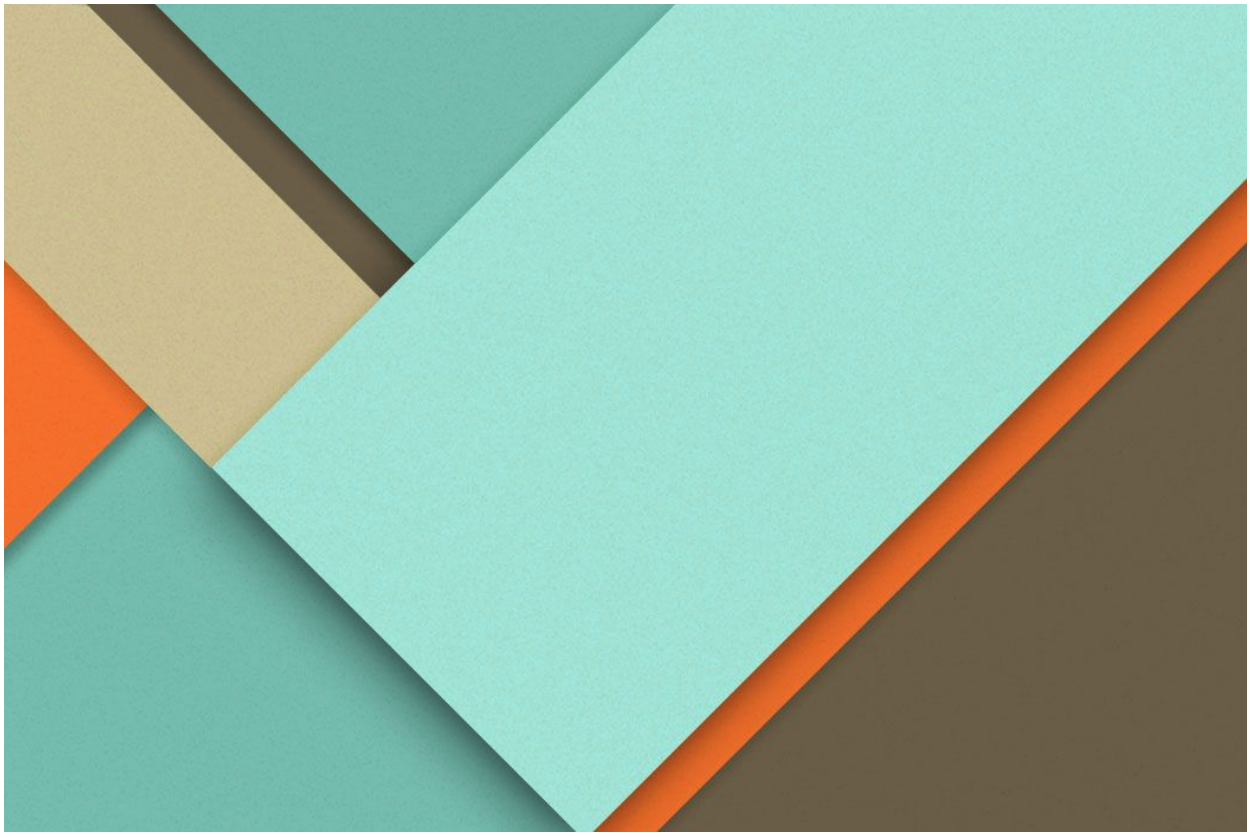
ITSP 2019



Marcos

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Tags:

#Sensory Data Fusion
#Inertial Navigation
#Mixed Reality
#Dead Reckoning

Flight of Fancy

How our project (Marcos) would look like? ... THE MOTIVATION

Remember those times when you wandered around in your colony with your friends pondering on what to play. Well here is a game that we might have all fantasized about but never considered seriously!

This is a game where players are handed Guns and Grenades and experience the thrill of the battlefield in the streets. Obviously these guns don't fire actual shots and these grenades don't actually explode but they create the same recoil and sound like a real one. The players can divide into teams or play individually and experience a Battle Royale in real environment. Last one standing WINS!

Exciting.. ? This ain't it. We further want to program a mixed reality visor equipped with live video camera feed and impart more realistic experience.

THIS VISION IS OUR MOTIVATION!

A Technical Narrative

What problem are we solving exactly ?

1. We wish to determine the position, altitude and orientation of an extended object in space upto an accuracy of ~1cm (within 500m) . From this info we define a fixed vector in space which on extension denotes the trajectory of bullet if the extended object is a gun. This is how we map bullet trajectories.
2. To map the players, they need to wear suits (jackets equipped with position trackers and IR-PIR sensors) .
3. Now if the [virtual] bullet trajectory coincides with the player volume, the suit records a damage until the player health reaches zero. Now the player can't fire a bullet as the suit sends a negative feedback to the gun.

THE INFI LEVEL

Ideally, we would have wanted to create a 3D generative map of the real play environment by placing kinetic cameras on the guns and the suits of players. What the players would be seeing is an augmented version of reality (which shows the blast of a gun when fired and essentially like a real battlefield). Now the map that has been created would be processed

(Image Processing) to distinctly identify objects and assign them as penetrable or impenetrable by bullets. Now realising this would require state of the art tech and serious amount of processing power and test data. This is practically impossible to achieve given the time and the money. So, instead we are working on a beta version of it.

Components required and expected budget:

- ★ Programmable AR Visor/Goggles
- ★ Arduino Microprocessor
- ★ PIR-IR sensors (5-10pcs)
- ★ Accelerometers (5-10pcs)
- ★ RF transciever modules (nRF24, 15-20pcs)
- ★ ADC and DAC (32 bit, 20-25 pcs each)
- ★ Encoders and Decoders
- ★ General electric stuff
- ★ General mechanical stuff (to build the gun)

Expected Budget: Rs. 15000

Learning objective

What we crave to learn out of this ?

1. Sensory data fusion: We would be using a variety of sensors for this project and to achieve the desired result we would need to utilise all of the sensory data simultaneously.
2. Inertial navigation: The core of our problem lies in this realm and learning it is crucial for our project.
3. Position tracking: We have to determine position very accurately so we can't use GPS tracking rather we have to develop our own tracking algorithms by utilising the sensory data.
4. Augmented reality: We will learn how AR actually works and design programs on AR visor. Starting with AR we would have to anchor the real world objects with virtual ones and take it to the level of mixed reality.
5. Air gun: As we want the gun to fire an air shot when the trigger is pressed we would need to work on the design of gun also.
6. Practical implementation: As we want our project to run in the real environment we would require a lot of practical testing and obviously we would learn a lot.

Feasibility

This is an innovative idea and therefore finding such previously made projects is seemingly impossible. Here are the links to projects involving similar concepts:-

Kalman filter

Gradient descent techniques

Practical 1

Practical 2

Pseudo-measurements

Dead reckoning

Inertial navigation

In Short,

The project is entirely feasible economically and well within the reach of present day tech.

Impact

In this project neither the concepts nor the design is new; what is innovative is that how we imagined to implement these concepts and designs to create something exciting. Such projects might have been made before but even after tremendous research we couldn't find any nor can we find them in the market. This project (Marcos) has the potential to steal the market as it is in perfect alignment and a step further with present day gaming.

This is a game which requires lot of agility, creativity, strategy and awareness. This game is non-addictive as it is played outdoors (it can be played indoors as well) and it can move the gamers who are glued to their seats. So this game is healthy both mentally and physically.

You might be thinking about the games that you have seen in malls. Well their first limitation is that they are restricted only to malls and further they are based on augmented virtuality whereas ours is based on mixed reality and hence is more realistic (it can be played without visors also but it would reduce their appeal).

Now let's talk about its cost. As we are assembling the game from crude components it gets quite costly but if made commercially it won't cost more than Rs. 5000 for one player's accessories. So it is cost efficient as well.

Flow-Sketch

The Project essentially involves 4 key components:

I. AR Goggles

These goggles are programmable and would be used to enhance the battle experience. However these would be an add-on. The game can be played without using them. All our AR resources are here:

https://bitbucket.org/Unity-Technologies/unity-arkit-plugin

Flow-Diagram: Showing the working of AR Program. The image processing algorithm identifies the gun tip (which would be especially coloured for it) and imposes a blast on it when trigger is fired.

II. Central Processor

We would be using an Arduino microprocessor along with a laptop as the coordinating unit. All our Arduino Resources are here:

https://www.arduino.cc/en/Tutorial/HomePage?from=Main.Tutorials

III. The Gun

The gun would employ two accelerometers: one at the base and other at the tip. We will calculate the position and altitude of the gun relative to the suit using IR-PIR sensors. All our research on sensors is here:

ITSP.zip

IV. The Suit

The suit is essentially a jacket which consists of various IR-PIR sensors (fitted physically) that calculate the body orientation. The position of the suit is deduced by triangulation. All our Research is here:

https://en.wikipedia.org/wiki/Mobile_phone_tracking

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How are they all coordinated?

Most of the calculations would be done on the Central Processor so that information loss due to transmission is minimum. All the sensors that are employed on guns and suits will send their readings to the central processor via an RF module (nRF24). Now the Central Processor would employ algorithms to deduce the fixed vector that denotes bullet trajectory. As a player fires the trigger, all the sensory data would be transmitted to the Processor which would deduce whether the bullet hits the target or not.

Now you may question that what will happen when the gun and the target suit are in the line of sight but there is obstacle in between. To solve this problem we will send an additional LOS signal straight from the gun to the target. Now if the signal gets attenuated too much the target won't record a damage (as would be the case if the obstacle was metal or concrete). But if the obstacles are like bushes, the signal won't get attenuated much and the target would record a damage. The setting of the 'Reference' would require experimentation and cannot be concluded as of now. For achieving recoil we would fire an air shot.

You can find our elaborate research here : Coordination

Retrospection

What was the aim for Phase 2?

We had hoped to achieve the following :

- A conceptual clarity on how exactly we would be implementing the vision.
- Figuring out what sensors and algorithms would be needed.
- A detailed info of the working of the sensors we would need.
- Getting the key learning materials to implement the concepts.

What have we achieved in Phase 2?

We have met all these targets and gathered tons of relevant material which are provided in the links. We even have worked out some of the exact components we would be using (like the RF modules and the processing chip) . You would certainly appreciate our effort if you go through all the links provided. Apart from this material we have done a lot of stray reading, talked to various people in the insti and attended various workshops and lectures (some of which are attached in the links).

Execution

Here is our plan for the Summer Phase:

- Week 1:
  - Finding out the exact quantity and model no. of the various components required and ordering them (some we have already figured out).
  - Give a finishing touch to our algorithms and searching extensively for possible bugs.

- Week 2:
  - Figuring out the data sheet and implementation for each individual component.
  - Experimenting and testing the materials procured.
- Week 3:
  - We would divide our team into two groups:

    i) They would work on implementing the accelerometer on the gun and the suit.

    ii) They would work on the implementing IR-PIR sensors on the gun and the suit.
- Week 4:
  - Implementing our algorithms via arduino to achieve the goal.
  - Giving a finishing touch to our circuitry and algorithms.
- Week 5:
  - Testing the gun and the suit under various circumstances and solving any bugs if encountered.
  - Modifying the outer design to get our project into a cool presentable form and making the air gun.