IsRun : Mobile Application for Beginning Runners*

Seungmok Kang[2017313821], Junseok Kim[2017311133], Jaeyoon Park[2017311784], and Hyewon Lee[2018314348]

Sungkyunkwan University, 2066,
Seobu-ro, Jangan-gu, Suwon-si, Gyeonggi-do, Republic of Korea
{twoskysm,factory22,jiwoo0110,pyan999960}@g.skku.edu

Abstract. Running is a simple workout one can perform. However, it is difficult to begin for who not used to. With the lack of motivation, there are many who quit before beginning. Currently, there are services and mobile applications that lead exercise and track one's fitness activities. In a different perspective, it results that they do not include entertaining features to attract beginners. To overcome the limitation, IsRun is designed as a fitness mobile application that includes gaming elements. A combination of running with virtual character simulation game lets users to relate themselves to the characters and visualize the accomplishments. The service will motivate, encourage and bring interest in running to newcomers.

Keywords: Running · Virtual Character · Mobile Application

1 Introduction

The COVID-19 pandemic has led to a dramatic loss of human life worldwide. One of the losses is outdoor activities which has effect on both physical and mental health. Many locked up themselves home; exercises and workouts outside have stopped. At the same time, interests in healthy lifestyles have increased. Now the world tends to live with the virus and people are searching for social and physical activities. Running is probably what most people can easily think of in the category mentioned. It is a simple and easy but a popular physical activity which individuals can enjoy daily. In addition, it includes benefits such as potential weight loss, improved cardiovascular and respiratory health, as well as psychological well-being.

* Supported by Sungkyunkwan University.

Running is mostly the start of any cardiovascular exercise. For people who used to run daily will find easy to jump back into it. For others, it would not be as easy. There are many services and applications that focus on fitness. Most of them provide analysis based on distance, time, calories burned, etc. These features are mostly set for people who perform in their daily routine. However, those features do not provide motivation to continue for newcomers. This brings to a question 'then what would let newcomers gain motivation in running?'

Bringing in entertaining components might sound a little different. In the project, the proposed solution is introducing a mobile application that includes health assistance features combined with gaming elements, providing motivation and entertainment simultaneously. A virtual character is included to let people check their current state and achievements; since there are limitations to feel different day by day.

2 Motivation / Objective

The purpose of the project is to create an application that lets users feel easy to begin running even without previous experience. There exists limitation in existing applications, lack of additional motivation other than user's own will. To fulfill the purpose, gaming elements will be introduced in the application. Additionally, there should be no lack in exercise assistant features compared to other applications. Thus, the main objectives are as follows.

1. Include sufficient exercise assistant features.
2. Virtual character simulation game for motivation.
3. Make possible for beginners to run with ease.
4. Let all user continue based on their current state.

3 Background / Related Work

3.1 Mobile Application

Nike Run Club [1] is an application for runners of all fitness levels. It is compatible with both Android and iOS devices, as well as wearable devices. There are workout types that can be selected such as basic, distance, duration, speed runs, etc. It also includes individual, community and custom challenges so that users can enjoy alone, with friends and with a community. Leader-board and training plans are included for users to check their accomplishments. Other positives include GPS distance tracking, Spotify and Apple Music compatibility, and nutrition coaching features.

Adidas Running by Runtastic [2] is an application geared toward tracking activities and connecting with others in the community. There is also Adidas Training which focuses on workouts. The running app provides stats tracking one's cardio exercise. GPS tracking is used to record the activity where after completed, helpful stats such as calorie burn, average pace, and average speed are given. There are about 90 activity options where the user can choose among the ideas given. Additionally, it helps the user to keep track of user's mileage, so one can change the shoes every 500 kilometers; changing shoes every 500 kilometers reduces the risk of injury.

3.2 Video Game

Wii Sports [3] is a compilation of five games including baseball, boxing, bowling, gold and tennis. Wii remote is given to the users as the controller. For different events, different gestures are used which are like what one would do in real life. For example, one would have to swing with the remote as they would play tennis with rackets. It is represented as the innovative video game combined with sports where users can enjoy both at the same time.

Ring Fit Adventure [4] is the next generation of Nintendo fitness games. It requires users to perform specific exercises in order to attack or defend during the game. It provides great full-body workout with entertainment. Ring Fit motivates and engages users both physical and mental challenges throughout the game. It is a game that lets users understand their body's needs but not push beyond limits.

4 Proposed Solution

We divided Application Proposal into two big parts. First are running elements, and second are gaming elements that application will need.

4.1 Running Elements

Challenge suggests users to do challenging objectives, such as running longer or faster. Challenge doesn't mean only one-day running, but includes long term challenges, for instance, running 30km in 4weeks. Challenging objectives can be either proposed from app or added manually by the user oneself. By allowing user to set your own challenge level, beginning users don't lose interest if they

don't meet the high challenge requirements and get stuck. And as a reward for the challenge, you can grow your character. Even if user can't feel your own growth through running, users can estimate their growth through character's visualized growth instead, making running more rewarding.

Landmarks are famous places that worth visiting with running places nearby. The landmarks are selected and registered by us, developers. If users visit the landmark, they will get rewards such as a landmark illustration for the background of character's room. The landmarks will be recommended to users in three categories, nearby, popular, and new. Nearby landmarks are proposed based on the distance from user's location. Popular landmarks are landmarks that are highly ranked in how many people visited the landmark or places with a high revisit rate. Lastly, new landmarks are recommended by where users have never went or landmark is newly registered.

4.2 Gaming Elements

Level Design [15][16] is the phase of the game development process that deals with creating the stages, maps, and missions of the game. In our case, selecting landmarks, suggesting running mission, differing rewards will be level design, etc.

Landmarks will be selected based on surrounding environment, whether there is a place to run or not. Running missions will be suggested based on body related numbers. The most important is the differing rewards. We are planning to give heavy users lesser rewards compared to light users. Heavy users mean users who are into running and used our application many times, which light users mean opposite. There should be some reasonable rewards for heavy users, but still, we think it is important for light users to have interest in running. So, we are thinking of starter's pack, which gives big rewards to starters only, or making the resource needed to develop a character increase dramatically. Also we are planning to put random character summoning system to provoke desire to collect, which will result in constant interest in running to earn in-game money. Some examples are described below.

- Reward: Easier to get character growth resource than in-game money.
- Running mission: The more difficult, the higher chance of getting rare character.
- Landmark: Can get background illustration and character as reward.

- In-game money: Decoration and summoning character Characters: Summons on different possibilities, provoking desire to collect.
- etc.

Achievements in our project are more of gaming element than running element. They include not only achievements based on running length and time, but also achievements like how much you didn't run or how much landmarks you've went. It does encourage you to go out and run, but their focus is to interact with users. This element was inspired by the achievement system on steam store. We are planning to make 3 types of achievement

1. Limited - fun achievement that are generated only on event season.
2. Rewarding – some usable reward given for progress in running made
3. Warning – warn users if they did not spend much time on running

Limited achievement will bring users' attention back to running. This will be helpful for starters who get bored of running fast, which are most of the starters. So, we are planning to give big rewards for this type of achievement, so that starters will soon have fun in running. Rewarding achievements will encourage users who are starting to like running. This look like challenge in the above section, but there are some differences. Challenge is flexible, could be recommended or manually set. On the other hand, these rewarding objectives will be set by us. Warning types will remind users to run again.

Character Design We introduced the virtual character and its growth as rewards, so the characters should be attractive enough to appeal to users. The character should have some user-interactive respond. Also, there should be several characters to prevent the users being stuck in a rut. These factors force us to draw many pictures. However, this is not a design class. Thus, we will use the pixel art tool, 'Aseprite', to create our characters and make some animations for the characters. With Aseprite, users can make and modify pixel images without any artistic ability.

Fig. 1. Original and pixelated pictures

5 Implementation

5.1 System Architecture

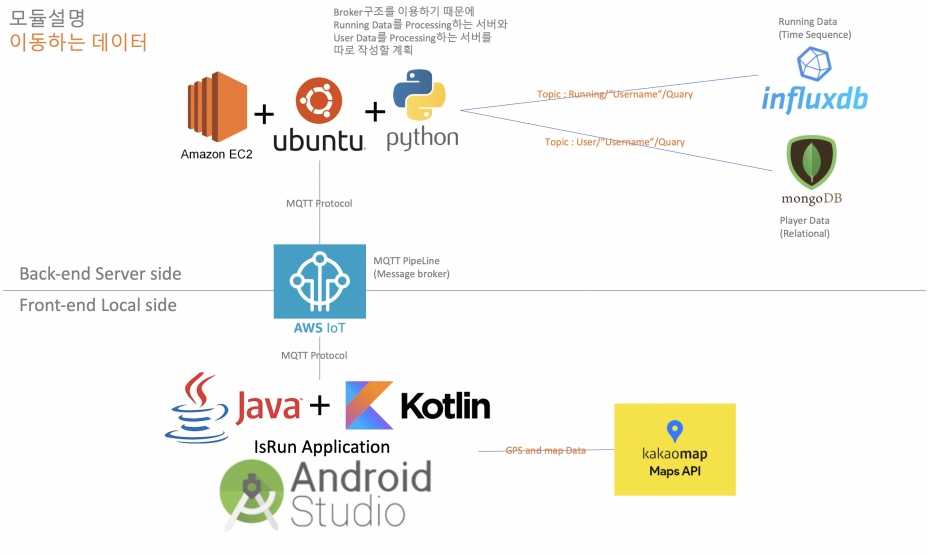

Fig. 2. Architecture

5.2 Front-end

Android App [17] There are many languages we can use to develop an Android App, such as Java, Flutter, and Kotlin. Among them we are using Kotlin as our language in developing Android App. Kotlin is an officially supported language

to write Android Apps. Because we knew how to use Java, we will be comparing Kotlin with Java.

Kotlin compiles to JVM bytecode or JavaScript Like Java, Bytecode is the compiled format for Kotlin programs also. Bytecode means Programming code that, once assembled, is run through a virtual machine instead of the computer's processor. By using this approach, source code can be run on any platform once it has been compiled and run through the virtual machine. Once a Kotlin program has been converted to bytecode, it can be transferred across a network and executed by JVM(Java Virtual Machine).

Kotlin can use all existing Java Frameworks and Libraries Kotlin programs can indeed use all existing Java frameworks and libraries, even advanced frameworks that rely on annotation processing. The main important thing about the Kotlin language is that it can easily integrate with Maven, Gradle, and other build systems.

Kotlin can be learned quickly, and it is approachable It can be rapidly learned by simply reading the language reference. The syntax is clean and intuitive(easy to use and understand). Between Kotlin vs Java, Kotlin looks a lot like Scala but is more straightforward.

Automatic conversion of Java to Kotlin JetBrains integrated a new feature into IntelliJ which converts Java to Kotlin and saves a considerable amount of time. And it also keeps us to retype mundane code. Kotlin's null-safety is great Now get rid of NullPointerExceptions. This type of system helps us to avoid null pointer exceptions. In Kotlin vs Java, Kotlin the system refuses to compile code that tries to assign or return null.

UI Design Figma[14] is an UI/UX design tool that supports the users' design needs. It provides pre-built assets and shareable styles. It can be the guidelines for new users and help them make fascinating UI/UX.

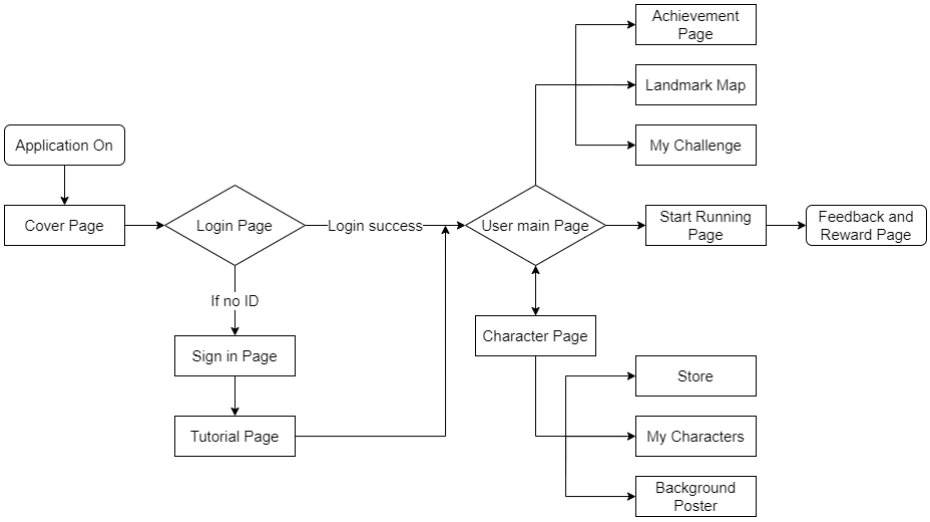

Fig. 3. UI design flow chart

5.3 Back-end

AWS (Amazon Web Services) [5] provide a variety of basic abstract technical infrastructure and distributed computing building blocks and tools.

Most services are not exposed directly to end users, but instead offer functionality through APIs for developers to use in their applications.

We decided to use AWS to allocate a static IP to the server for global services and to use the necessary services without complicated settings. We are going to use following two services on our project. First, AWS IoT and second Amazon EC2 [Ubuntu + MongoDB(User Data), InfluxDB(Running Data)].

Amazon Elastic Compute Cloud (Amazon EC2) [6] can be used to launch as many or as few virtual servers as you need, configure security and networking, and manage storage. Amazon EC2 provides the following features:

- Pre-made virtual computing environments, known as instances can be used for service.
- Preconfigured templates for your instances, known as Amazon Machine Images (AMIs), that package the bits you need for your server (including the operating system and additional software).
- Static IPv4 addresses for dynamic cloud computing, known as Elastic IP addresses.

Due to the nature of the running app, services outside the local environment must also be possible, so we plan to use AWS EC2, which provides such convenience.

MongoDB [7] is a source-available cross-platform document-oriented database program. Classified as a NoSQL database program, MongoDB uses JSON-like documents with optional schemas. MongoDB is developed by MongoDB Inc. and licensed under the Server Side Public License (SSPL).

- Management and graphical front-ends : The primary interface to the database has been the mongo shell. Since MongoDB 3.2, MongoDB Compass is introduced as the native GUI. There are products and third-party projects that offer user interfaces for administration and data viewing.
- Server-side JavaScript execution : JavaScript can be used in queries, aggregation functions (such as MapReduce), and sent directly to the database to be executed.

We decided to use MongoDB to manage user data because visualization is good and data table changes are not complicated, and it is judged that database access with python through pymongo will be easy. However, it is judged that it is appropriate to use influxDB, a TSDB, for managing running data. For this, it is expected that it will be necessary to design the server that manages the running data and the server that manages the user data separately.

InfluxDB [8] is an open-source time series database (TSDB) developed by the company InfluxData. It is used for tasks like storage and retrieval of time series data in fields such as operations monitoring, application metrics, Internet of Things sensor data, and real-time analytics.

InfluxDB has no external dependencies and provides an SQL-like language, listening on port 8086, with built-in time-centric functions for querying a data structure composed of measurements, series, and points. Each point consists of several key-value pairs called the fieldset and a timestamp. When grouped together by a set of key-value pairs called the tagset, these define a series. Finally, series are grouped together by a string identifier to form a measurement.

Values can be 64-bit integers, 64-bit floating points, strings, and booleans. Points are indexed by their time and tagset. Retention policies are defined on a measurement and control how data is downsampled and deleted. Continuous Queries run periodically, storing results in a target measurement.

InfluxDB was judged to be suitable for storing data generated from running in that it is open source and can store 64-bit floating points GPS data as a time sequence.

AWS IoT [9] provides the cloud services that connect your IoT devices to other devices and AWS cloud services. AWS IoT provides device software that can help you integrate your IoT devices into AWS IoT-based solutions. To help you manage and support your IoT devices in the field, AWS IoT Core supports these protocols:

- MQTT (Message Queuing and Telemetry Transport)
- MQTT over WSS (Websockets Secure)

The AWS IoT Core message broker supports devices and clients that use MQTT and MQTT over WSS protocols to publish and subscribe to messages. Since the server of this pub-sub structure is easy to manage multiple clients, Our team decided to create a server using the MQTT(Pub-Sub Server) protocol.

MQTT (Message Queueing Telemetry Transport) [10, 11] is a lightweight, publish-subscribe network protocol that transports messages between devices. It is designed for connections with remote locations where resource constraints exist or the network bandwidth is limited.

- The protocol is an open OASIS standard and an ISO recommendation (ISO/IEC 20922).
- MQTT broker is a server that receives all messages from the clients and then routes the messages to the appropriate destination clients.
- An MQTT client is any device (from a micro controller up to a fully-fledged server) that runs an MQTT library and connects to an MQTT broker over a network. Multiple clients can subscribe to a topic from a single broker (one to many capability), and a single client can register subscriptions to topics with multiple brokers (many to one).
- The publisher does not need to have any data on the number or locations of subscribers, and subscribers, in turn, do not have to be configured with any data about the publishers.
- control message can carry 2 Bytes to 256 MegaBytes.
- The default unencrypted MQTT port is 1883. The encrypted port is 8883.

The MQTT protocol is suitable for this project because it has good security, data transmission can be guaranteed through QoS, server implementation is

easy, and multi-user and fast transmission speed are guaranteed to be used in IOT or smart factories. In AWS, persistent sessions are a paid service, so We should look into other ways to guarantee the connection.

Publish–subscribe pattern [12] in software architecture, is a messaging pattern where senders of messages, called publishers, do not program the messages to be sent directly to specific receivers, called subscribers, but instead categorize published messages into classes without knowledge of which subscribers, if any, there may be. Similarly, subscribers express interest in one or more classes and only receive messages that are of interest, without knowledge of which publishers, if any, there are. Publish–subscribe is typically one part of a larger message-oriented middleware system. This pattern provides greater network scalability and a more dynamic network topology, with a resulting decreased flexibility to modify the publisher and the structure of the published data.

Using the Pub-Sub structure increases security and simplifies the server structure. In order to configure the running data server and the player data server separately, and to effectively use the broker structure of the MQTT protocol, a PUB-SUB structure server was selected.

GPS API the Big3 (Google, Naver, Kakao) in service in Korea were selected as candidates, taking into account their characteristics.

-	Google	Naver	Kakao
Given	Free 200 Credit/Month	-	Free 300,000 Case/Day Contact KakaoTalk for further use
Dynamic map	7 Credit/1,000 Case	For Web, 10,000,000 Case/Month Free	
Static map	2 Credit/1,000 Case	Free	
Geocoding	5 Credit/1,000 Case	Free 3,000,000 Case/Month	
Street view	7 Credit/1,000 Case	-	
Route guidance	10 Credit/1,000 Case	Free 60,000 Case/Month (Max 5 way-points) Then ₩5/Case Free 3,000 Case/Month (Max 15 way-points) after ₩20/Case	
Place search	17 Credit/1,000 Case	Service terminated	

Unlike the other two APIs, the map provided by Google uses a pixel image instead of a vector image, which means lower quality. And since export of maps from Korea to foreign countries is legally prohibited, we have decided to exclude them due to various restrictions.

Since it is not yet clear how and for what purpose the map API will be used, we decided to use the kakao map API, which provides a wide range of general-purpose services.

6 Planning in Detail

6.1 Role Distribution

Our work is divided into two big categories, front-end and back-end. For front-end, we divided it into game elements and running elements. Also, for back-end, we divided it into protocol management and database management. Our team has 4 members, so we selected our main role based on our interest and experience. It's shown in Table 1. While we do have our main role, it doesn't mean that we can't help each other beyond our role.

Table 1. Main roles allocated by interests of each teammates.

Group	Names	Roles
Front-End	Junseok Kim Jaeyoon Park	Game Elements Running Elements
Back-End	Seungmok Kang Hyewon Lee	Protocol Management Database Management

6.2 Brief Schedule

Planning schedule for one semester, we have divided our project into several subtasks. Then we assigned subtasks based on main roles. For each subtasks, due dates were set weekly, because one semester has 15 weeks. More explanations for schedule. Table 2 shows a brief schedule of our project.

Table 2. Project roadmap of 2022, 1st semester.[13]

-	Subtask	Week 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Overall	Subject Proposal Integration Test, Tuning Final Report	All	All	All								승목/준석	승목/준석	승목/준석 재윤/혜원	재윤/혜원	
App	UI/UX Design Skeleton App GPS, Game, Contents			혜원	혜원	재윤	재윤/혜원	재윤 준석/재윤	Midterm	준석/재윤	준석/재윤					
Server	Data Structure Design DB Setting Build Flask Server Run on AWS			승목/준석	혜원/준석	승목/준석	승목	승목 혜원	Midterm	혜원						Finalterm

References

1. Jessica, Jonsen. "Nike Run App Review". Fitrated, 11 Nov 2021,https://www.fitrated.com/gear/workout-apps/nike-run-club-app-review/. Last accessed 27 Mar 2022.

2. Jessica, Jones. "Adidas Runtastic App Review". Fitrated, 12 Jan 2022, https://www.fitrated.com/gear/workout-apps/adidas-runtastic-app-review/. Last accessed 24 Mar 2022.
3. Casamassina, Matt. "Wii Sports Review". IGN, 14 Nov 2006, https://www.ign.com/articles/2006/11/14/wii-sports-review. Last accessed 23 Mar 2022.
4. Jenas, Sitzes. "Ring Fit Adventure Review: One Year Later". Gamespot, 18 Oct 2019, https://www.gamespot.com/reviews/ring-fit-adventure-review-nintendo-switch/1900-6417586/. Last accessed 23 Mar 2022.
5. "Amazon Web Services About Us". Amazon,https://aws.amazon.com/ko/what-is-aws/?nc2=h_mo/. Last accessed 21 Mar 2022.
6. Julie, Solon. "amazon-ec2-user-guide". Github, Awsdocs, 27 Jan 2022, https://github.com/awsdocs/amazon-ec2-user-guide/blob/master/doc_source/concepts.md. Last accessed 25 Mar 2022.
7. "Introduction to MongoDB". Mongodb, https://www.mongodb.com/docs/manual/introduction/. Last accessed 26 Mar 2022.
8. "InfluxDB 1.7 documentation". Influxdata, https://docs.influxdata.com/influxdb/v1.7/. Last accessed 27 Mar 2022.
9. Gausekha. "aws-iot-docs". Github, Awsdocs, 25 Nov 2021, https://github.com/awsdocs/aws-iot-docs/blob/master/developerguide/what-is-aws-iot.md. Last accessed 24 Mar 2022.
10. "MQTT". Amazon, Developer doc, https://docs.aws.amazon.com/ko_kr/iot/latest/developerguide/mqtt.html. Last accessed 25 Mar 2022.
11. "MQTT Version 5.0". OASIS, OASIS Standard, 7 Mar 2019, https://docs.oasis-open.org/mqtt/mqtt/v5.0/mqtt-v5.0.html. Last accessed 23 Mar 2022.
12. "발행-구독 모델". Wikipedia, 7 Feb 2022, https://ko.wikipedia.org/wiki/\%EB\%B0\%9C\%ED\%96\%89-\%EA\%B5\%AC\%EB\%8F\%85_\%EB\%AA\%A8\%EB\%8D\%B8. Last accessed 27 Mar 2022.
13. "Team-C Project Roadmap", https://capstone-2022-1.atlassian.net/jira/software/projects/CP22/boards/2/roadmap.
14. "Figma design, collaboration". Figma, https://www.figma.com/.
15. https://www.nuclino.com/articles/level-design
16. https://gamedevacademy.org/level-design-open-world-tutorial/
17. https://www.xenonstack.com/blog/kotlin-andriod