

Developing a Tracking System for Animals with an Application

By

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DESCRIPTION OF WORK

In United States of America, they're using a system, which is called National Animal Identification System¹ to trace the animals that have owners. System works over a microchip. Veterinarians or Shelter Officers implant a microchip under the skin of an animal and chip uses passive radio frequency identification technology. Generally, the chip is used on dogs and cats. In order to identify farm and ranch animals, they use ear tags. Generally animal shelters, animal control offices and veterinarians check for microchip. Microchip is used to return a lost pet to their owner and check medical care or vaccination. Lots of countries uses this system. There are a lot of pet owners and animals to trace in Turkey, too. However, there is a gap in our country about controlling animals that have been already adopted or living under governments applications like in shelters or thrown to the street after they vaccinate by government.

This project offers a system that will help to pet owners to trace or observe animals from a mobile application. Application will use Global Positioning System (GPS) technology to determine the location.

Global positioning system is a satellite-based navigation system hat uses at least 24 satellites placed into orbit by the U.S Department of Defense in 1973. GPS was originally developed for military applications, but in the 1980s, the government made the system public. GPS works in any weather conditions, anywhere in the world, 24 hours a day.²

A series of satellites orbiting the earth send a unique signal that is then read and interpreted by a GPS device, situated on or near the earth's surface. Figure 1.a describes how GPS works.

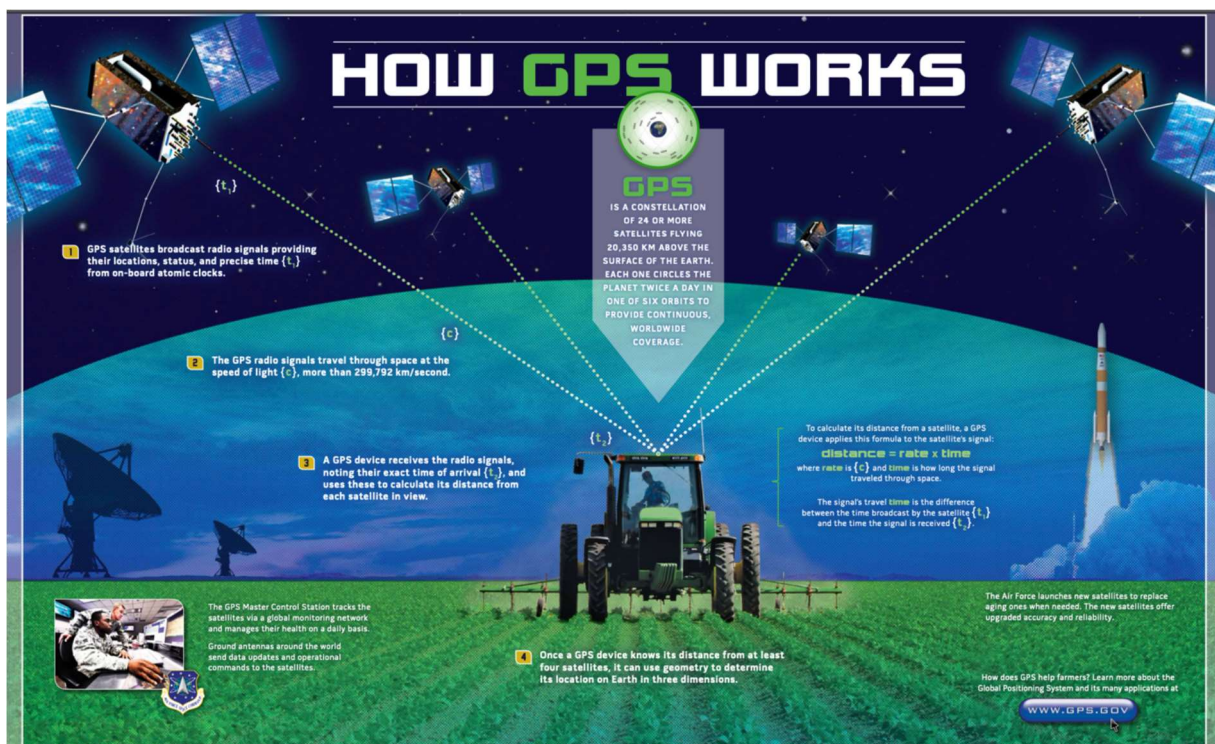


Figure 1.a

Our implementation will be getting location from GPS modulo and send the location to the application via Bluetooth modulo in order to visualize the current location of the pet in the map. Map will occur in connect to device page. User can visualize his/her pet in pet page. If user wants to see his/her pet on the map, he/she will click on the bluetooth device that appears in connect to device page. Then, the pet's location in the map will be shown to the user.

Our aim is to show pet's location on map in real-time. In order to do that, we are going make transmit signals from the component. Approximately, the transmission time will be shorter than 2.5ms in order to find location without refreshing page. The design and implementation of the response time will be close to Google Maps if the related components support such shorter response time. If does not support such shorter time, implementation will be done at the minimum response time that components supports us. But keeping transmission time shorter, will be harmful for pets and components battery.

To make response time shorter, component will communicate with the satellite every 1ms. This will effect pet's health in long term. Because of using bluetooth, component will be battery efficient.

ANALYSIS AND DESIGN

Functional & Non - functional Requirements

Functional Requirements:

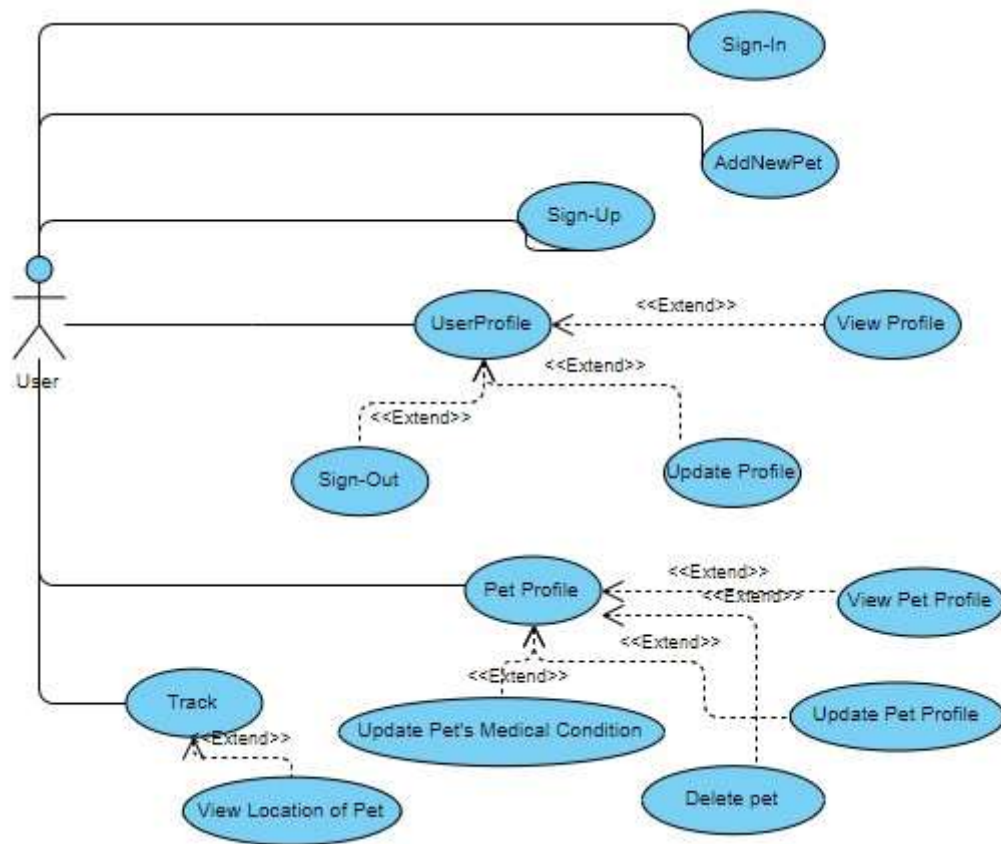
- **Sign - Up:** User is able to sign - up to the application; otherwise user cannot use the application without an account.
- **Sign - In:** User is able to sign in to the application.
- **Sign - Out:** User is able to sign out from the application.
- **View his/her Profile:** User is able to view his/her account profile.
- **Update Profile:** User is able to update his/her profile information.
- **Create Pet Profile:** User is able to create a profile for his/her pet.
- **View Pet Profile:** User is able to view his/her pet profile.
- **Update Pet Profile:** User is able to update his/her pet profile.
- **Delete Pet Profile:** User is able to delete his/her pet information.
- **Add New Pet:** User is able to add new pet to his/her account.
- **View Location of Pet:** User is able to view the location of his/her pet from the application.

Non - Functional Requirements:

- The applications needs to be connected with an internet.
- User will receive response messages after every operation.

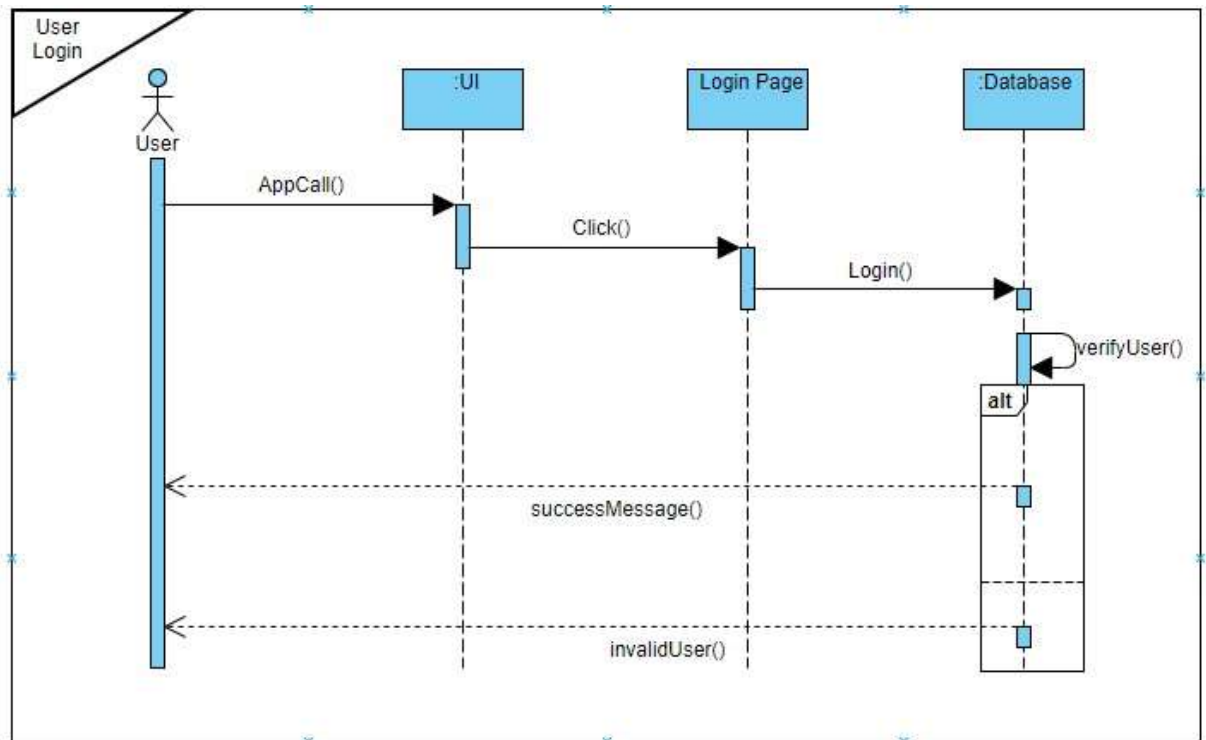
- Application will be up - to - date.
- System will use database to check users for the validation.
- System will give response lower than 1.5ms in order to keep real time tracking.
- The system can have 100 user at the same time in the application.
- The system will contain authentication and validation.

Use Case Diagram

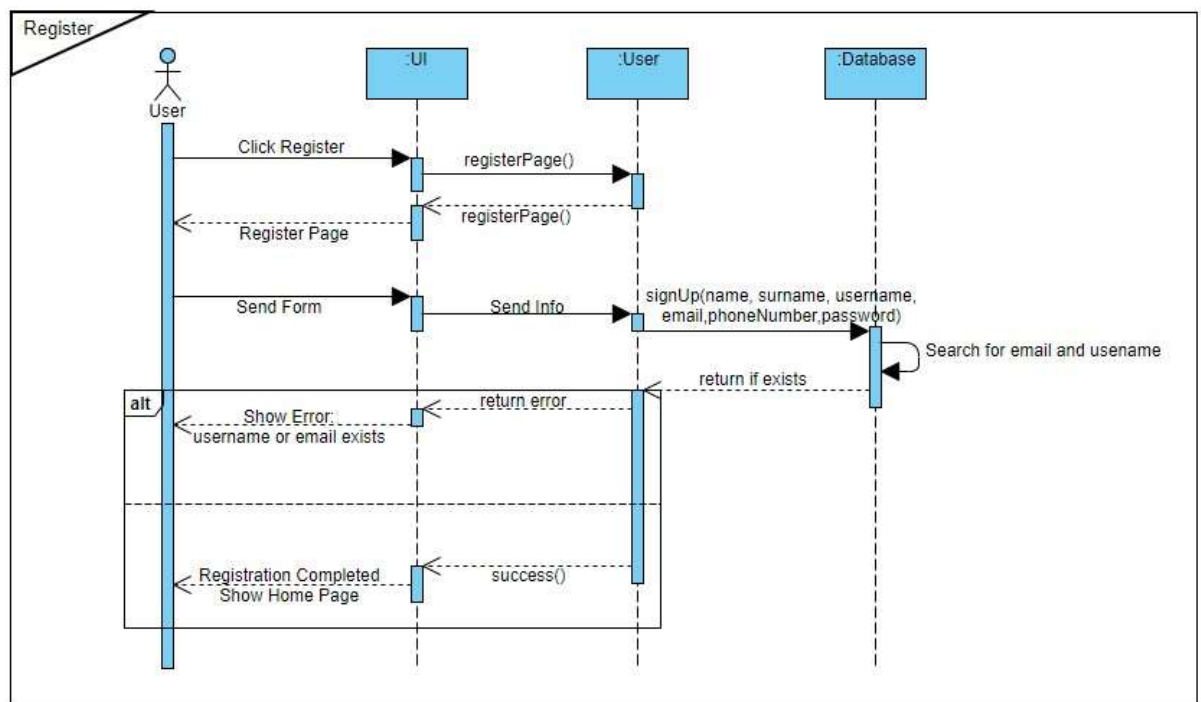


Behavioral - Sequence Diagram

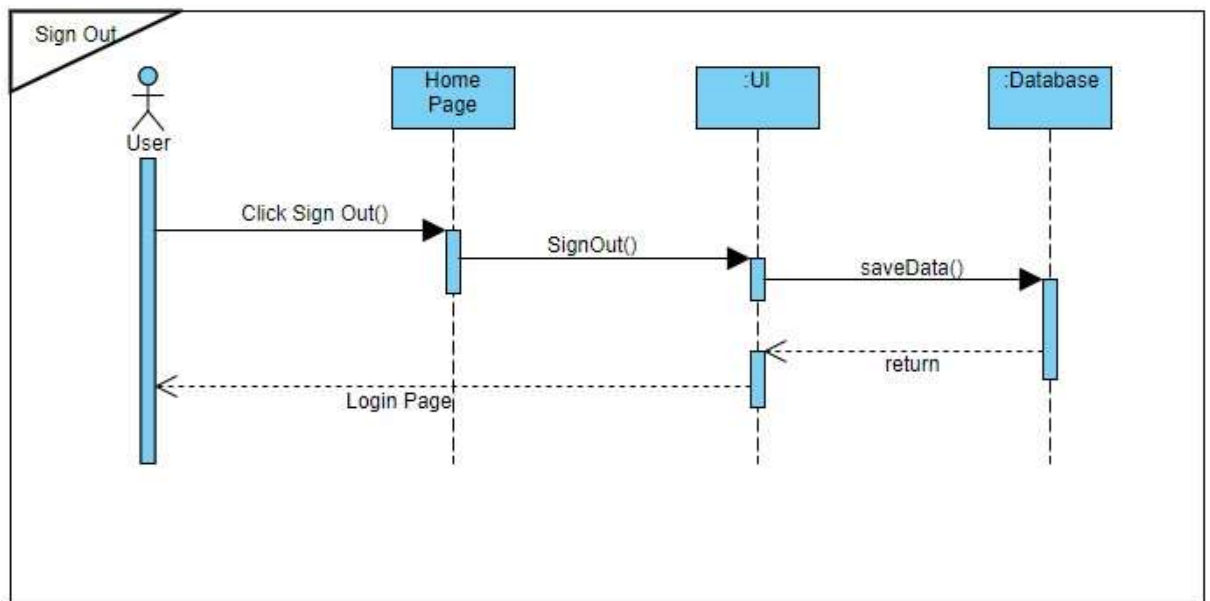
User Login:



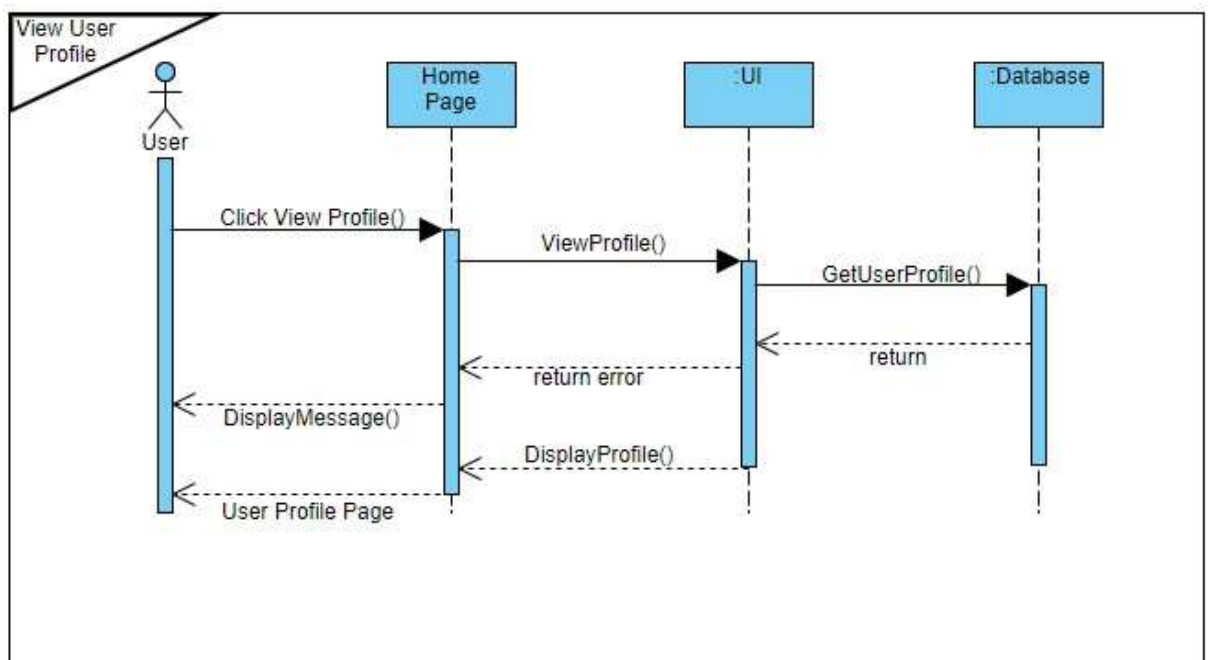
Register:



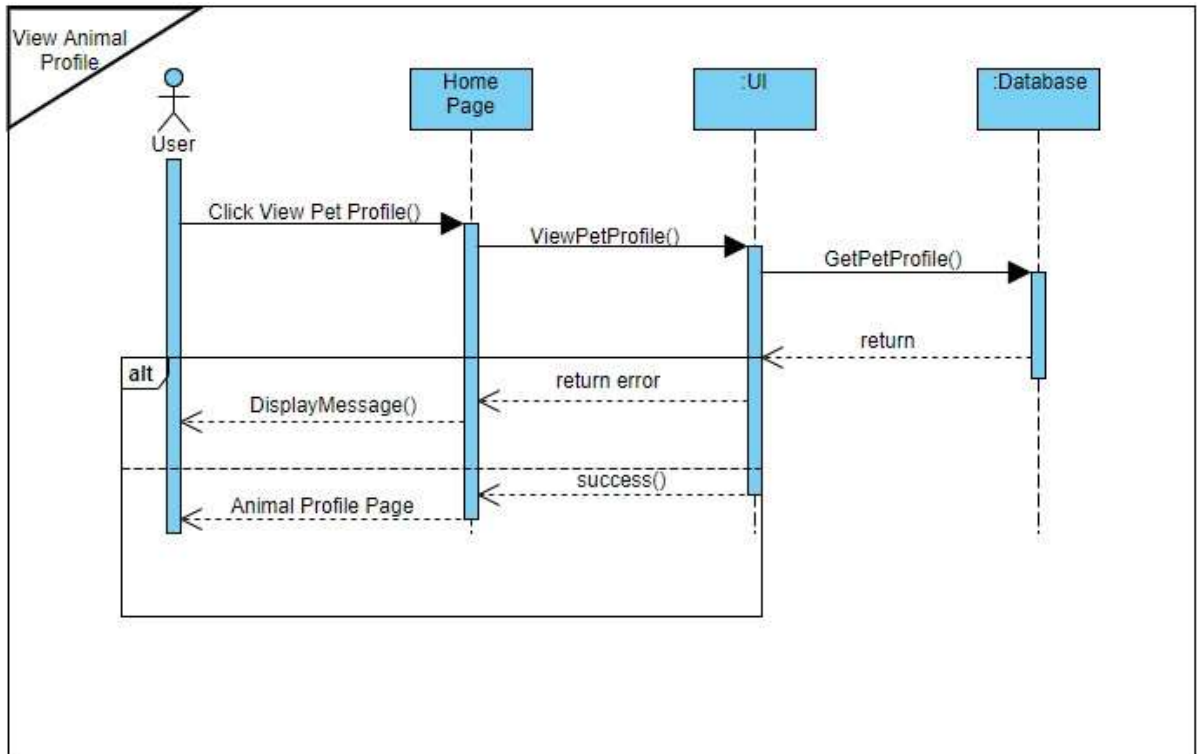
Sign Out:



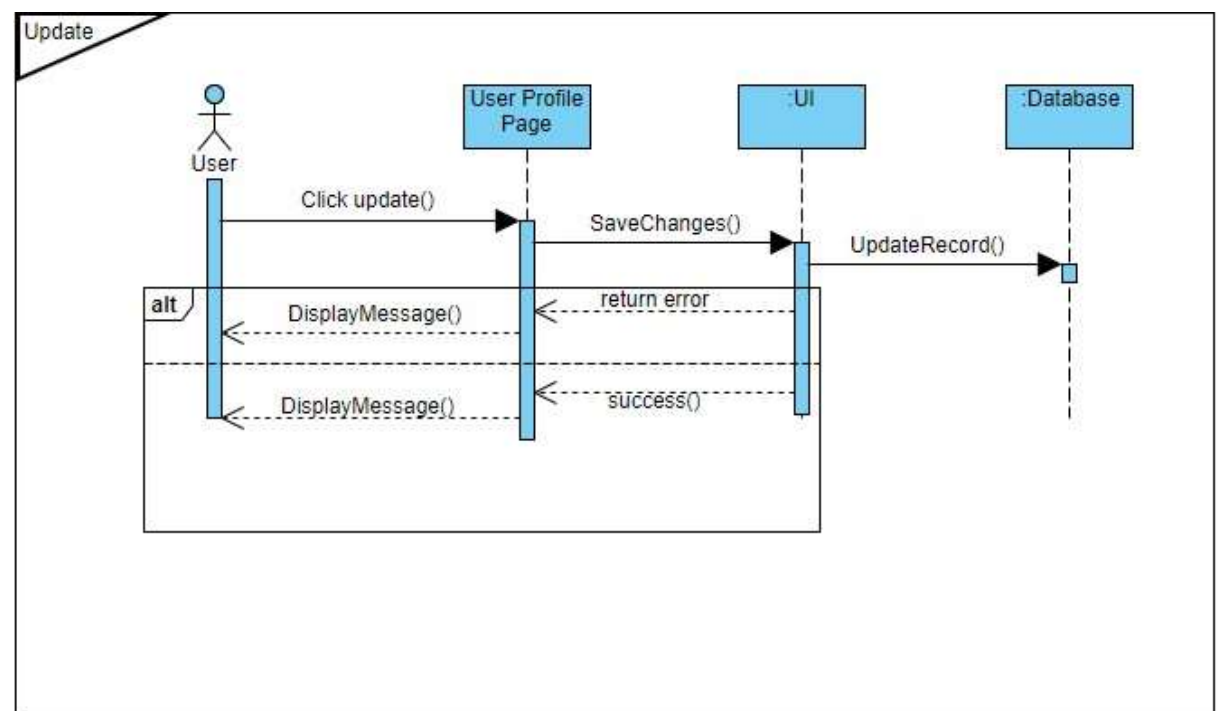
View User Profile:



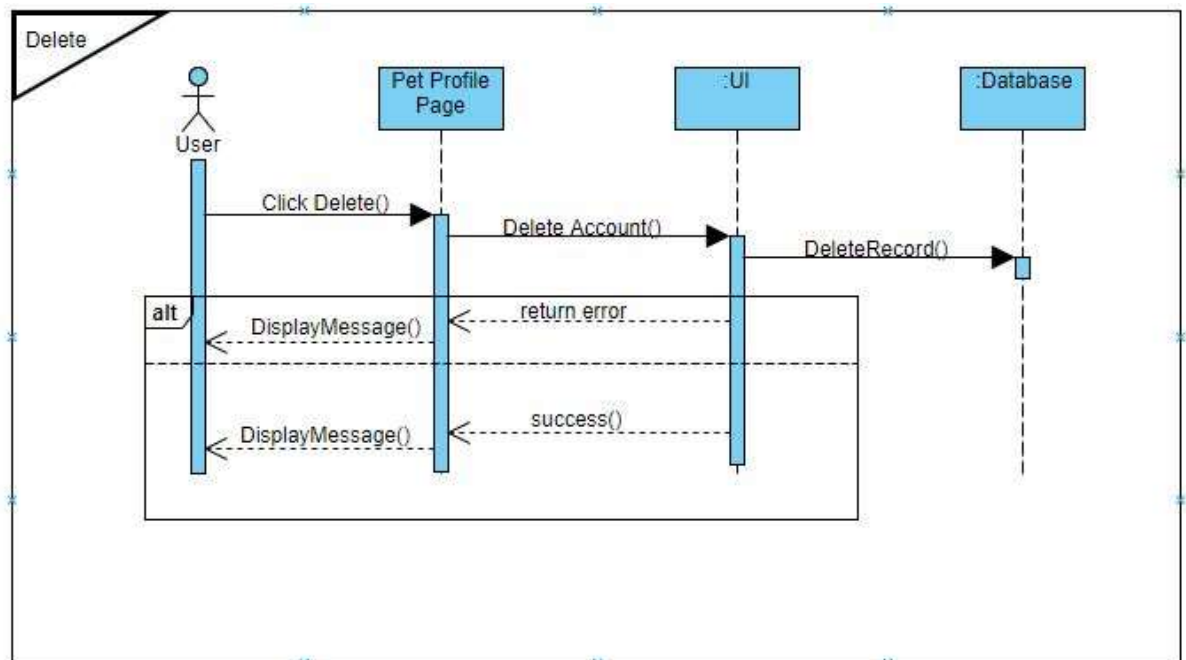
User Update Profile:



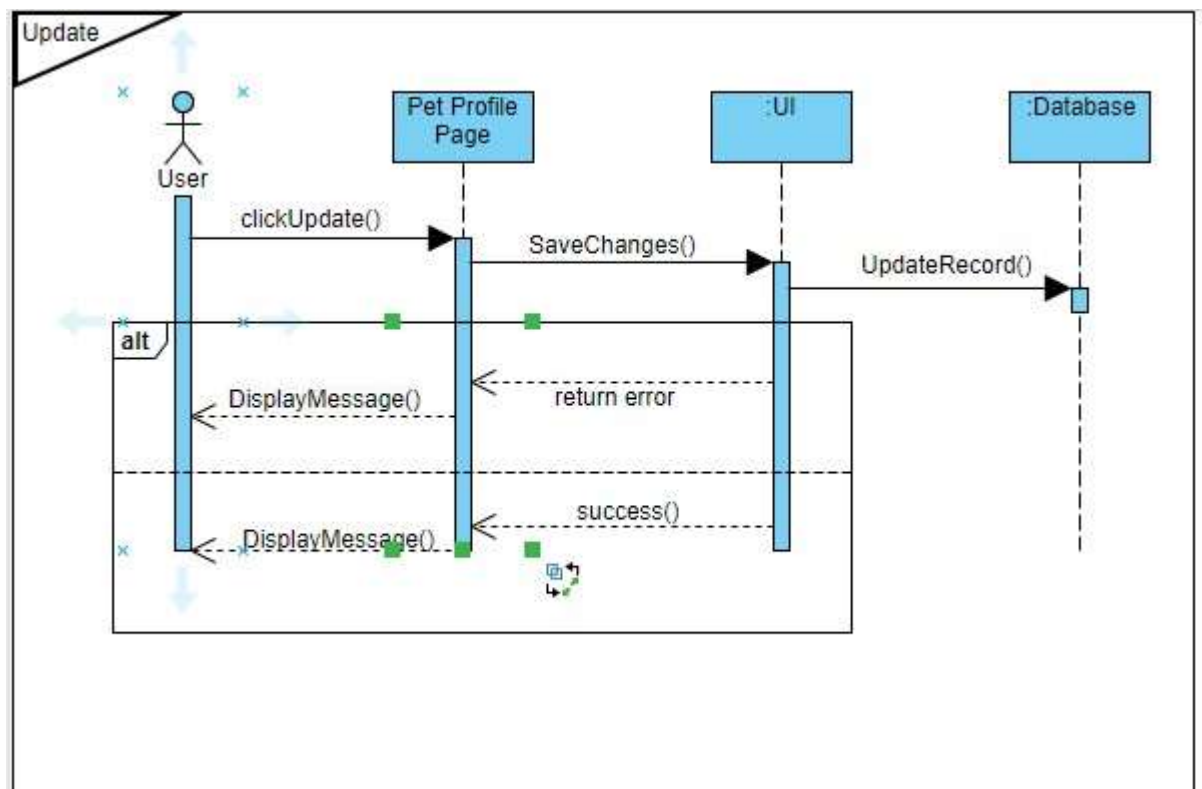
View Pet Profile:



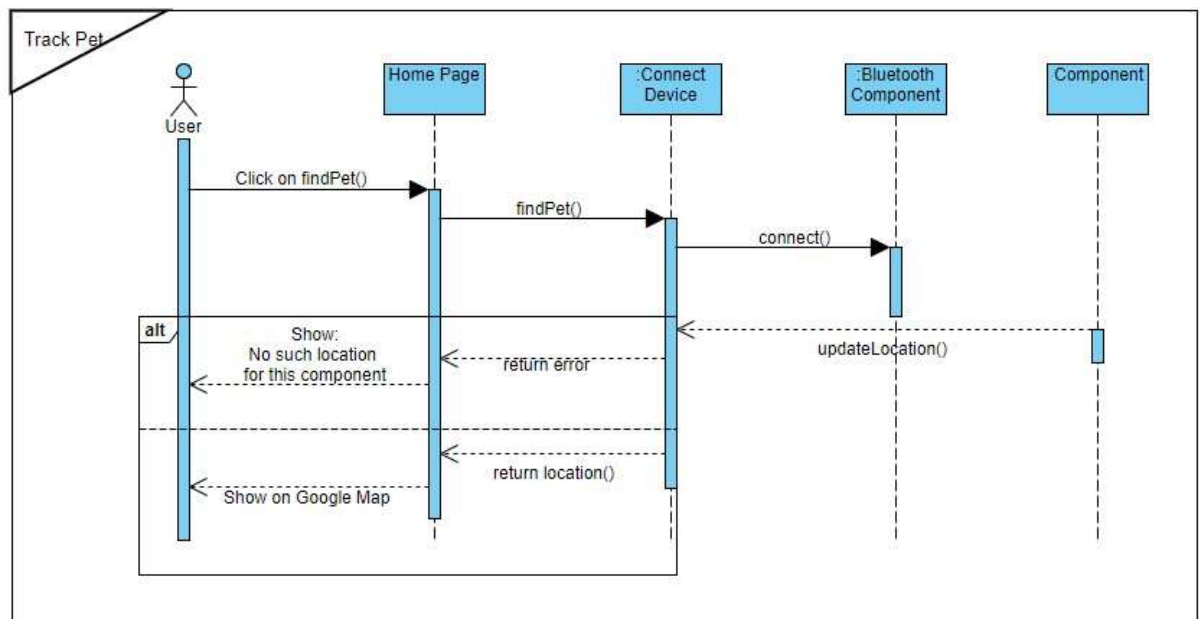
Update Pet Profile:



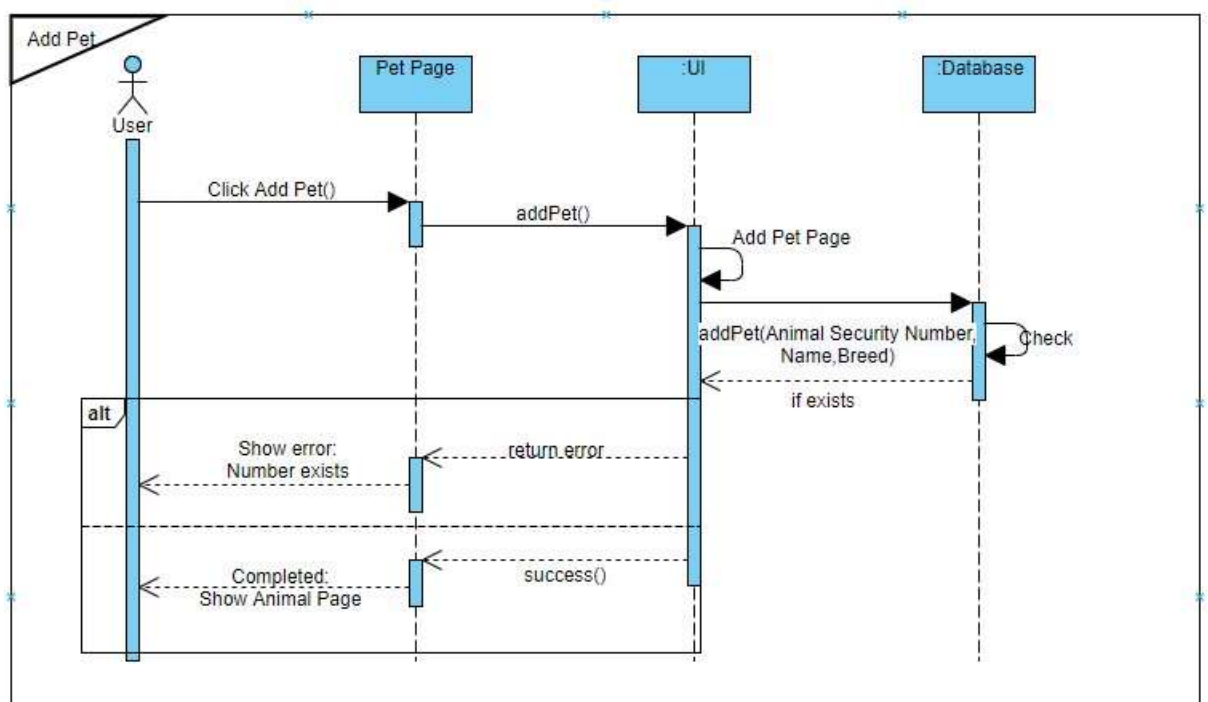
Delete Pet Profile:



Add Pet:



Track Pet:



JSON Structure of Database:

```
{  
  User authentication token : {  
    "Pet" : {  
      "breed" : " ",  
      "coordinates" : "[ ] ",  
      "healthIssues" : " ",  
      "id" : " ",  
      "name" : " ",  
      "vaccination" : " "  
    },  
    "address" : " ",  
    "email" : " ",  
    "name" : " ",  
    "password" : " ",  
    "phone_number" : " ",  
    "surname" : " "  
  }  
}
```

Example of Database Design:



SOLUTION/PRODUCT & DESIGN

Product:

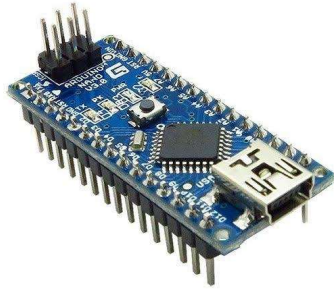
Sometimes pets get disappeared or escape from his/her living area. This situation creates an anxiety on the owners. In order to solve the problem, we implemented a mobile application that can help owners to track their pets in real-time. This product contains a hardware and software components. Software part, works on Android devices. Hardware component assembles with lots of different components which are, GPS modulo, a microcontroller and Bluetooth modulo.

- **GPS Modulo (Ublox NEO-6M GPS):** Modulo is a well-performing complete GPS receiver with ceramic antenna, which provides a strong satellite search capability.[4]
- **Microcontroller(Arduino Nano):** Arduino Nano is a small, compatible, flexible and breadboard friendly microcontroller board, developed by Arduino.cc in Italy, based on AT-Mega328P.[5]
- **Bluetooth(HC-05):** HC-05 modulo is an easy to use Bluetooth serial port protocol modulo, designed for transparent wireless serial connection setup. Serial port Bluetooth modulo is fully qualified Bluetooth version 2.0 + EDR(enhanced data rate) 3MB per second modulation with complete 2.4 GHz radio transceiver and base band.[6]

Normally Bluetooth version 5.0 have connection range with 400m. But in our case, our Bluetooth modulo uses 2.0 version and that restricts the range with 100m. GPS modulo does not have any connection range restriction. However, when the GPS initialize at the beginning, it takes 10 minutes to charge the battery of the GPS logger.

On the other hand, component's size are important in order to put on your pet.

- Size of Arduino Nano: 18.5x43.2 mm



- Size of GPS Modulo: 25x25x4 mm



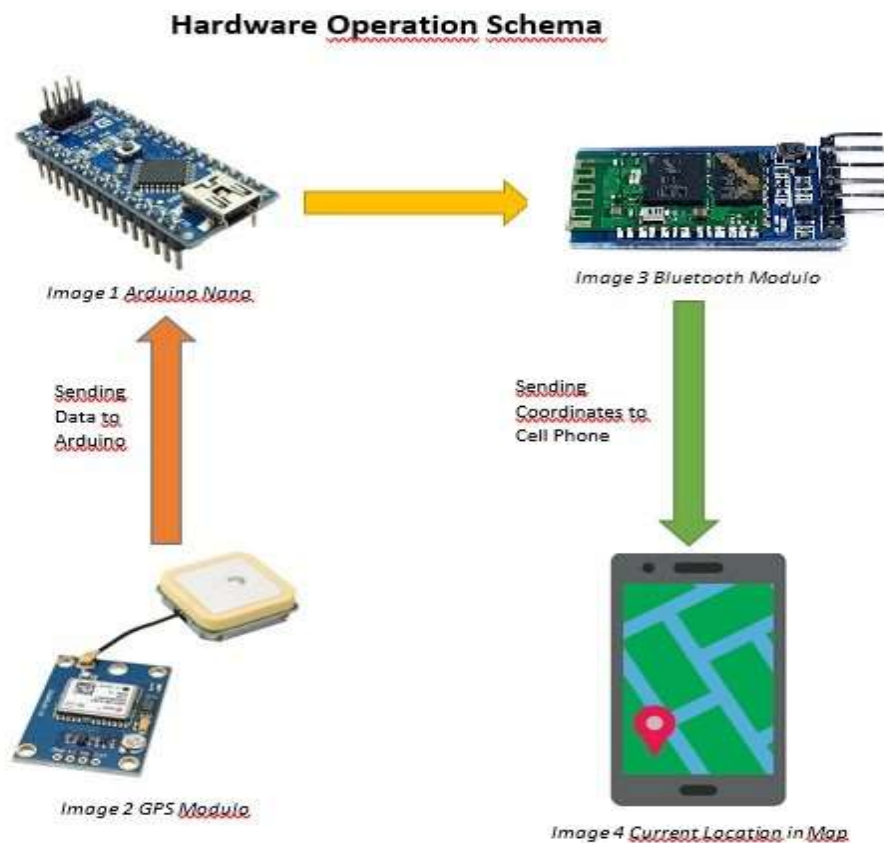
- Size of Bluetooth Modulo: 43x16x7 mm

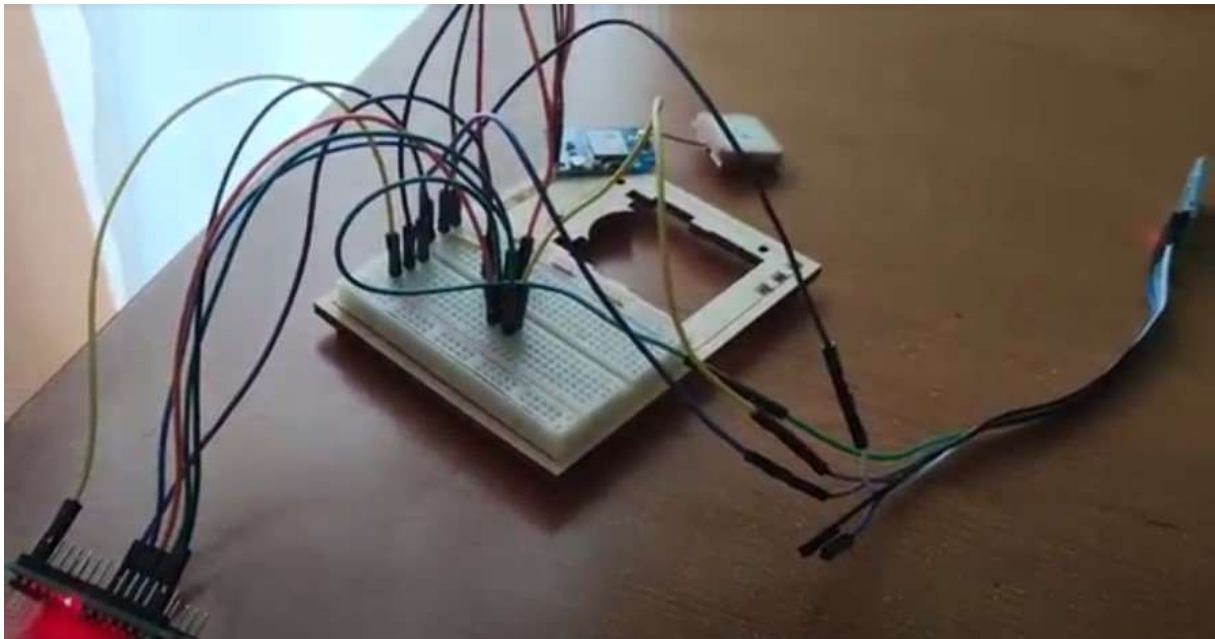


Both GPS and Bluetooth module works with 3.3V. With 1500 mA battery, depends and the usage of the component it varies between 1 and 3 day.

Calculation of battery usage is $(\text{Capacity/Current}) * 0.707$ (Factors that can affect the battery). The power consumption of components are reasonable in order to use in real-life. When we combine all the components in one product, we obtain a satisfying power consumption result for a device that works for 7/24 hours every day. In addition, it is small and light weighted. It makes easy to carry on pet's neck.

Components and Their Relation with Each Other:





Design and Implementation of Software:

In the implementation of the mobile application will contain 7 pages which are:

- Login Page
- Sign Up Page
- Home Page
- User Profile Page(Edit and View in same page)
- Pet Page
- Pet Profile Page(Edit and View in same page)
- Add Pet Page
- Connect to Device Page

Login Page:

User will be login to the system using his/her:

- Username
- Password

Sign Up Page:

The potential user will sign up to the application with his/her information needed by the system which are:

- Name
- Surname
- Username
- Password
- Phone Number
- E-mail Address

Home Page:

This page is the main page that contains some buttons such as profile, connect to device, pet profile and main page.

User Profile Page:

In this page, user will view his/her personal information. There will be an save button on the page so that user can edit his/her personal information. Also, user can update his/her information from this page. Required information are:

- Profile Photo
- Name Surname
- Username
- Phone Number
- E-mail

Pet Page:

In this page, user will view his/her pet's. User can add a new pet using Add Pet button. Also, user can view his/her pet's information by clicking on them.

Pet Profile Page:

User can visualize his /her pet's information. Also, user can update or delete his/her pet's profile from this page. User can see and update his/her pet's general and medical information. Under these titles:

- Vaccination
- Illness
- Animal Security Number
- Name
- Breed

Add Pet Page:

User will fill the related information about his/her pet on this page so that user can add a pet to the application. In order to add a pet to the system, user needs to fill this information:

- Animal Security Number
- Name
- Breed

The Animal Security Number is going to be provided with the component.

Technical Side:

- To get GPS location of the pet, we will be using a GPS modulo to locate pet's location. GPS modulo gets location with type of coordinate. After finding the coordinates, the information will be sent to the related connect with a Bluetooth modulo. Then, the coordinates will be visualized on the Home – GPS Tracking Page using a Map. So, user can see the current location of his/her pet.
- Each hardware component will contain only one unique number that will be their identification number. From the security number, owners will be able to track their pets in real-time.

- Information of pet and owner will be kept in a database system. The medical information and vaccination information will also be kept in the database for each pet that are entered to the system by their owners in order a need situation.

Software Implementation:

In software implementation, to implement the hardware component, we used set of C/C++ language to get the location from the GPS component and transmit over Bluetooth to the mobile application. We used TinyGPS++ and SoftwareSerial library.

In software implementation of mobile application, we used MIT App. MIT App Inventor is a web application integrated development environment, originally provided by Google and now maintained by Massachusetts Institute of Technology and it uses Java programming Language on backend side. At the same time, it is a blocks based coding program and tool facilitates the creation of complex, high impact apps in significantly less time than traditional programming environments.

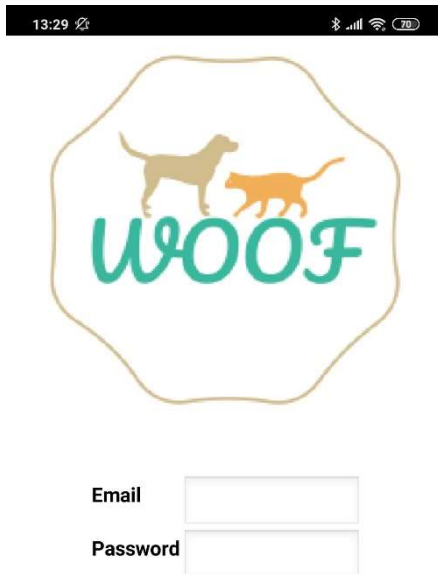
In backend side, we used Firebase database to keep the user data. Firebase let developers to build apps fast without managing infrastructure. It is build on Google infrastructure and scale automatically for the larger apps. Firebase provides authentication in lot of different platform like Facebook, Email-Password, Phone Number etc. Firebase allows 200 Thousand connection simultaneously. But in our case, because of registering with free accounts, allows 100 active users simultaneously.

When we look at the success criteria for each selected functional and non-functional requirements, we satisfied all the requirements, except change password functionality and 30 days usage with one charge. Android
The reason of the not satisfying change password functionality, MIT App Inventor restricts the functionality. For the 30 days usage with one charge, in ideal circumstances with larger battery it will be satisfied. But the measurements we have done are up to 3 days of usage.


For the installation, process Android platform users will be able to download the APK using QR code and it will be directly install on the phone.

Screen Shot of Application

Login Page:



13:29



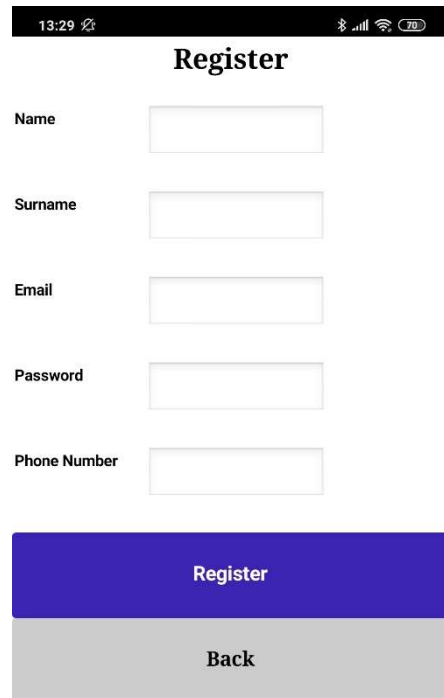
Email

Password

Login

Register

Register:



13:29

Register

Name

Surname

Email

Password

Phone Number

Register

Back

Home Page:

13:29

78

Menu

Welcome!!!

Cemal Sofuoglu

Exit

User Profile Page:

13:29

78

Menu

Your Profile

Personal Information

Name:

Cemal

Surname:

Sofuoglu

E-mail:

cemal@gmail.com

Password:

123456

Phone:

12345678901

Address:

Urla

Save Changes

Pet's Profile:

13:29

Menu

Pet Profile

Personal Information

Name:

Barney

Breed:

golden

ID:

98:D3:31:F9:70:EE HC0

Map

Medical Information

Vaccination:

no

Health Issues:

no

Save Changes

Delete Pet

Pet's Page:

13:29

Menu

My Pet's

Barney

New Pet

Tracking Page:



When Bluetooth Online:

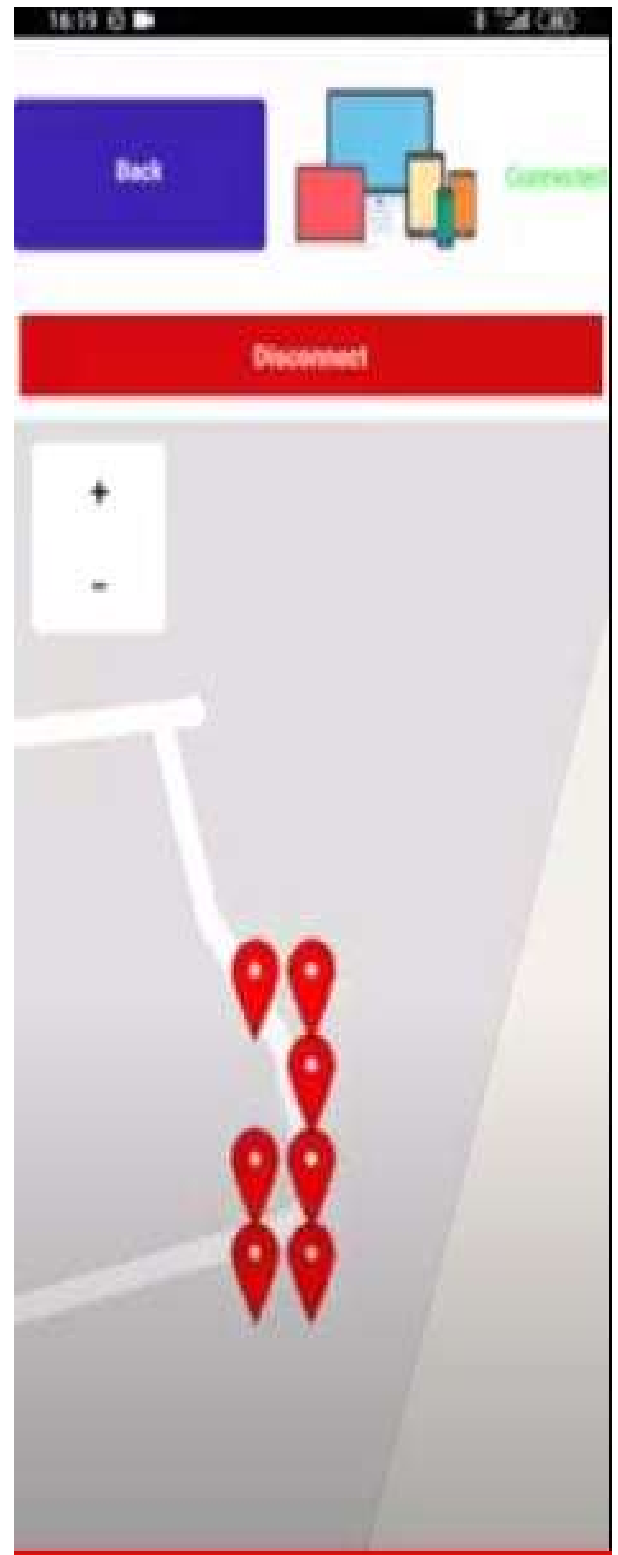
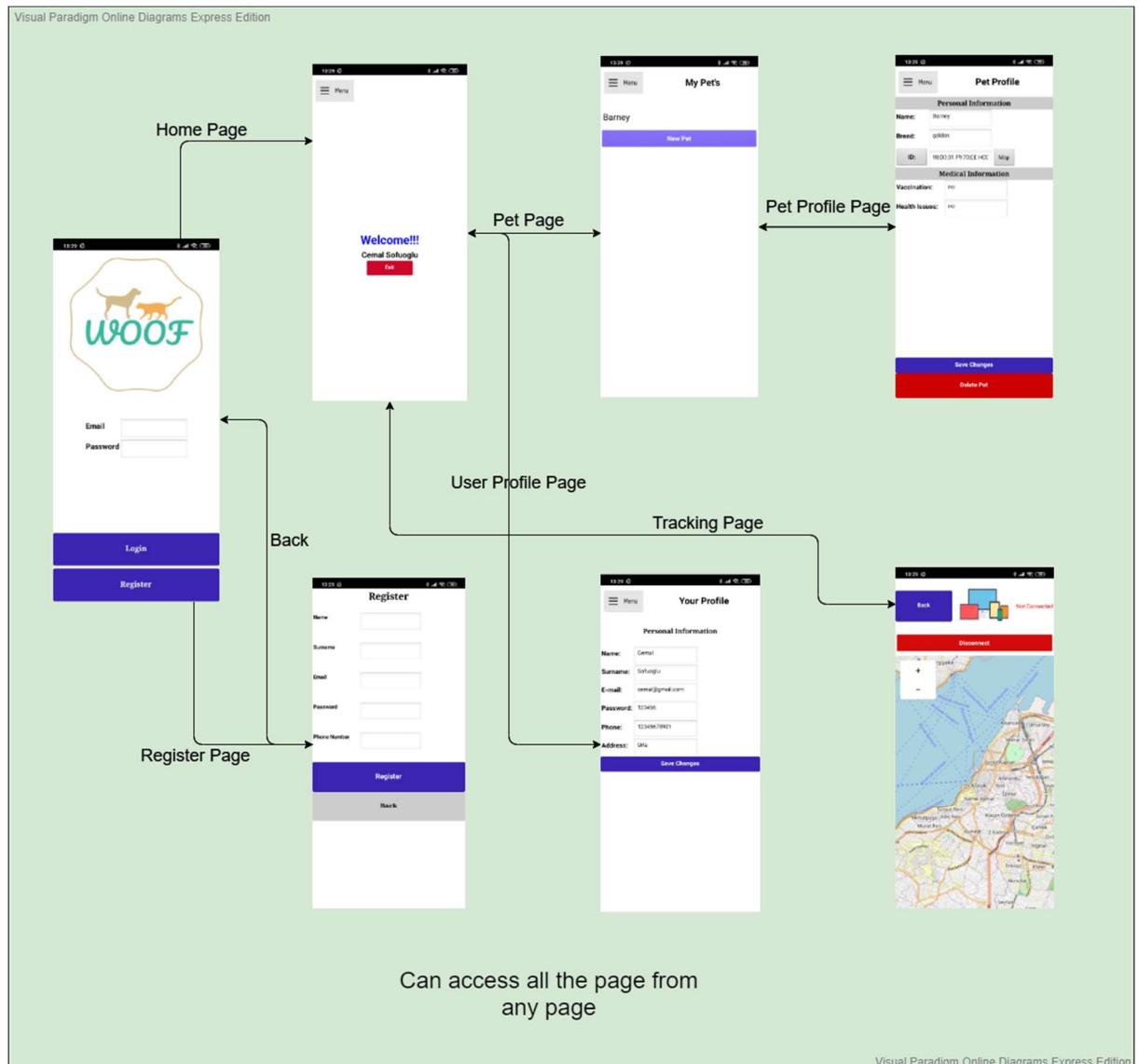


Diagram of Screen Shots:



RELATED WORK/SIMILAR SOLUTIONS

Our aim is to build such a system that will be easy to use and cheap for users. There are similar projects or products. In United States of America, there is a system which is called National Animal Identification System to trace the animals that have owners. The microchip is injected under the skin of an animal and chip uses passive radio frequency identification technology (RFID). Idea is to identify the animal that is either lost his owner or thrown to street. They can reach the owner's information. We inspired from this technology and wanted to implement such a system that will help owners to track their pets in real-time. There is a project that is called Koala Smart, which is done by İstanbul Technical University students. Their aim is to track pets from a mobile application. Koala Smart is using a GPS module to identify the location then, share the information using Bluetooth signal. So, they transmit the information using Bluetooth signal. [7] Also, Alcatel made a device for tracking. Their purpose is to track pets, children, cars and elders. The difference from the Koala device is, they use GPRS technology with Nano sim card. [8] Turkey started to increase the usage of RFID technology to track animals. But, system is new so it is not wide enough to use it. Beside these devices or projects, there are lots of different kinds of implementation or devices to trace different type of animals in worldwide or in Turkey.

CONCLUSION AND IMPACT

Conclusion:

Thanks to the product that we obtain, users will be able to track their pet's location in real-time. In addition, users can store their pet's medical or personal information in the application and can access to data from anywhere has an internet connection. Because of the price of each component, the project can be implemented and maintained in real life easily.

We keep the location of the pet on database every 60 second. In the future, to improve the application, we will use the location data to do data analysis in order to observe pet's behavior outside his/her territory and guess the location of pet using Artificial Intelligence.

Impact:

There are lots of issues or gaps that will affect the efficiency of the application and component related to environmental issues, health, security and economic effects.

Environmental Issue:

The system need to be connected to internet in order to use it. But maybe in somewhere user's phone cannot get connection to internet because of not having base station close to him.

Health:

System will be sending signals to user in order to track it because of radiation that releases by the component can affect the animal's health in a bad way.

Security:

In some condition security cannot be ensure. For example, there can be a jamming signal in order to avoid user to find his/her pet by the attacker or manipulating the location of the animal in order to find faster than its owner to take advantages from this situation.

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