K.R.A.K.E.N. – The Kids' Routine App For Kinetic Energy

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Chapter 001

Introduction

Studies show that, in more ways than one, routines developed in one's childhood have a large impact on a person's adulthood – for better, or for worse. These studies also claim that even before the pandemic came about, forcing the population away from the open areas where kids and adults alike so frequently gathered to run and play, a staggering 92% of Filipino youth aren't able to get enough exercise daily. In fact, based on research conducted by the U.S. Department of Health and Human Services, more than 80% of adolescents worldwide are insufficiently active, with several people not getting any physical exercise at all.

These numbers have only increased as countries began implementing strict lockdown measures, preventing people from stopping by their usual gyms or going about their daily jogging routines. Back then, students with or without regular exercise habits were pushed to play various sports and games as part of their physical education classes – but even these mandatory forms of physical activity have had to be cancelled, or at least significantly minimized, as a large percentage of schools are now being conducted online.

Depression, anxiety, cancer, obesity, and even heart disease – this isn't even the full list of effects often faced by those who lack physical activity in their day-to-day lives. However, if there were some way to encourage more and more people all over the world to get active, whether or not they did so before the pandemic, perhaps it would be possible for these consequences to be significantly reduced, ultimately turning the tide of this global catastrophe.

It's time to release the KRAKEN.

Statement of the Problem

The World Health Organization recommends that children get at least 60 minutes' worth of exercise daily, a standard followed by less than a third of children worldwide.

That is…before the dawn of the coronavirus. Data collected by a smartphone step-counting app shows that in some regions of the world, the average number of steps taken by users has decreased by almost 50% since lockdown measures have been implemented in various countries. Based on a survey conducted by BMC Public Health, the decline in physical activity isn't merely among adults – 66% of parents with children aged 9-12 reported that their kids have been exercising less than they have before the pandemic began.

In addition, nearly 20% of youth all over the world are disabled or experiencing chronic health conditions, and are much more likely to be sedentary than those who aren't. For all kids, with or without disabilities, lack of exercise and movement has multiple harmful effects. These range from mental health issues, such as increased chances of depression and anxiety, to physical concerns, including heart disease, diabetes, and osteoporosis. An inactive lifestyle can greatly affect both the mind and the body, which is why it is ideal to start getting accustomed to regular exercise habits from a young age. With this in mind, what can be done to encourage children to get moving, despite the numerous challenges presented by today's world?

Purpose

KRAKEN is a wearable device that uses sensors to track a person's movement speed and direction. When paired with its mobile app counterpart, it utilizes augmented reality to allow users from all over the world to play together without having to meet face-to-face.

Using data collected by gyro sensors and accelerometers, KRAKEN can show a virtual image of an opponent's avatar moving in real time, allowing two or more people in different locations to interact through various activities – tag, racing games, fighting games, and more. It can also be worn by players while they walk, run, do household chores, and exercise in other ways. Users can earn in-game money the more they move, enabling them to buy outfits and hairstyles for their avatars, as well as new playing modes and power-ups to be used within games.

Certain playing modes will be available through the KRAKEN app that involve moving one's arms or head, letting users with disabilities exercise and play as well. There will also be a handicap

option that lets disabled players participate in running games by moving their wheelchairs. This setting makes their avatars run slightly faster to make up for the difference in speed.

Through the Kids' Routine App for Kinetic Energy, we hope to encourage kids worldwide to exercise through physical activities that anyone can enjoy, and to allow users to play and have fun together despite the obstacles brought about by the pandemic and differences in location.

Significance of the Study

Below are the 4 main objectives we hope that KRAKEN can someday achieve.

1. Our device encourages kids to get active through different types of games that exercise multiple parts of the body. It uses sensors to measure how much a user has moved, both within KRAKEN games and in everyday life. The more active they are, the more in-game money players will receive. This allows them to customize their avatars, purchase new playing modes, and buy power-ups that can be applied in certain games. By motivating children to be more physically active from a young age, they'll overall become healthier and more energetic, with improved mental health and reduced risk of heart disease.
2. Through KRAKEN, users will be able to play together and communicate with each other, no matter where they are in the world. This allows friends to reconnect with each other, despite being unable to meet face-to-face during the lockdown – and, even when the pandemic is over, we hope our device can encourage people to interact with other players all over the world, in spite of differences in location and culture. Studies also show that people are more motivated to exercise when they can do so with others.
3. Our app has several games that allow users with disabilities to engage in physical activity, through moving their arms or head. They can also move their wheelchairs to play games that involve walking or running, and use the handicap setting to compensate for the difference in speed. Through our device, we hope to promote inclusion of people with disabilities, and to help them develop an active lifestyle despite restraints in mobility.

4. Wearable technology is a relatively new concept, one that we believe has plenty of potential. One common concern when it comes to robotics is that someday, robots may end up replacing humans, lessening the number of available jobs for people in certain fields. However, with the use of wearable technology – one of the many branches of robotics – we aim to build devices that enhance what humans can do, rather than replacing them entirely. Starting with KRAKEN, we aim to explore the possibilities of wearable devices in assisting humans with various activities, and to further the mission of robotics in raising efficiency, increasing safety, and positively transforming the lives of those around us.

Chapter 002

Related Literature

Wearable Technology

When we hear of wearable technology, it's easy to associate it with more futuristic gadgets, from smart glasses to microchips implanted in one's skin. However, wearable tech has actually been around since centuries ago, when people began wearing the first forms of eyeglasses and portable timepieces. The field itself pertains to any portable, hands-free electronic gadget, and is mainly affiliated nowadays with the Internet of things.

Apart from the more common watches and fitness trackers, one example of wearable technology is smart glasses. These are spectacles that substitute the usual phone or computer screens in displaying data and images in front of a user's eyes, using a mix of wearable technology and augmented reality. They allow wearers to take pictures and videos, and even to search things up online, without having to move one's hands. In the future, we hope that KRAKEN can utilize smart glasses to let players see their opponents' avatars moving in real time, almost as if they're playing with others face-to-face, and to simulate a more realistic playing experience that doesn't involve holding and frequently glancing at one's phone.

Smart glasses, and many other forms of wearable technology, aren't very popular as of yet – after all, this particular field of engineering is still being explored, and wearable devices are still quite costly. However, as science and technology advance, it is being predicted that with the arrival of new technologies every year, smart glasses will become more common and less expensive, allowing us to fully implement KRAKEN someday.

Existing Video Games Involving Exercise

There are multiple existing games that encourage people – particularly gamers – to exercise. These games typically use augmented or virtual reality to make the experience more immersive, persuading people to play, thereby increasing fitness among players. For example, a game called Pokémon Go utilizes augmented reality to motivate players to walk around and collect cute virtual creatures called Pokémon, while Beat Saber is a virtual reality game that challenges users to cut virtual blocks of debris by moving their arms to a certain rhythm. Other examples of virtual fitness games require users to own a video game console, one with a camera or controllers used track a player's movement. Just Dance, for instance, measures how well users mirror dance moves on a screen by tracking the motion of a controller held by the player, and Ring Fit Adventure does the same with ring-shaped controllers as users perform different fighting moves to battle in-game monsters. Kinect Adventures, on the other hand, uses a camera to track the player's progress through a series of minigames.

In fact, as fitness games become more popular, there are even some games on the market similar to KRAKEN, which allow players to exercise together online. These games are called Zwift and Peloton, online multiplayer cycling games which prove that it is possible to develop an app that lets people exercise with others over the Internet. However, with these games, players are required to purchase bulky equipment, such as turbo trainers, treadmills, or stationary bikes. In addition, the only playing option available in these games is cycling. On the other hand, KRAKEN will have various playing modes to appeal to a wider audience, and the equipment required to enjoy it is wearable technology, which, by definition, is portable and easy to store.

Augmented Reality (AR)

While virtual reality is known for immersing players in an entirely new world with large headsets and detailed graphics, augmented reality utilizes smaller devices – such as smart glasses or even just phone screens – to enhance one's surroundings with a new layer of fantastical creatures

and images, allowing users to explore and appreciate the real world as they play. While commonly used in games, such as the renowned Pokémon Go, AR is also present in enhanced navigation systems, military fighter planes, historical sites, furniture apps such as IKEA Place, and even football games.

Someday, we hope that our project can use augmented reality to simulate actual, face-to-face games, making the KRAKEN experience more appealing and interactive for players, thus encouraging more people to get moving using our app. In addition, by using AR instead of virtual reality, KRAKEN will be more accessible – as smart glasses are less bulky than VR headsets – and safer, since players will still be able to see obstacles in the real world.

As the augmented reality industry continues to grow, telecommunications companies are working on 5G mobile phones to speed up connection, allowing AR to load faster in the latest mobile apps, and enabling people to play together online without too much lag. We hope that in the future, this technology can be adapted into smart glasses as well, allowing AR games like KRAKEN to run more smoothly.

Chapter 003

Methodology

Procedure and Time Frame

After several months – almost a year, by now – of being restricted from meeting face-to-face, we wondered if there was a way for us to play together, running around and chasing each other, just as we used to do before the pandemic. This line of thinking led to the birth of the very first form of KRAKEN, a simple virtual tag game wherein players in different locations could run around their homes and track each other's positions by watching dots on a computer screen.

At first, we intended to use Scratch, similar to what we did in a previous robotics project from a couple of years ago. We had plenty of prior experience with this programming language, and decided that it would be one of the best options for creating a graphical user interface for our game. Not to mention, there is a function in Scratch that allows users to program online multiplayer games - in other words, games that two or more people in different locations can play together – which was precisely what we needed for our project. However, we were dismayed to find that the capabilities of Scratch in EV3 programming were severely limited, with no way to program a gyro sensor, which we intended to use in order to measure a player's heading and speed as part of our project.

More research led us to discover App Inventor, another programming language used for mobile apps, with many more sensors and functions available. We realized that KRAKEN would make more sense as a mobile app than as a computer game, since phones are more common and easier to carry around than laptops. With this, we started researching on ways to program an online multiplayer game in App Inventor. We soon discovered Firebase, a site that allowed us to develop databases that could be accessed by App Inventor and updated in real time. We figured out that KRAKEN could send the coordinates of a player's avatar to their opponent's copy of the game, allowing the dots on the screen to move in sync with the two players.

Now that we found a way to develop the game itself, we started working on the app, the wearable device with the sensors needed to track a user's movement, and the finer details of the

project. We learned more about augmented reality and smart glasses, and chose to apply these to our project in the future. In this phase, we also decided to implement in-game money, avatar customization, power-ups, and more.

With all our new ideas and learnings associated with KRAKEN, we decided to consult experts on game development, augmented reality, and physical therapy. Here are some of the things we have learned from our interviews:

Interview Information

Wearable Technology: Advantages and Disadvantages

Using wearable technology equipped with sensors to track a player's movement has several benefits and drawbacks. Wearables are less expensive than other technology used to detect motion in existing games, such as cameras. This makes KRAKEN more accessible to a wider user base, as it is more affordable. In addition, using smart glasses to allow players to view an augmented reality world is smoother than having users constantly glancing at a computer screen.

However, sensors are less accurate than cameras, and this could frustrate users as the movement of their virtual avatars may not be precise. Connection errors may also arise, as players are required to link their smart glasses and sensors to the mobile phone app, which then has to connect to the Internet to let the user play with others online. One of the game developers interviewed suggested that an offline option could be added to KRAKEN, wherein the user can play with a computer-controlled opponent in case of connection issues. While this option will be available on the app – in order to make it more accessible – KRAKEN will primarily focus on fitness games that allow players to interact with one another.

Legal Requirements for Kids' Apps

To protect the privacy of KRAKEN's users, measures must be put into place to ensure that the personal data of players will not be shared without consent. As users are able to play with strangers online, they will be given animated avatars to use within the game. Their opponents will be able to see this avatar, and not their real faces. Players will also have usernames, and will be encouraged not to use their real names when creating an account. As KRAKEN is primarily directed towards a younger audience, lawyers will have to be consulted upon its implementation to create a privacy policy for the game.

Making KRAKEN Inclusive

Children generally have plenty of energy, allowing them to exercise for three hours straight without a problem. However, those with disabilities and health conditions wouldn't find this as easy. Asthma, cardiac disease, and other health problems lower endurance in kids and adults alike. With this in mind, a heart rate sensor will be added to KRAKEN, and an alarm system will be put into place to alert users if they are overexerting themselves. Some children have short attention spans as well, which is why KRAKEN will have a simple and colorful user interface to keep players' attention.

There are certain people with cramped muscles that make it painful for them to exercise. However, if KRAKEN's games are engaging enough, players may be able to forget about muscle pain by playing.

In addition, our project can help kids with conditions that make it difficult for them to move or follow instructions. Playing modes will be added that involve simple movements like stepping forward and backward, waving one's hands, drawing, and more. Disabled children can move their wheelchairs to play running games, and a handicap option will be available to compensate for the speed difference.

The app will be tested on different types of phones, with several people from various age groups, to ensure that anyone will be able to play.

Augmented Reality

AR is a good way to compensate for players being unable to see each other face-to-face, and it is more accessible than virtual reality, which requires a lot of cumbersome equipment. As KRAKEN aims to encourage a wide audience to become more active, experts believe that augmented reality is the best choice to simulate playing with one's friends in the physical world.

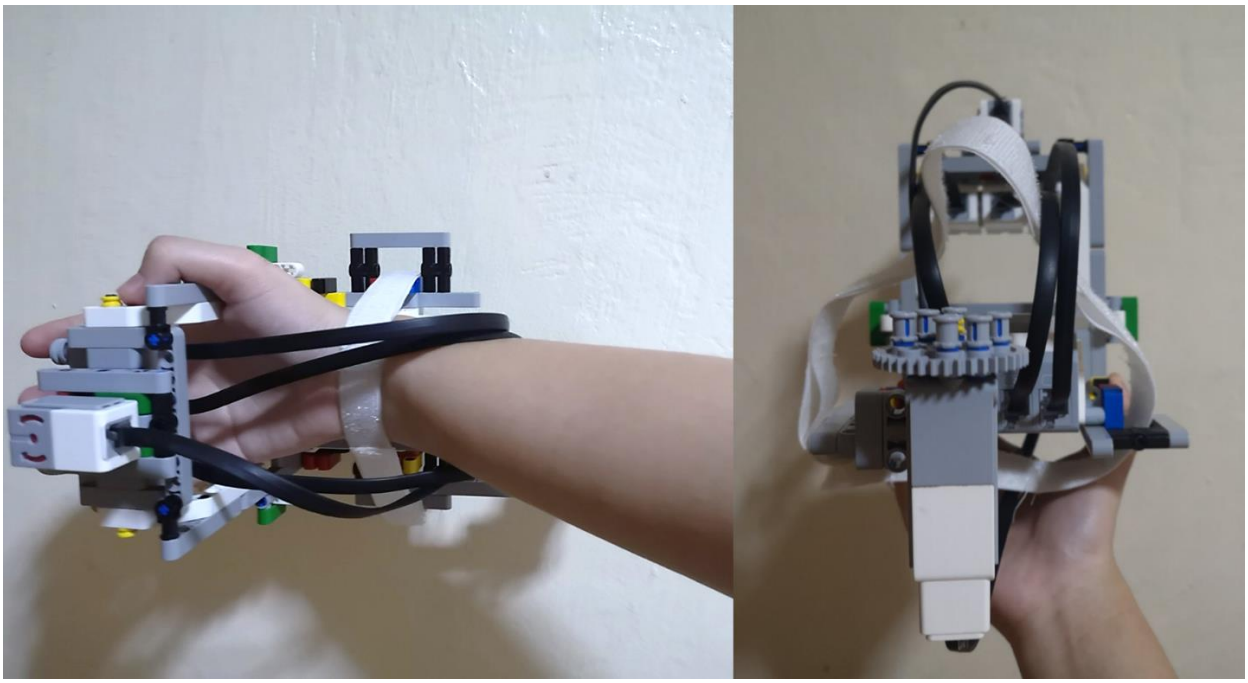
Prototype

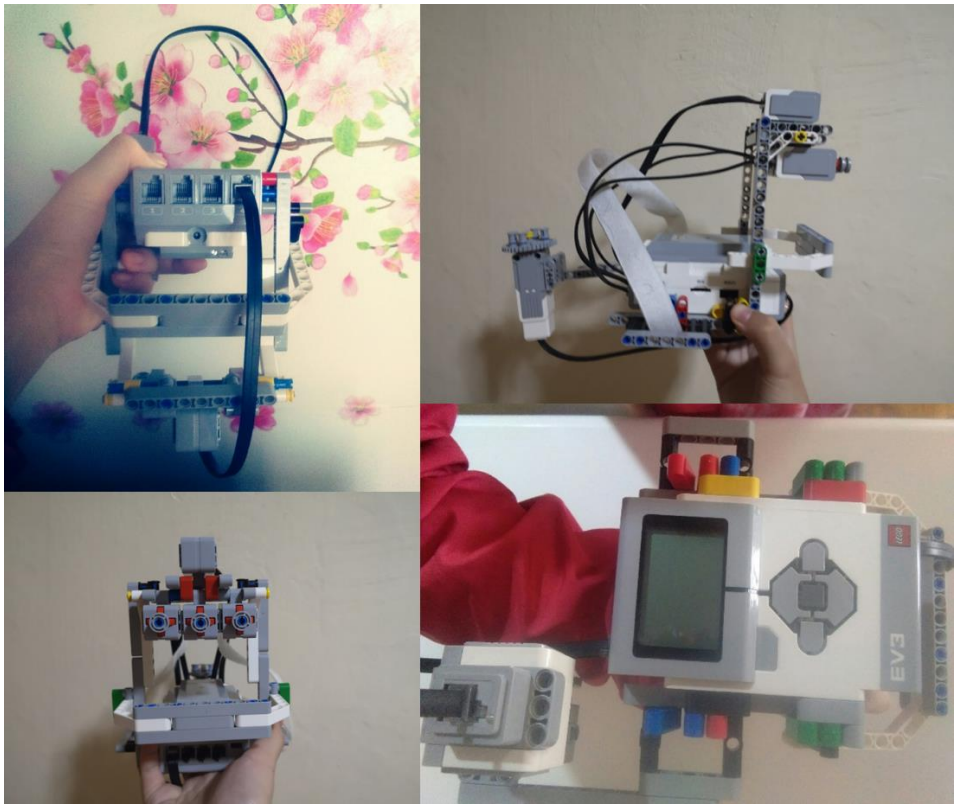
The experts interviewed believe that KRAKEN is a very ambitious project. As it has many features, we were encouraged to start by creating the minimum viable project so as not to get overwhelmed. First, we made a simple program with two dots on a phone screen that could be dragged by users. The onscreen coordinates of each player's dot would be sent to and retrieved from an online database, allowing each dot to move on each screen in real time.

When this worked successfully, gyro sensors were paired with the app so that each circle would move in sync with the player controlling it. One gyro sensor was used per player to detect both the rate and angle – that is to say, speed and heading – of the user's movement. However, the values changed erratically, with the ball moving throughout the screen randomly. It was then discovered that it is not possible to measure both rate and angle with a single sensor. Similar results were received when two sensors were used, one for each value.

With this in mind, a tag game was created, wherein users can control the direction of the ball based on their own heading, but the speed of the dot remains the same.

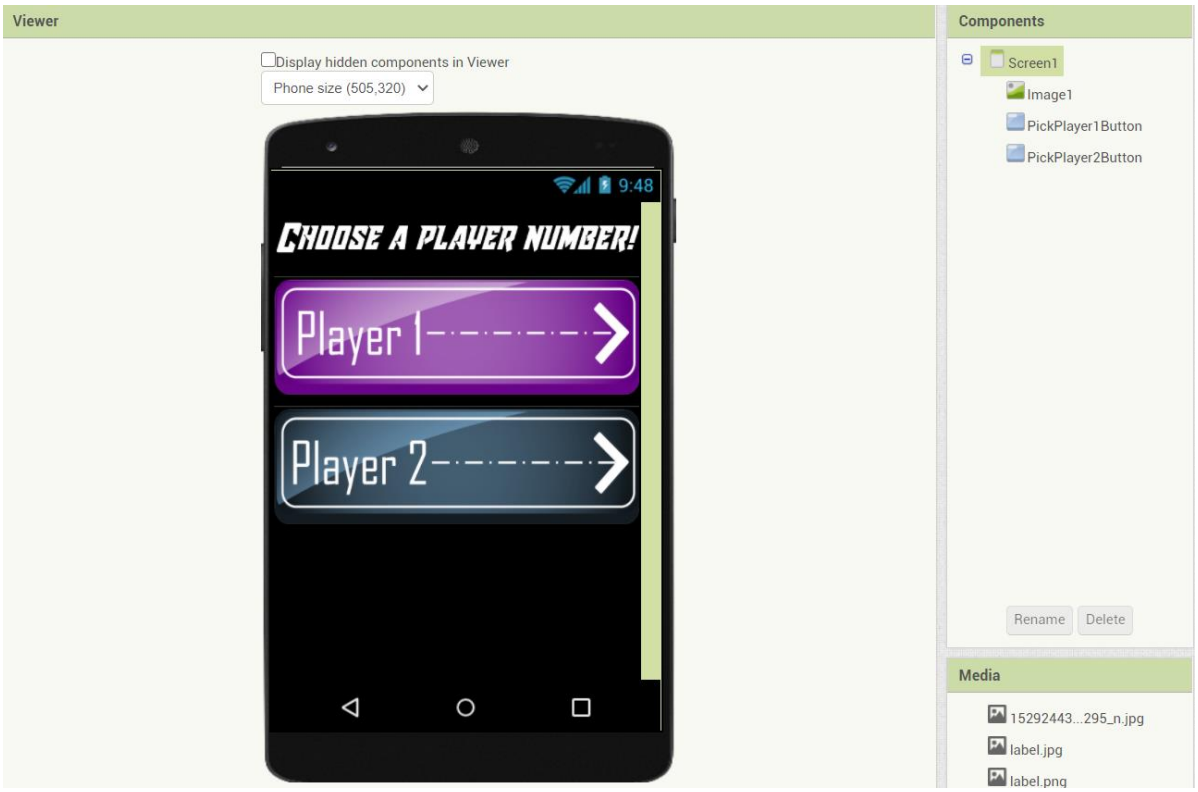
A device was created to be worn on the arm. This is equipped with gyro sensors to measure the player's rate or angle, buttons that allow users to tag opponents when within range, and a motor that turns when a player gets tagged.

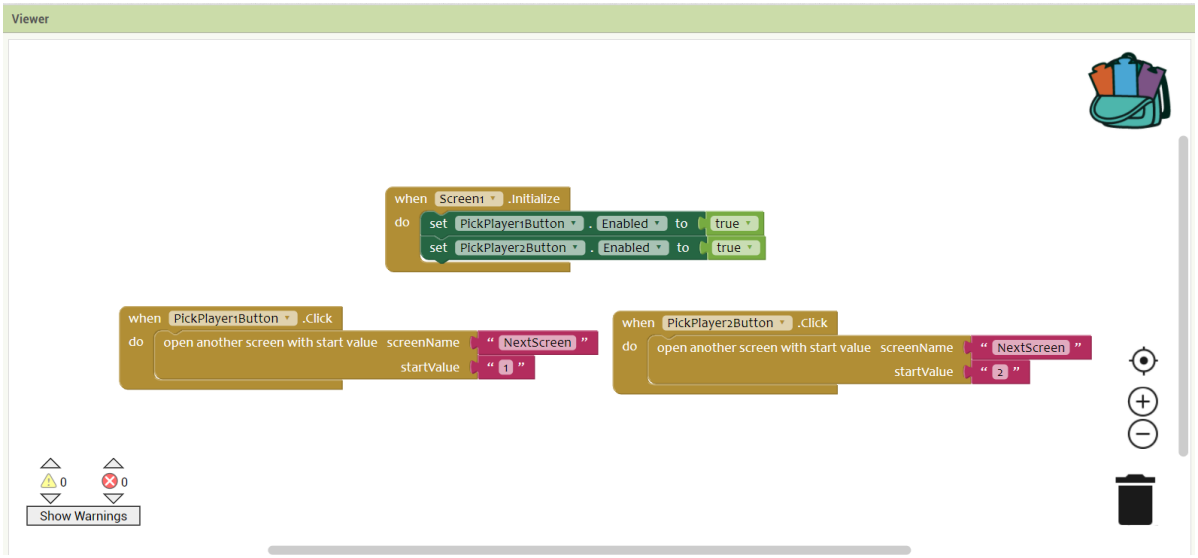



EV3

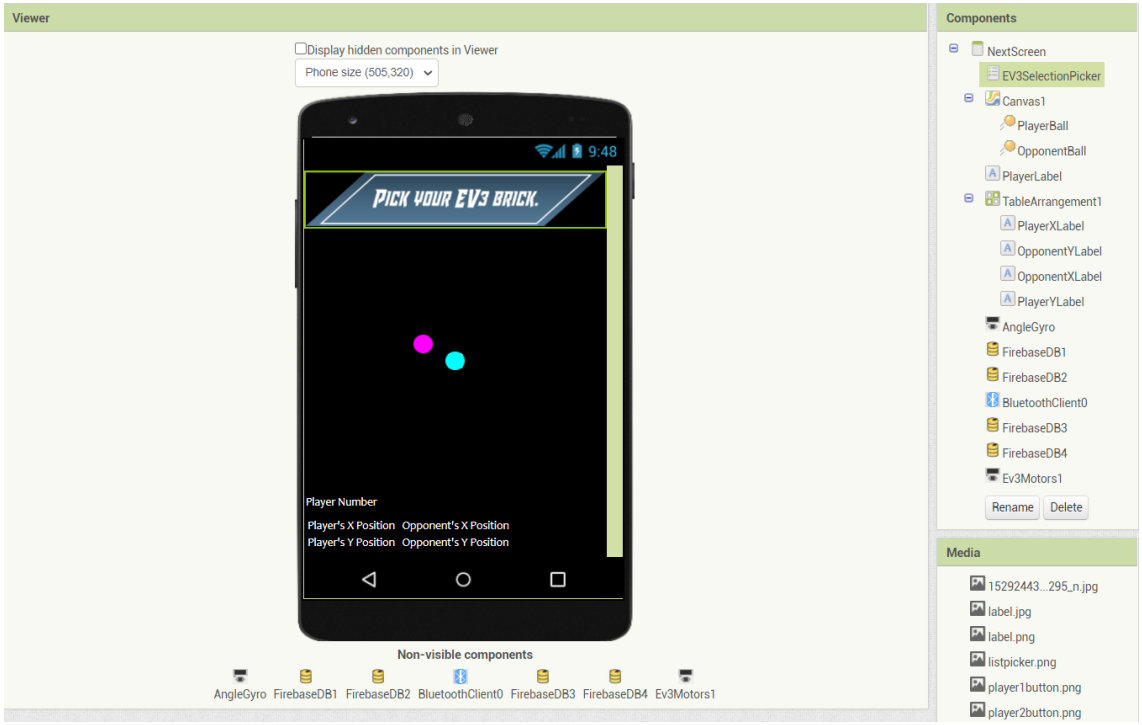
Analysis Plan

Below is the first screen in the KRAKEN app prototype, which allows users to choose a player number. When a number is picked, this value will be carried on to the next screen using a global variable called a start value.

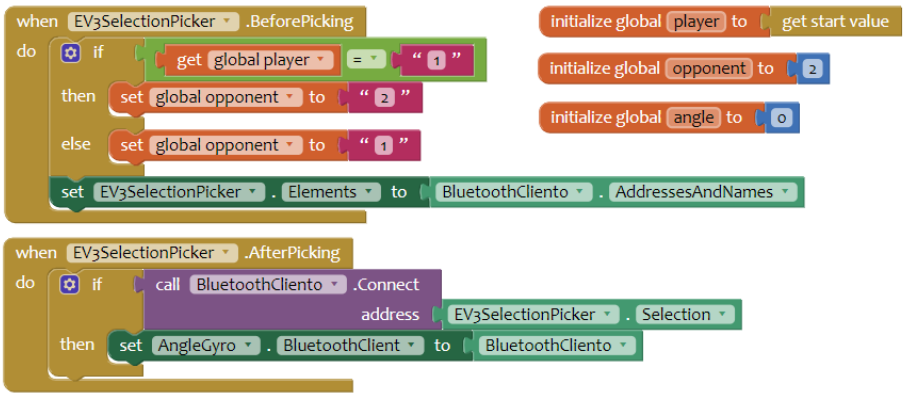




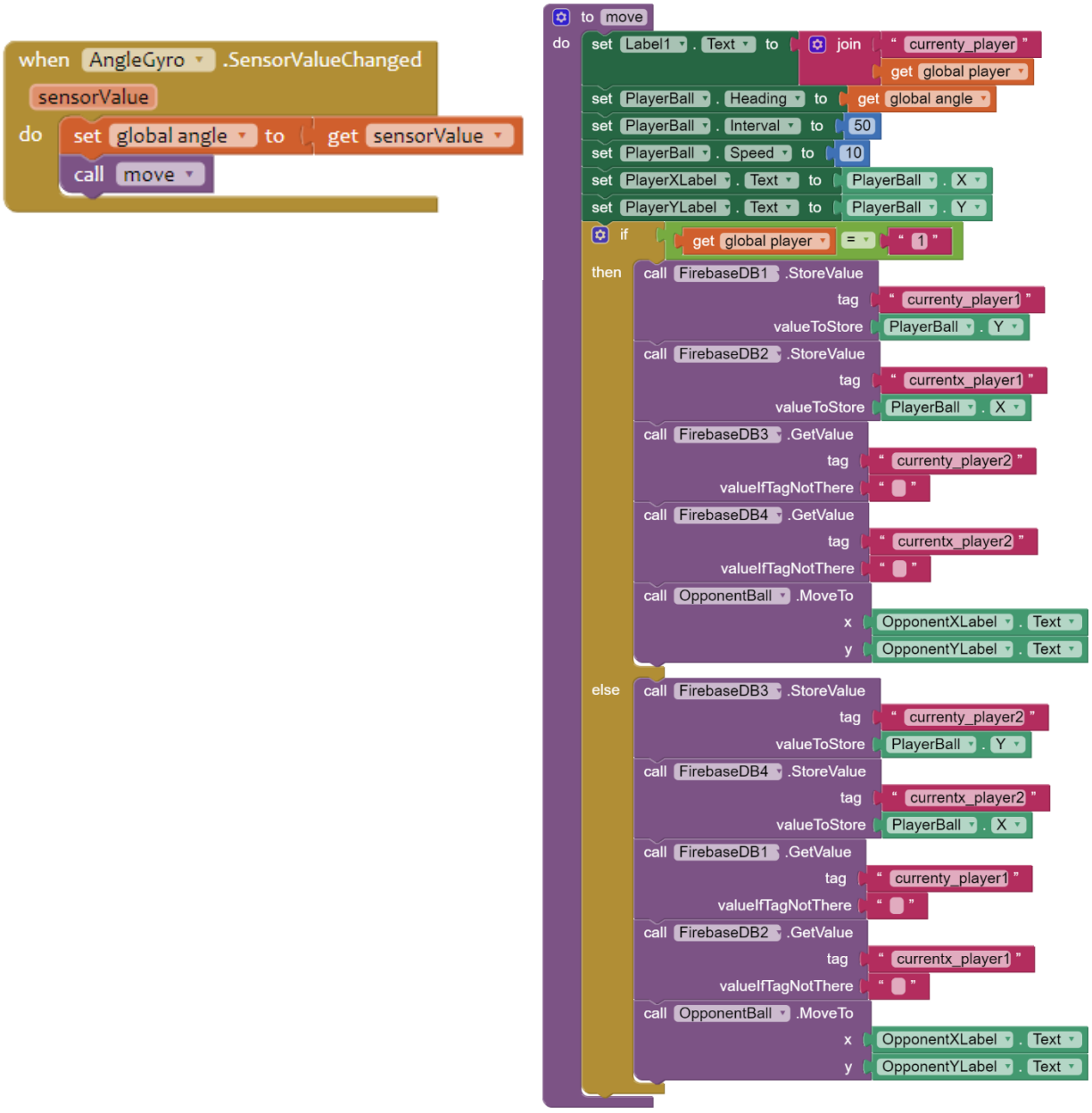
Here is the second screen, wherein players can select their EV3 brick and play a game of tag with their opponent by moving around their respective areas as the sensors measure their heading.



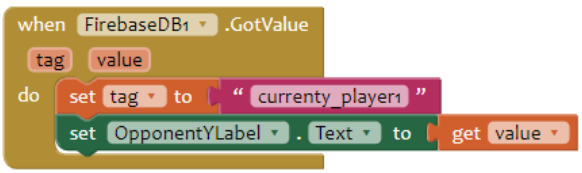
The below code allows players to choose an EV3 brick to connect to using a List Picker, called EV3SelectionPicker. It then initializes variables to store the player number, opponent number, and player's angle.

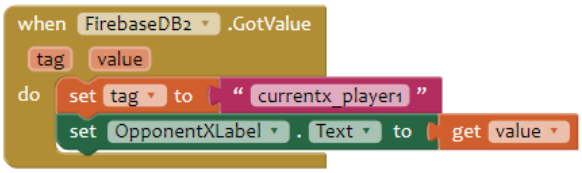


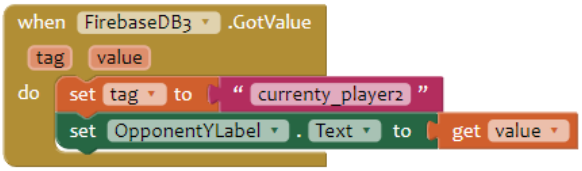
After that, these blocks of code detect when the gyro sensor value changes – or, when the player moves in a certain direction – and change the trajectory of the dot. The ball's coordinates are then sent to a database, where they can be retrieved by the opponent to ensure that the dots are in the same position on both screens.

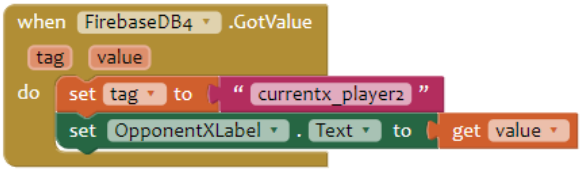


This is the code that retrieves specific values from the database. Due to limitations in App Inventor, two databases had to be made, one for each player.

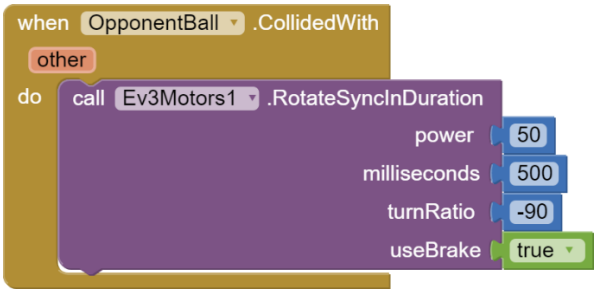




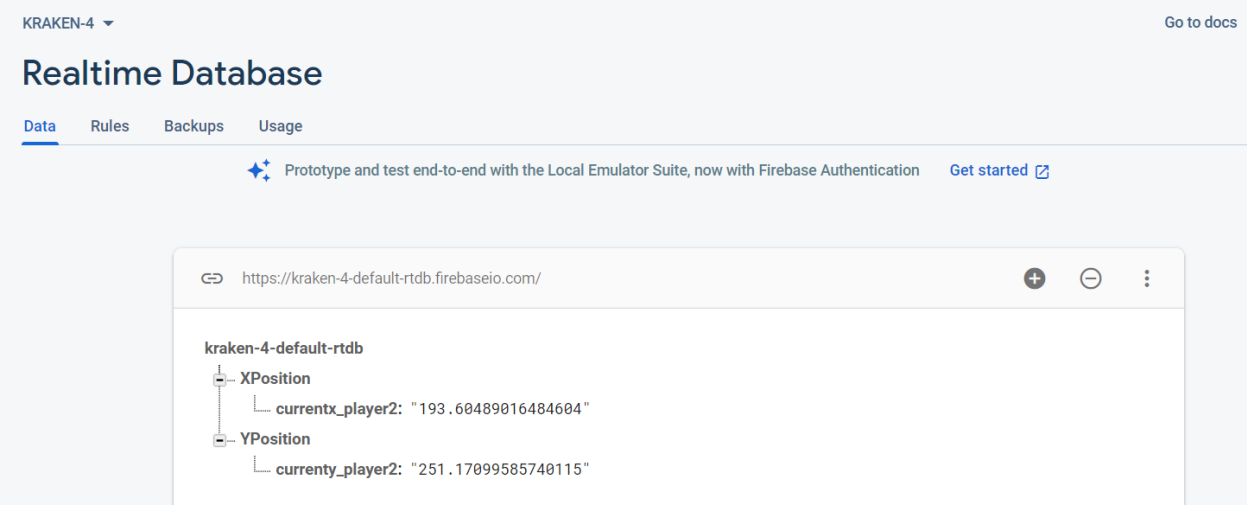




This code causes a motor attached to KRAKEN to move whenever the dots collide. A gear fitted with pegs will then turn, allowing the user to experience motor feedback as if being touched by the opponent.

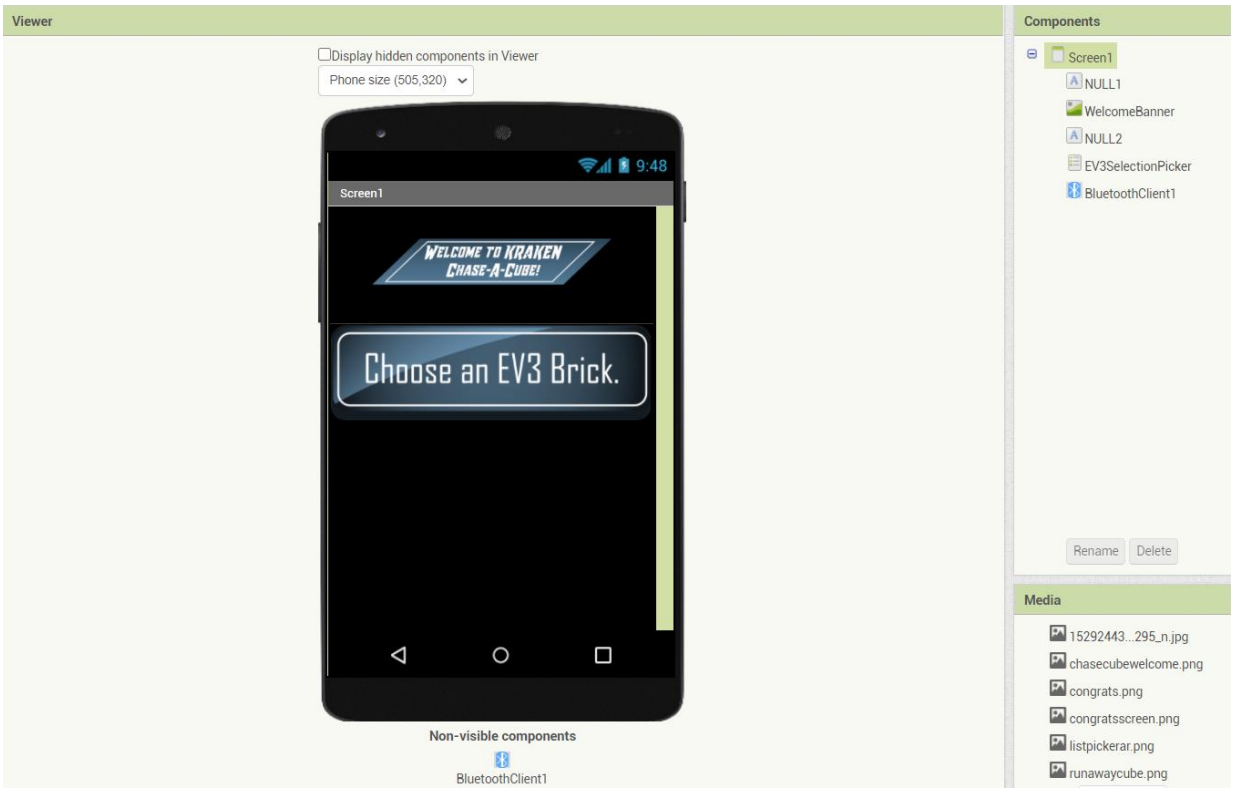


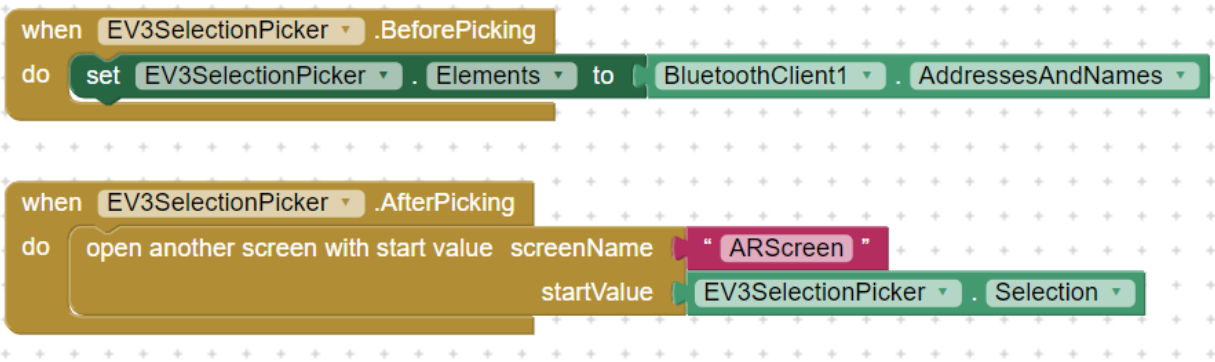
Finally, here are the databases containing information on the onscreen coordinates of each player's ball, based on the last tag game played. While a game is in progress, these numbers rapidly change in real time.



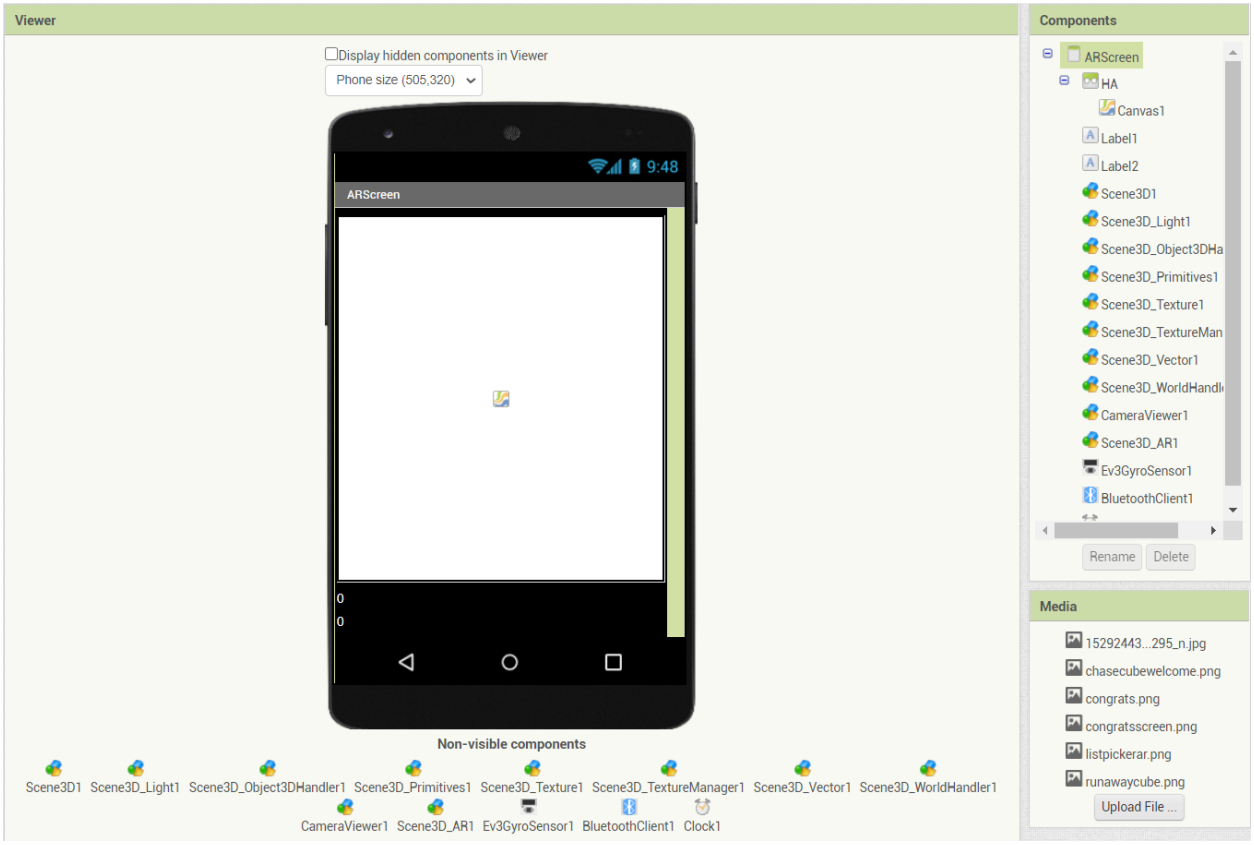
Apart from a tag game, another playing mode was created as part of KRAKEN's prototype. This one measures a player's movement speed as they run after a virtual cube, made using a simple augmented reality extension in AppInventor. Players have the option of using only their arm in the game, as the gyro sensor can sense motion no matter which part of the body it is attached to.

Below, you can see that the ListPicker, which allows the user to select an EV3 brick, was put on the first screen, as it interferes with the camera feed if placed on the second screen.

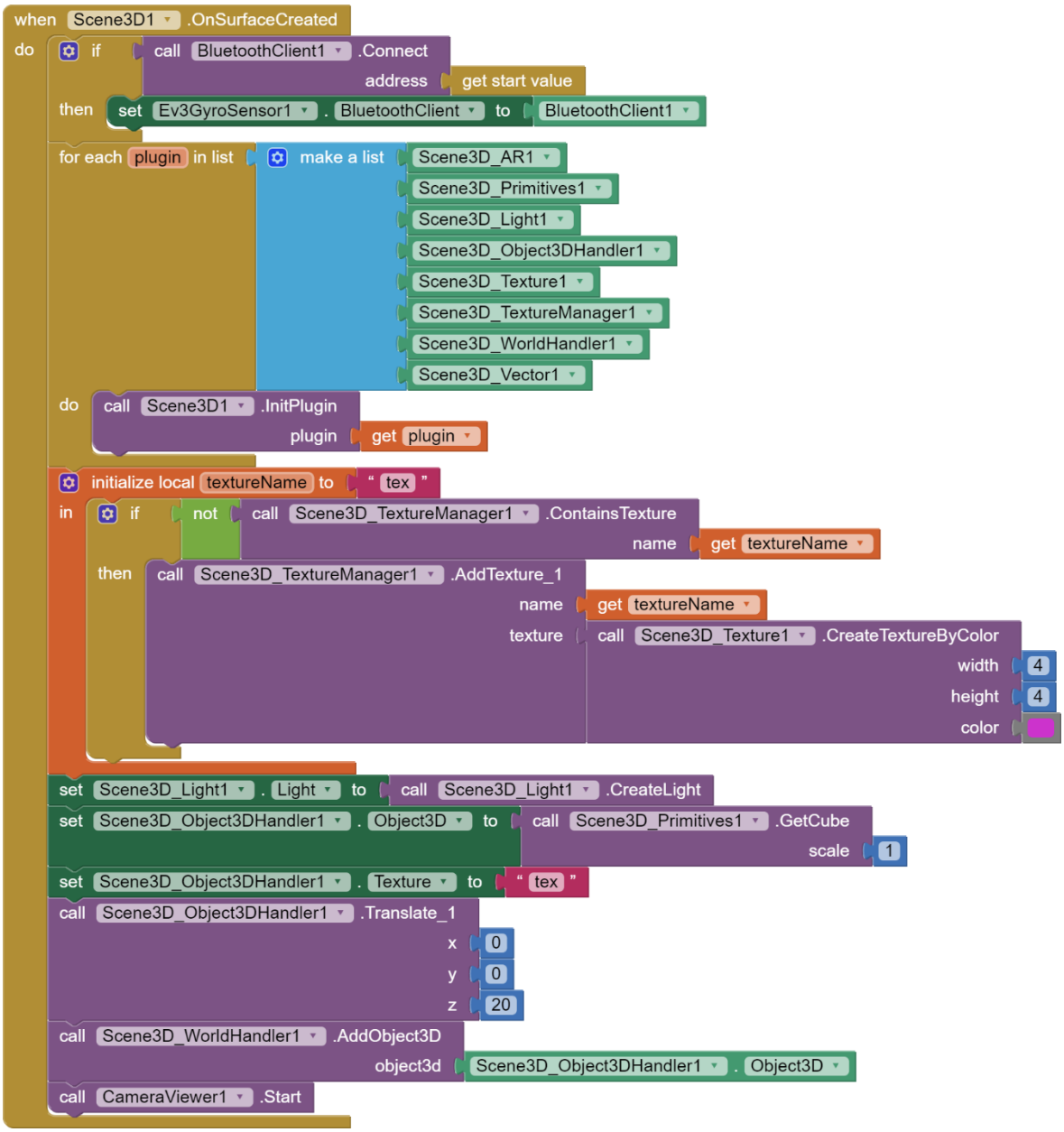




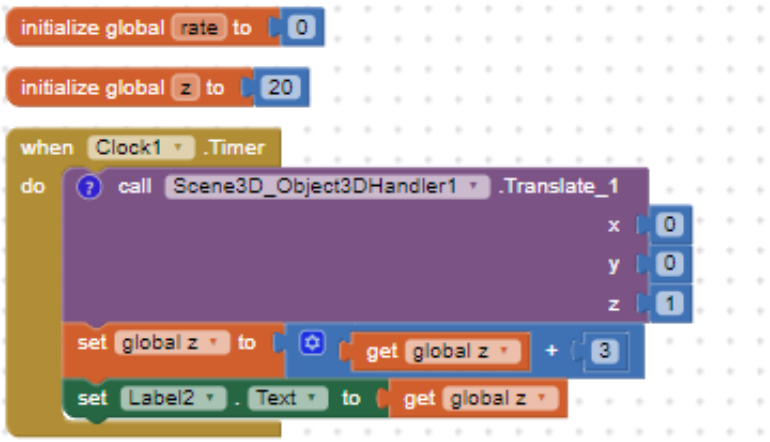
In the second screen, a virtual cube is shown in front of a live camera feed. This cube changes in size as if growing closer or further from the user, depending on how fast they run or wave their hand.



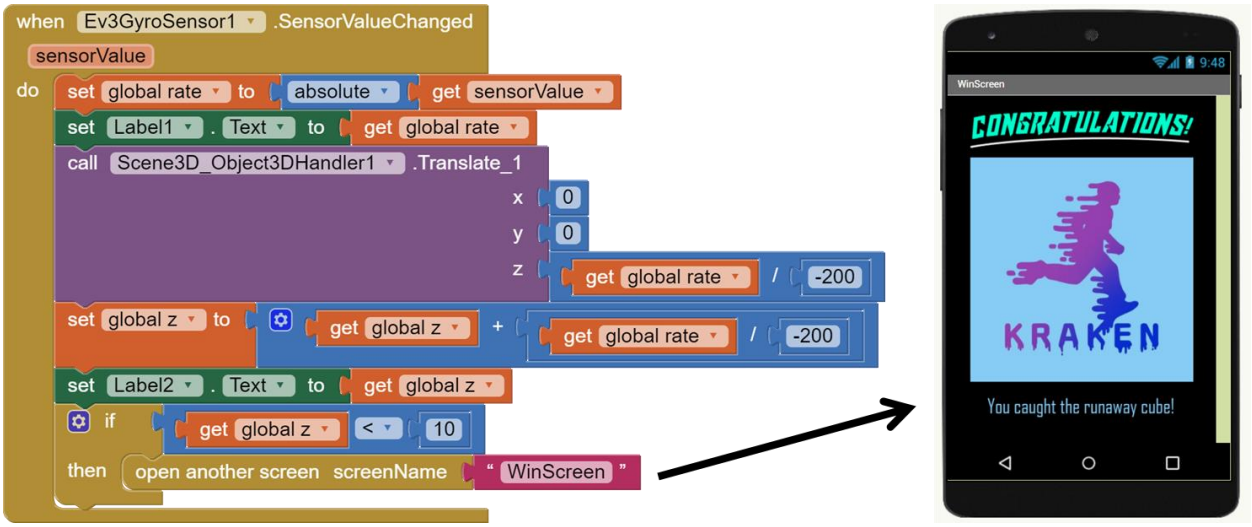
This code first connects to the EV3 brick chosen in the previous screen, then creates a virtual cube over the camera feed using the AppInventor AR extension.



Variables are set for the rate – the player's movement speed, which starts at zero until the gyro sensor detects motion – and the Z coordinates of the cube. Every second, the cube moves further from the player, like a real person running.



Whenever movement is sensed, the gyro sensor returns the player's speed. With this, the cube moves closer, until its Z position – that is to say, the measure of depth in a three-dimensional plane, and in this case, how far the cube is from the player – is less than 10 pixels. Then, a new screen is opened, announcing that the player has won.



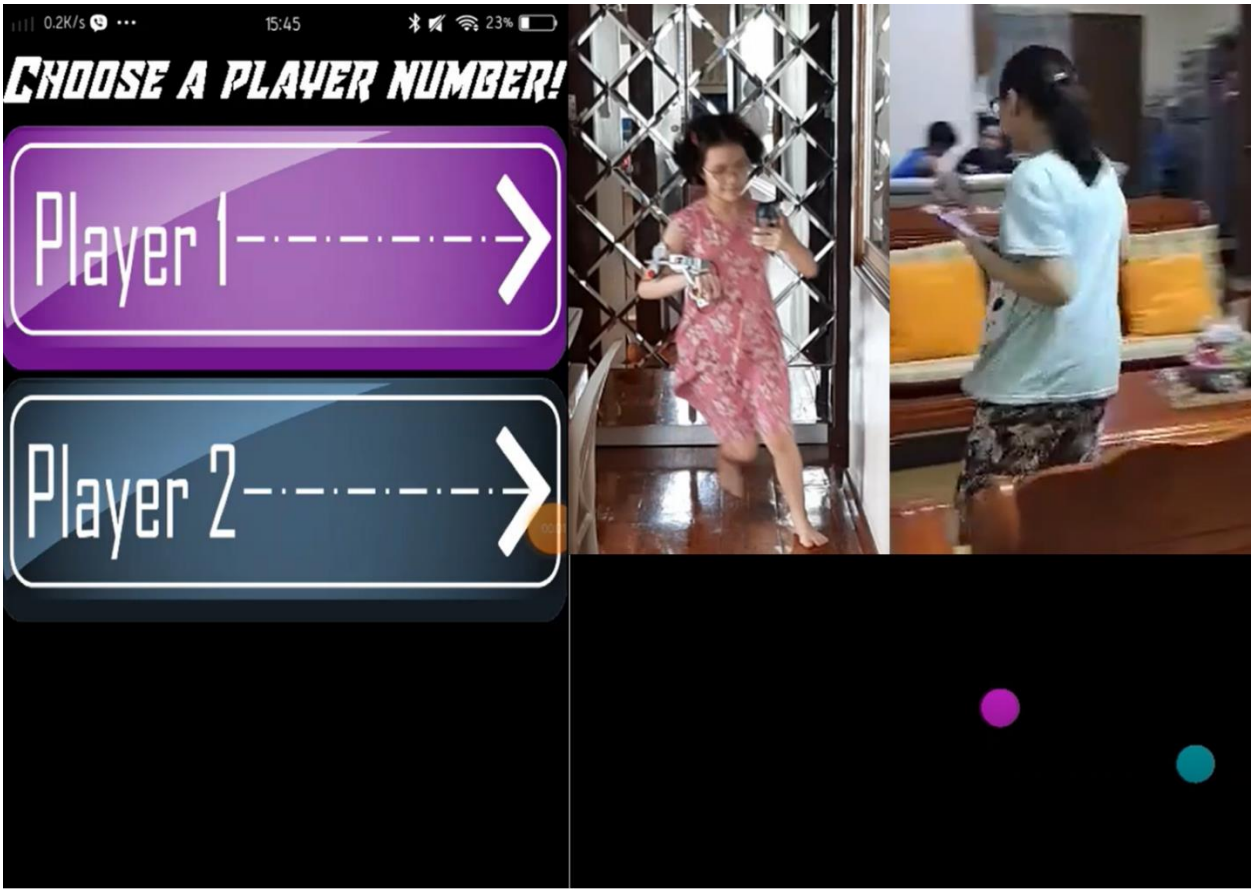
Scope and Limitations

1. Since smart glasses are currently expensive and not yet fully developed, and we have little experience working with augmented reality, the KRAKEN prototype could not include AR glasses and detailed virtual avatars. However, an extension is available in App Inventor that allowed us to create a simple augmented reality simulation that can be viewed through one's phone, showing a built-in three-dimensional shape that can move depending on the orientation of the phone.
2. We were limited to using the EV3 gyro sensors to detect a player's movement speed and direction. These sensors easily drift, so the movement of the dots on the screen is not completely accurate. We also had to make separate games, instead of a single program that could detect both rate and angle at the same time. In the future, KRAKEN will include both accelerometers and gyroscopes to measure a player's movement more precisely.
3. We had to use App Inventor to create the KRAKEN app, as we do not have the time or experience to learn more complex mobile development languages that can support EV3. As such, we weren't able to include the avatar customization, in-game money, and several of the playing modes, but we plan to implement these in the future.

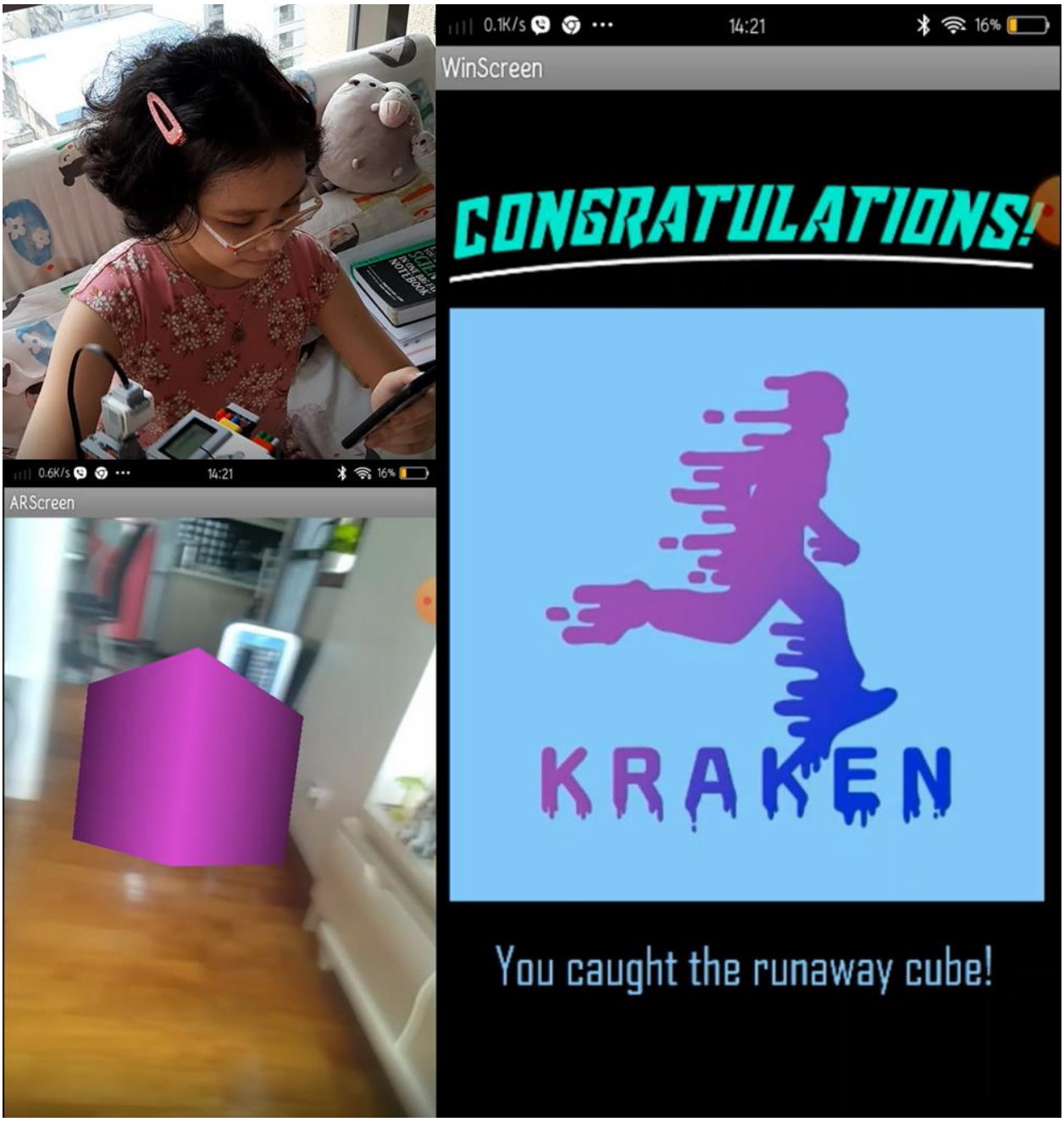
Chapter 004

Results

All in all, both prototypes ran successfully, and the mobile app connected to the real-time database and the EV3 bricks without issue. In the tag game, the players' dots moved throughout the allotted area on the screen based on the orientation of the gyro sensor, and the movement of their opponents was mirrored on the app with minimal lag, even if both players were in different locations as they used the KRAKEN app.



As for the augmented reality simulation, the cube moved appropriately closer and further from the player depending on the speed of the user's hand movements, and a message was shown as soon as the cube collided with the phone in the virtual world displayed on the player's screen.

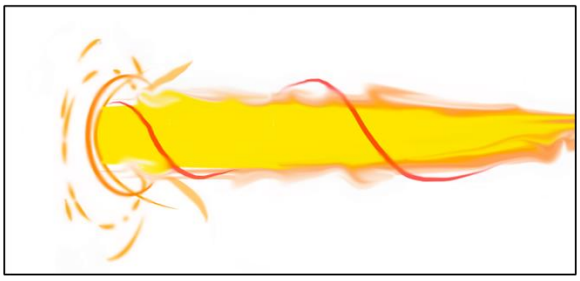

0.1K/s
14:21
16%
WinScreen
CONGRATULATIONS!
KRAKEN
You caught the runaway cube!
0.6K/s
14:21
16%
ARScreen

Chapter 005

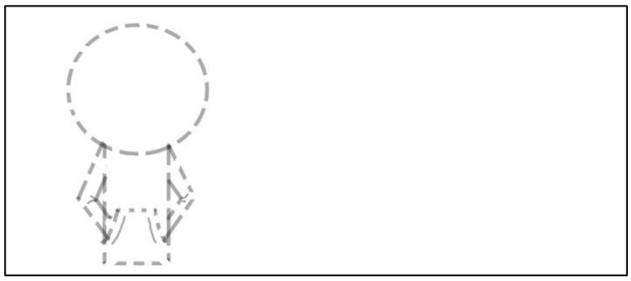
Conclusion

With this prototype, it was proven that it is possible to merge simple fitness games with augmented reality and sensors in a way that allows people in different locations to play together online. In the future, we hope to combine the concept of KRAKEN with more accurate sensors, as well as smart glasses, to better simulate a face-to-face playing experience. More playing modes will be added to appeal to different types of players, along with power-ups and avatar customization options that can be bought with in-game currency.

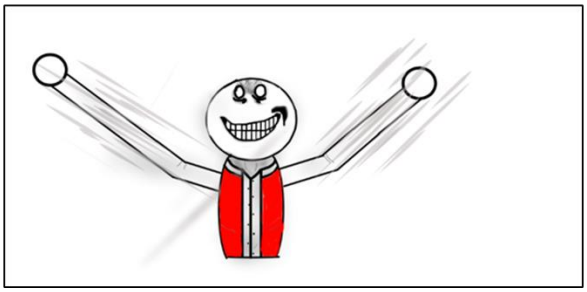
Powerup 1 : Fireball (Cost – Cheap/Medium)
Desc : Release a small ball of flame, anybody touched by this is tagged
Cooldown : Medium (if cooldowns are implemented)



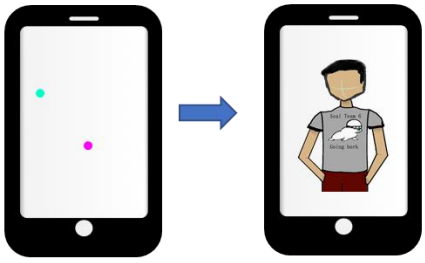
Powerup 2 : Partial Invisibility (Cost – Medium)
Desc : The user becomes partially invisible for 6 seconds. (Still deciding if it should flicker or be slightly visible). This reduces tag range by a small amount (Won't be in the description)
Also has an audio que when activated.
Cooldown : Medium



Extend-o-Arm (Cost : Medium-High)
Desc : The user's right hand extend for a short period of time, allowing the user to strike targets from a longer range (The arm can be tagged since it's part of the user)
Cooldown : Low-Medium



Avatars instead of dots:



By allowing users to exercise and play with each other, KRAKEN has the potential to bring together people from all over the world, perhaps even save the lives of several players by encouraging them to be healthy and develop lasting fitness habits. Someday, it can also be used by players with mental or physical conditions, giving them the opportunity to easily interact and play games with others. All in all, we hope that our project can encourage players to stay active and to have fun together, without being constrained by their differences.

No matter who you are, where you're from, whether you like sports, or not at all, there's always a way to play when you release the KRAKEN!

- Team Vortex Runners 

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