the application to prevent any problems that could cause some stress or costs.

Non-Functional Objectives Issue ID	**Non-Functional Objective Issue Description**	
NFOI_06	Buttons in the system shall have divergent functionality. What does "functionality" mean?	
	Option 1	Each button has a purpose and is not useless to the user.
	Option 2	Each button does not take up an amount of unnecessary space for its function, as largeness of buttons will be important to the unsighted person.
	Option 3	For every action that the user can perform, have a button that will resemble it.
	Choice	**Options 1 & 2**
	Rationale	Since the software has limited page space, it ensures the usefulness of each displayed function button.

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Problem

Problem_ID	Description
P_01	Visually impaired users may run into undetected obstacles while using the system
P_02	GPS may be unavailable in certain locations
P_03	Wi-Fi or cellular data may be disconnected or not work properly in certain locations
P_04	The system must comply with state and federal laws such as HIPPA
P_05	Current location may be incorrectly detected due to technical issues
P_06	The user's screen may be visible to multiple people when using the system which may be an invasion of their privacy
P_07	Navigation may be interrupted due to incoming notifications such as phone calls or text messages or different applications installed on the user's device
P_08	Navigation may be interrupted due to malfunction in the system
P_09	Desired destination may be changed by the user in the middle of navigation
P_10	The user might add additional stops in the middle of navigation
P_11	Instructions provided by the system may be unclear to the users, causing a fall or an accident
P_12	The user may not be able to get help by themselves if they are stuck in an accident

Goal

Goal_ID	Description
G_01	The system should provide safety for its users
G_02	The system should be easily accessible and easy to use for all users, especially for those who are visually impaired
G_03	The system should work in parallel with other applications that are installed on the user's phone. In other words, it should work in conjunction with other apps.
G_04	The system should only collect relevant data that is necessary for the user
G_05	The system should assist with connecting to emergency contacts, services, or other facilities via phone call or text messages
G_06	The system should be localized to the ECSS building
G_07	The system should be reliable and secure

Improved Understanding of the Domain

After the discussion over the issues with preliminary domain definition, the understanding of the domain has been improved. For this smartphone application, the purpose is to help mainly blind people to navigate around the 2nd floor of ECSS (Engineering & Computer Science South) building, which can possibly host classrooms, offices, restrooms, lounges, elevators, etc... The application allows its user to input the destination location via either voice or the traditional keyboard and will provide the user with multiple paths from the user's current location to the respective destination each with respect to least time cost, shortest length, or least crowdedness.

If the user has saved a preferred path before, the application will provide the user with his/her favorite path. The application can play audio instructions to help with guiding the user to his destination. Moreover, the application will detect the obstacles in front of the blind person within one meter or the fast-moving objects using its camera and send a voice alert to help the blind person avoid the obstacles or dangers. If any accidents should happen to the user, the application will ask the blind person for their permission with the help of voice assistance to make sure there is an actual emergency happening and an emergency call is necessary, then the system will perform the action of calling.

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Functional Requirements

FR_ID	Description
FR_01	The system shall locate the current location of the user
FR_02	The system shall display an interactive interface for both the user and their assistant (friends, family, etc,.)
FR_03	The system shall allow the user to customize the notification sounds
FR_04	The system shall allow the user to add their preferences regarding their emergency contacts
FR_05	The system shall give directions to the users
FR_06	The system shall detect obstacles and warn the users to avoid collision
FR_07	The system shall tell the users when to stop at the right place for a turn or change in direction
FR_08	The system shall contact the user's emergency contact or other services based on their preference via call or text message when detecting a fall or an accident
FR_09	The system shall alert and notify the user when they start navigation and when they have arrived at their destination
FR_10	The system shall find multiple routes to the user's destination and choose a route based on their preferences
FR_11	The system shall be able to identify the destination based on the room number
FR_12	The system shall keep track of shortcuts or favorite routes taken by the user
FR_13	The system shall push notifications according to the user's course schedule or personal schedule registered into the system

Non-Functional Requirements

NFR_ID	Description
NFR_01	The system shall help the user safely navigate indoors
NFR_02	The system shall be user-friendly
NFR_03	The system shall be reliable
NFR_04	The system shall be maintainable
NFR_05	The system shall be portable
NFR_06	The system shall be adaptable
NFR_07	The system shall be ubiquitous
NFR_08	The system shall be responsive

NFR_09	The system shall be customizable to every user based on their preferences
NFR_10	The system shall be extensible to accommodate different variations in interface, language, new features, new sensors and hardware, etc

Functional Specifications

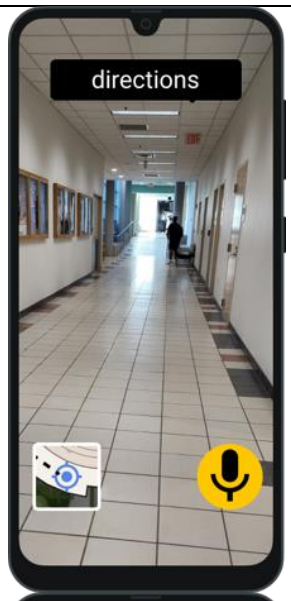
FS_ID	**Description**
FS_01	The system shall be able to accept voice input (speech-to-text) from the user utilizing the device's built-in microphone or from their headphones/earphones
FS_02	The system shall be able to accept text input from the built-in keyboard on the device
FS_03	The system shall utilize GPS location (geomagnetic sensor and accelerometer) and the CAD map to identify both the user's current location and their desired destination
FS_04	The system shall utilize vibration motor to produce vibrations when notifying the user when they start and end navigation
FS_05	The system shall utilize the built-in accelerometer and gyroscope sensors to track the user's movements and detect when the user is falling
FS_06	The system shall utilize the built-in proximity sensor to measure the distance between the user and the detected obstacle(s)
FS_07	The system shall utilize the alarm system of the device to send alarm notifications to the users based on their schedule and preferences

Preliminary Prototype and User Manual

1. Login Page
The first screen that opens when the user or the person assisting them opens the application is the Login Page, the user must scan their fingerprint to log in successfully.

+ Tracking the User
After successfully identifying themselves and logging in, the application will locate the user's current position and place a pointer on the application. If the app is unable to locate the user within a certain amount of time, it will contact the emergency contact of the user to ensure their safety.

2. Main Page
The user can use voice input with either their device's built-in microphone or another input microphone to tell the application where they want to go. The application then will map out an optimized route for the user.

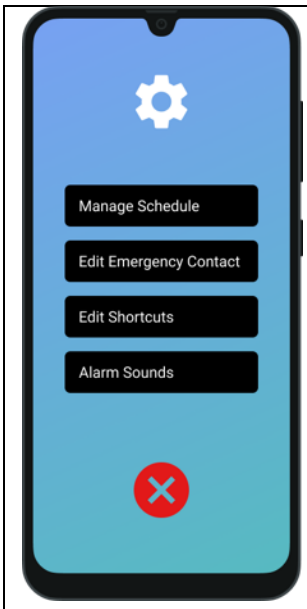


3a. Starting Navigation Screen

The system takes the user's request and finalizes the route that the user will take. The device in which the application is being used will vibrate when the navigational route is about to start. The camera will be pointed at the same direction where the user is facing. The system will also detect any potential obstacles using the built-in camera and alert the user via a sound notification for their safety. In addition, it will display what the user/camera is seeing on the screen along with a small map of where they are in the building for assistants to help and locate them. If one would like to view a bigger version of the map, they can easily click on the small box and it will expand to display a larger map on the screen.

3b. Ending Navigation Screen

Once the user reaches their destination, the device will vibrate again to let the user know that they've reached their destination. If the user needs to take a detour or stop somewhere in the middle of their route, they can once again use the voice command and let the application know where they want to go or stop by.



4. Settings Page

The settings page includes a few options:

a) Manage Schedule

The user can add or remove their class schedules on the application so that the application can send out alarm notifications when it is time for their next class. This will allow the application to take the user to their needed destination without the user manually starting the app every time. It will also help the users if they forget or are preoccupied with something else. They will also have the option to edit their personal schedules and add new destinations whenever they want to.

b) Edit Emergency Contact

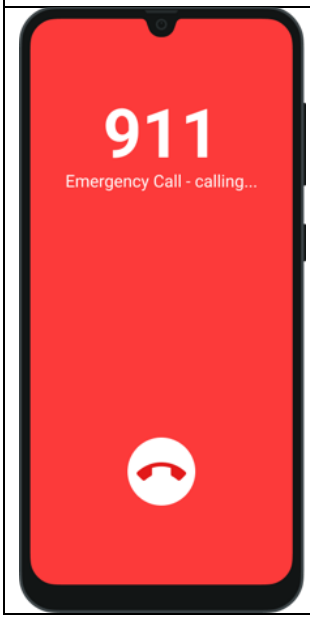
The user can add or edit their emergency contact information to contact when they are in danger or in need of assistance. However, the default emergency contact information like 9-1-1 or other resources will always be saved in the application.

c) Edit Shortcuts

This allows the users or the assisting person to put preferences regarding their routes along with some shortcuts that the user often takes on the main page if they wish to do so.

d) Alarm Sounds

If the user is not comfortable with the vibration option, the user can choose some other alert sounds that they wish to for customization.



+ Connecting to an Emergency Contact

This screen is an example of what the application will look like once it is automatically connected to Emergency Services in an emergency.

Traceability

Traceability among W

The following traceability matrix shows the mapping of the problem statements according to the goal statements. Each problem statement is connected to one or more goal statements which means they have all been considered and will be resolved.

	G_01	G_02	G_03	G_04	G_05	G_06	G_07
P_01	×						
P_02						×	
P_03						×	
P_04	×			×			
P_05			×				
P_06				×			×
P_07			×		×		
P_08			×				
P_09		×					
P_10		×					
P_11	×	×					
P_12	×				×		

Traceability among Functional Requirements and Non-Functional Requirements

The following traceability matrix shows the mapping of the functional requirements to the non-functional requirements.

	NFR_01	NFR_02	NFR_03	NFR_04	NFR_05	NFR_06	NFR_07	NFR_08	NFR_09	NFR_10
FR_01	×	×								
FR_02		×								
FR_03				×					×	
FR_04				×				×	×	
FR_05	×	×						×		
FR_06	×					×	×			×
FR_07		×	×				×			
FR_08		×						×		
FR_09					×			×		
FR_10		×	×			×				
FR_11		×				×				
FR_12				×			×			
FR_13		×						×		×