**IMPLEMENTATION OF AUGMENTED REALITY FOR DIGITAL CLASSROOM APPLICATIONS**

**A PROJECT REPORT**

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***in partial fulfillment for the award of the degree***

***of***

**BACHELOR OF TECHNOLOGY**

**IN**

**INFORMATION TECHNOLOGY**

**SAGI RAMAKRISHNAM RAJU ENGINEERING COLLEGE (AUTONOMOUS)**

**BHIMAVARAM, 534 204. ANDHRA PRADESH**

**2017-2021**

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### SELF DECLARATION

We hereby declare that the project work entitled “IMPLEMENTATION OF AUGMENTED REALITY FOR DIGITAL CLASSROOM APPLICATIONS” is a genuine work carried out by us in B.Tech., Information Technology at SRKR Engineering College(A), Bhimavaram and has not been submitted either in part or full for the award of any other degree or diploma in any other institute or University.

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**TABLE OF CONTENTS**

[LIST OF FIGURES](#_TOC_250015) 1

ABSTRACT 2

1. INTRODUCTION 3-9
2. PROBLEM STATEMENT 10
3. LITERATURE SURVEY 11-15
4. SOFTWARE REQUIREMENTS SPECIFICATION 16-21
   1. PURPOSE 16
   2. SCOPE 15
   3. OBJECTIVES 17
   4. EXISTING SYSTEM 17
   5. [PROPOSED SYSTEM](#_TOC_250010) 18-21
   6. [REQUIREMENTS](#_TOC_250009) 22-24
      1. [FUNCTIONAL REQUIREMENTS](#_TOC_250008) 22
      2. [NON-FUNCTIONAL REQUIREMENTS](#_TOC_250007) 23
      3. PSEUDO REQUIREMENTS 23-24
5. SYSTEM DESIGN 25-31
   1. [SYSTEM ARCHITECTURE](#_TOC_250005) 25
   2. [UML DESIGN](#_TOC_250004) 25
      1. [USE CASE DIAGRAM](#_TOC_250003) 25-26
      2. [CLASS DIAGRAM](#_TOC_250002) 27
      3. INTERACTION DIAGRAMS 28-30
         1. [SEQUENCE DIAGRAM](#_TOC_250001) 28-29
         2. COLLABORATION DIAGRAM 29-30
      4. STATE CHART DIAGRAM 30-31
6. METHODOLOGY 32-43
   1. IMPORTING LIBRARIES 32-35
      1. NUMPY 32
      2. OPERATIONS USING NUMPY 33
      3. NUMPY- A REPLACEMENT FOR MATLAB 33
      4. OPENCV 33
      5. COMPUTER VISION 34
      6. FEATURES OF OPENCV LIBRARY 34
   2. IMAGE PROCCESSING 35
   3. FEATURE DETECTION AND MATCHING MODULES 35-43
      1. INTRODUCTION 35-36
      2. ORB 37
      3. FAST 37-40
      4. BRIEF 40-43
7. FEATURE DETECTION 44-45
   1. CODE 44
   2. OUTPUT 45
8. FEATURE MATCHING 46-50
   1. CODE 46-47
   2. OUTPUT 48-50

# LIST OF FIGURES

|  |  |  |
| --- | --- | --- |
| 1.1 | Augmented Reality | 3 |
| 1.2 | Ivan Sutherland’s AR creation | 5 |
| 4.5.1 | Student interacting with real objects | 17 |
| 4.5.2 | AR example in biology | 19 |
| 4.5.3 | AR in physics | 20 |
| 6.3.1.1 | Train key points with size | 35 |
| 6.3.1.2 | Train key points without size | 35 |
| 6.3.3.1 | Features from Accelerated segment | 37 |
| 6.3.3.2 | Example to ORB | 38 |
| 6.3.3.3 | Binary descriptors | 39 |
| 6.3.4.1 | Binary Features | 40 |
| 6.3.4.2 | Smoothed image patch | 40 |

# ABSTRACT

# In recent years, a new method of teaching has emerged, utilizing projectors to display the information to be taught. This method of instruction has evolved to include the use of tablets and cell phones in the classroom to record what has been taught. This has now been extended to include the use of augmented reality to show students the matching videos during an online class. This method of instruction will boost student enthusiasm and participation in class while also allowing for new forms of interaction and visualization. The pupils are shown a combination of a real scene and a virtual scene produced by a computer, which is known as augmented reality. An application for the digital classroom is provided in this study. Lecturers can display the virtual content on the screen using unique image cards. Feature detection and matching are used in this process of presenting the related videos. Object recognition, picture retrieval, and other computer vision applications all employ feature detection. Objects, edges, points, or any other type of relevant information can be included in these characteristics. And these traits are utilized to achieve computational problems in some applications. Lecturers can use augmented reality as a supplement to bring teachings to life. Traditional online lessons are enhanced with augmented reality, which adds a function that shows the needed video depending on the picture card displayed by the speaker.

**Chapter 1**

**INTRODUCTION**

Augmented Reality time period turned into coined withinside the year 1990 with the aid of using Tom Caudell however it turned into first invented with the aid of using the improvement of the primary head-set up show gadget with the aid of using Ivan Sutherland withinside the year 1968. From then the Augmented truth has grown plenty in tremendous ways. It combines actual and digital worlds with the aid of using such as the actual-time interplay and additionally the 3-D registration of actual and digital gadgets. AR is each interactive and 3-D recorded, and it combines real and digital gadgets. Milgram's Reality-Virtuality Experiment As proven in Fig.1.1 [2], a continuum that spans among the actual and digital environments is described with the aid of using Paul Milgram and Fumio Kishino as a continuum that incorporates Augmented Reality and Augmented Virtuality (AV) in among, in which AR is towards the actual international and AV is towards a natural digital surroundings. The aim of augmented truth is to make the user's existence less difficult with the aid of using introducing digital data now no longer simply to his instantaneously surroundings, however additionally to any oblique view of the actual-international surroundings, inclusive of a live-video feed. The user's angle of and interplay with the actual surroundings is advanced thru augmented truth. While Virtual Realism (VR) era, additionally referred to as the Virtual Environment, completely immerses customers in a artificial surroundings with out permitting them to view the real international, AR era complements the sensation of truth with the aid of using superimposing digital gadgets and alerts onto the actual international in actual time. We do now no longer regard AR to be restricted to a positive shape of show era, inclusive of a head-set up show (HMD), nor can we accept as true with it to be restricted to the experience of sight, as Azuma et al. [3] do. AR has the capacity to beautify all senses, such as smell, touch, and listening to. AR will also be used to complement or update customers' lacking senses thru sensory substitution, inclusive of the use of audio cues to enhance the sight of blind or low-imaginative and prescient customers, or the use of visible cues to enhance the listening to of deaf customers.

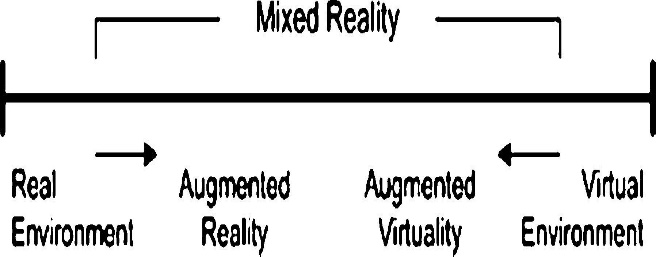


Fig 1.1

In addition to introducing virtual items, Azuma et al. [3] examined AR applications that involve eliminating actual elements from the environment, often known as mediated or reduced reality. Indeed, eliminating items from the actual world entails covering the object with virtual data that fits the background to give the user the sense that the object does not exist. The information sent on by the virtual item can assist the user in doing daily activities, such as guiding employees through electrical cables in an airplane using a headset to show digital information. Information can also be used for amusement purposes, as in Wikitude or other mobile augmented reality applications. Medical visualization, entertainment, advertising, maintenance and repair, annotation, robot path planning, and so on are all examples of AR applications.

The earliest appearance of Augmented Reality (AR) goes back to the 1950s, when Morton Heilig, a cinematographer, thought of film as an activity that could bring the audience into the onscreen experience by effectively incorporating all of the senses. Heilig created a prototype of his vision, Sensorama, in 1962, which preceded digital computers [4], which he outlined in 1955 in "The Cinema of the Future." Ivan Sutherland in 1966 (Fig.1.2) created a head mounted display in the year 1966. Sutherland was the first to use an optical see-through head-mounted display to build an augmented reality system in 1968 [5]. In 1975, Myron Krueger builds the Videoplace, a room that for the first time allows people to interact with virtual items. Later, while assisting employees with the assembly of cables and cabling for an aeroplane, Boeing's Tom Caudell and David Mizell coined the term Augmented Reality [1].

They also started talking about the benefits of Augmented Reality (AR) over Virtual Reality (VR), such as the fact that it uses less power because fewer pixels are required [5]. In the same year, L.B Rosenberg created one of the earliest working AR systems, Virtual Fixtures, and proved its impact on human performance, while Steven Feiner, Blair MacIntyre, and Doree Seligmann delivered the first significant article on an AR system prototype, KARMA [1.] The reality virtuality continuum depicted in Figure 1.1 was not established until 1994 by Paul Milgram and Fumio Kishino as a continuum spanning the actual and virtual worlds. AR and AV are both at the same place.



Fig. 1.2 Ivan Sutherland’s

HMD [5] in among with AR being in the direction of the actual-global surroundings and AV being in the direction of the digital surroundings. In 1997, Ronald Azuma writes the primary survey in AR offering a extensively stated definition of AR via way of means of figuring out it as combining actual and digital surroundings whilst being each registered in 3-d and interactive in actual time [5]. The first out of doors cell AR game, ARQuake, is evolved via way of means of Bruce Thomas in 2000and confirmed at some point of the International Symposium on Wearable Computers. In 2005, the Horizon Report [6] predicts that AR technology will emerge extra completely in the subsequent 4–five years; and, as to verify that prediction, digital digicam structures which can examine bodily environments in actual time and relate positions among gadgets and surroundings are evolved the equal year. This form of digital digicam machine has emerge as the idea to combine digital gadgets with fact in AR structures. In the subsequent years, increasingly AR packages are evolved particularly with cell packages, which include Wikitude AR Travel Guide released in 2008, however additionally with the improvement of clinical packages in 2007. Nowadays, with the brand new advances in generation, an growing quantity of AR structures and packages are produced, significantly with MIT sixth feel prototype and the discharge of the iPad 2 and its successors and competitors, significantly the Eee Pad, and the iPhone 4, which guarantees to revolutionize cell AR. Augmented Reality (AR) is a generation that permits pc-generated digital imagery data to be overlaid onto a stay direct or oblique actual-global surroundings in actual time. AR isn't the same as Virtual Reality (VR) in that during VR humans are anticipated to revel in a pc-generated digital surroundings. In AR, the surroundings is actual, however prolonged with data and imagery from the machine. In different words, AR bridges the distance among the actual and the digital in a unbroken way. According to the records of AR is going lower back to the Sixties and the primary machine turned into used for each AR and VR. It used an optical see-via headmounted show that turned into tracked via way of means of one in all one-of-a-kind methods: a mechanical tracker and an ultrasonic tracker. Due to the confined processing strength of computer systems at that time, best quite simple wireframe drawings can be displayed in actual time (Sutherland, 1968). Since then, AR has been positioned to apply via way of means of some of main agencies for visualization, schooling, and different functions. The time period ‘Augmented Reality’ is attributed to former Boeing researcher Tom Caudell, who's believed to have coined the time period in 1990. AR structures can both be marker-primarily based totally or markerless- primarily based totally. Marker-primarily based totally packages are produced from 3 primary additives which encompass a guide for presenting marker data, a gripper for purchasing data from the guide and changing it to any other form of data, and a dice for augmenting data into 3-d-rendered data on a screen. On the alternative hand, markerless-primarily based totally packages want a monitoring machine that entails GPS (Global Positioning System), a compass, and an photograph reputation tool as opposed to the 3 factors of maker-primarily based totally structures. Markerless packages have wider applicability due to the fact they feature everywhere with out the want for unique labeling or supplemental reference points. Several researchers have counseled that newbies can support their motivation for mastering and decorate their instructional realism-primarily based totally practices with digital and augmented fact. In spite of a high-quality quantity of studies over the last decades, adopting AR in schooling and schooling remains pretty tough due to problems with its integration with conventional mastering methods, fees for the improvement and preservation of the AR machine, and preferred resistance to new technology.

# Chapter 2

**PROBLEM STATEMENT**

Presenting corresponding lecture videos while teaching an online class is a major difficulty for lecturers. An automated Augmented reality app is designed in-order to ease their task. This app recognizes the hand gestures or image cards and plays the corresponding video to the students. In this way the task of lecturers to present the corresponding video without giving a pause to lecture becomes very easy. Lecturers can show the image cards to play a related video.

**Chapter 3**

**LITERATURE SURVEY**

Antonio-Jose and his colleagues have been experimenting with Augmented Reality to improve learning in physical education classes. They polled students at a neighboring college and separated them into two groups: control and experimental. The control group consists of students who are taught in a traditional manner without the use of technology resources, whereas the experimental group consists of students who have been taught in a more innovative manner, with the training process using augmented reality. Basic statistics such as mean, standard deviation, skewness, and kurtosis were utilized in the analytical procedure to determine the distribution. They utilized basic statistics including mean, standard deviation, skewness, and kurtosis to determine the distribution trend during the investigation. The magnitude of the effect is then determined using a student's t-test, Cohen's d, and biserial correlation. Some statistical techniques, such as Kappa and W, were used to supplement the first validation by determining the degree of agreement and significance of the specialists' judgments. They used 140 students in their study and found that the experimental group's responses were more scattered than the control group's, with kurtosis values ranging from +1.96 to -1.96.

Christian Grevisse, Carina Martins Gomes, and Steffen Rothkugel created a semantic platform for open educational augmented reality resources. In today's classrooms, tablet computers are becoming more ubiquitous, allowing students to use a variety of apps for note-taking and evaluation. Di Serio et al. looked at the influence of augmented reality on motivation in a visual arts class. Mitsuhara et al. used a paper-top interface to project learning information linked to the notes students were taking in an early research. The requirement for independent augmented reality experiences to be integrated into other educational apps led to the creation of the AR4OER2 platform. The basic idea is to keep all of the apps involved loosely linked, resulting in a scalable and adaptable ecosystem. The 4 AR scenarios presently indexed on AR4OER will be shown. Each scenario is focused on a different school subject. They were created using a range of computer languages, and the way the user interacted with the AR experience differed. They offered four examples from diverse educational fields, as well as explanations for how students may benefit from them.

Josef Buchner and Jörg Zumbach worked on Augmented Reality in teacher education. A framework for teachers to utilize to assist their knowledge of technology pedagogical material. Augmented reality has a lot of potential as a learning and instructional tool for developing and/or upgrading new learning environments. According to a recent review of the literature on learning and teaching with augmented reality, the majority of research has focused on student learning. This research study used the Learning Technology by Design approach as part of an in-service teacher-training course on AR deployment in the classroom. The question of whether and under what conditions certain instruction technologies are suitable arises, as it does with any ID issue. A thorough examination of how AR may contribute to learning environments is necessary, taking into consideration pedagogical content knowledge and the material itself, with specific attention paid to the TPCK-underpinnings. Model's The approach incorporates technical (TK, in this example in connection to AR) and didactical/pedagogical (CK and PK) viewpoints, as well as a third, enrichment level. AR can help all students go from their personal fundamentum to their personal additum, which is something that all teachers can benefit from.

For a STEM education group, V V Osadchyi, N V Valko, and L V Kuzmich cooperated on augmented reality technology. STEM education is structured around project-based activities that use a range of instructional methods and technology solutions. There are different forms of participant engagement within project activities. Apart from categorizing resources, the authors divide them into two groups based on user activity: active AR content production and passive AR content consumption. The use of augmented reality (AR) in STEM education research facilitates the production of three types of resources: electronic educational materials, systematic supervision, and content generation by teaching experts, and instructors. In the process of training future natural and mathematical disciplines instructors, further study into method definition and types of augmented reality deployment is required. It is decided what role the STEM approach with augmented reality plays in the teaching process.

Nilam Desai wrote an article in 2018 titled "Recreation of History Using Augmented Reality." The structure of a location, as well as the art produced in that area, may reveal its history and heritage. It's a hidden gem that reveals important details about our past. As a result, it's critical to keep it alive for the sake of the bloodline. For the past several years, historical sites have been harmed by pollution, maintenance difficulties, and tourism, with pollution being the most significant cause. We may utilize a variety of technologies to conserve these priceless relics of our past and legacy by allowing people to digitally view antiques, architectural monuments, and historic places.3D images assist in gaining a spatial perspective on any thing. Virtual reality allows users to interact with geographical information from cultural heritage sites in a virtual three-dimensional environment. The experience is multiplied if one can interact with the object by placing it in a real-world setting using augmented reality. Virtual archaeology, Virtual Museums, virtual and AR Heritage, and other applications have evolved from the newest technology aimed to enrich the virtual experience of cultural and archaeological historical places. Virtual high-definition interactive technology aids in the virtual recreation and reconstruction of damaged cultural sites. The use of AR-enabled software and hardware aids in the development of such applications. People can use hand-held devices such as mobile phones and tablets to see historical items utilizing Augmented Reality coupled with Virtual Reality.

**Chapter 4**

**SOFTWARE REQUIREMENT SPECIFICATION**

### PURPOSE:

* + - The system used in schools Teachers only have to provide the books and students can scan the book pages, bringing them to life on their phones.
    - Whereas students used to put together PowerPoint presentations, they can now use augmented reality to bring presentations to life.

### SCOPE:

Augmented reality (AR) has been quietly but steadily revolutionizing the education sector, digitizing classroom learning and making training more diverse and engaging, much like its precursor virtual reality. Educators must still examine what is worthwhile their investment and would help their curricula, especially with so many new inventions hitting the market every day. Because AR may not always respond to their needs, it is vital to grasp the technology and what it has to offer before making that decision.

In a word, mobile augmented reality may benefit learners of all ages, from preschoolers through primary school students, and all the way up to college and university students, if used wisely. Recently, augmented reality (AR) has been introduced to assist workers in many industries with on-the-job training and has been recruited inside specific sectors to help people understand complex topics and learn in an engaging manner.

### OBJECTIVE:

When students are more engaged in the subject, classes will be more effective and appealing to them. Augmented reality allows pupils to grasp a subject by combining a real and virtual scene, resulting in increased interest and enthusiasm among students.

* The purpose of augmented reality in the classroom is to boost students' passion and interest in their classes by incorporating a virtual and real-world setting.
* To improve efficiency, many approaches for recognizing characteristics in picture cards are used.

### EXISTING SYSTEM:

### 

* In the existing Augmented Reality system we login into the user interface and scan an object with the camera, this will be compared with the images in the database and the details of the object in the database which is similar to scanned image, will be provided as the output in the user interface.
* This system only provides the details of the object but what we aim in our project is to retrieve a video to a corresponding hand gesture

### PROPOSED SYSTEM:

**AR in K-12 Settings**

The SMART (System of augmented reality for teaching) that is an educational system using AR technology. This technique use augmented reality to teach 2nd grade concepts such as modes of transportation and animal sorts. This method superimposes three-dimensional models and prototypes, such as a car, truck, or aero plane, on a live video feed that is broadcast to the entire class. Game-based learning is one technique to interest youngsters in learning because they spend so much time playing digital games. Several trials were conducted with 54 pupils in three distinct Portuguese schools. According to the findings of a number of studies, SMART helps students become more motivated and has a favorable impact on their learning experiences Particularly among students who are less academically successful.



Figure 4.1. A view of a student interacting with real objects (foam core card, table, wall) and artificial objects (Sun, Earth, annotations) through the augmented reality interface. This view is as would be seen if wearing an HMD (Shelton, 2002).

**The Application of AR in Different Subjects**

Astronomy with enhanced capabilities. Students learn about the earth's and sun's interaction in an astronomy class. Educators can employ AR technology to assist student comprehension by using 3D rendered earth and sun shapes.

1. **Augmented biology**

In biology, AR can be used to examine the anatomy and structure of the body. Teachers might utilize AR technology to highlight what human organs are made of and how they look by watching 3D computer-generated models in real classrooms, according to the Specialist Schools and Academies Trust (SSAT). Furthermore, using their camera-embedded laptops and AR markers that connect PCs with AR information about biological features of the human body, students may be able to study human organs autonomously.



Figure 4.2: An augmented fact version of a human's inner organs that maybe utilized in Biology lesson.

1. **Mathematics and geometry education.**

With AR technology, instructors and college university students can collaborate through interacting with every precise for a few troubles on shapes or arrangements

According to Chang an AR utility, called Construct3D, especially have become designed for mathematics and geometry education with three-dimensional geometric advent models. This software program lets in multiple clients, on the aspect of instructors and college students, to percentage a digital area collaboratively to bring together geometric shapes via carrying head set up displays that permit clients to overlay computer-generated photos onto the real world. AR can be applied in dynamic differential geometry education in a big type of ways. For instance, the usage of the AR utility, teachers and university college students can intuitively find out houses of thrilling curves, surfaces, and unique geometric shapes.

1. **Physics education**

Physics is any other region in AR also can be used to illustrate numerous kinematics properties. AR to dynamically gift an item that varies in time, which include speed and acceleration. The actual and envisioned experimental effects may be visualized through the use of AR strategies which might be extra thrilling than present getting to know methods, and hence enhance getting to know. The physics simulation is brought to gadgets the use of open dynamics engine (ODE) library.



Figure 4.3: Students running with construct3D inscribe a sphere in a cone

We utilized the openCV package in Python to identify the picture card displayed by the lecturer, analyze it, and compare it to an image in the database to achieve augmented reality courses. Numpy is also used to do

1.mathematical and logical calculations

2.fourier transformations

3.shape manipulation routines

OpenCV stands for "Open Computer Vision," and it's used to conduct things like image processing, pattern recognition, and photogrammetry, all of which will be covered in the pseudo-requirements section.

### REQUIREMENTS:

### FUNCTIONAL REQUIREMENTS:

### Start Camera: The front camera is accessed in order to retrieve or capture the image card shown by the lecturers.

### Detect Object: The camera video is divided into frames and the image card(frame) is detected.

### Create AR objects: An AR object will be created and shown on the screen based on the image card shown.

### Place AR objects: Based on the sensor the created video will be appended on the screen without any disturbance or obstruction.

### Support of Interactive AR content

### Indirect retrieval of AR content

### Visual composition of AR content

### NON- FUNCTIONAL REQUIREMENTS:

### Usability: This is mainly about the view of the app and the user interface.

### Reliability/Availability: Requirement of the app whether it has to work 24/7 or not.

### Scalability: This is about the handling of the system incase of future enhancements.

### Performance: It is about the efficiency or how fast it operates.

### Security

### PSEUDO REQUIREMENTS:

**Software Requirement:**

The Following are the software requirement necessary of the project:

* + - * OpenCV, Numpy
      * Operating system : Windows XP.
      * Coding Language : Python

### Hardware Requirement:

The Following are the hardware requirement that are most important for the project:

* + - * System : Pentium IV 2.4 GHz.
      * Hard Disk : 40 GB.
      * Floppy Drive : 1.44 Mb.
      * Monitor : 15 VGA Colour.
      * Mouse : Logitech.
      * Ram : 512 Mb.
      * Web Camera

Fluently working Laptops

### Chapter 5

### 

### SYSTEM DESIGN

### SYSTEM ARCHITECTURE

ORB based object recognition

Input line Video feed

AR video overlapping

### 

### UML DESIGN

### Use Case Diagram

A use case diagram is the representation of a user's interaction with the system and depicts the specifications of a use case. A use case diagram can portray different types of system users and different in which they interact with the system. This type of diagram is typically used in conjunction with the textual use case and will often be accompanied by other types of diagrams as well.



### Fig. 5.2.1 Use Case diagram

****

### Fig. 5.2.1.1 Sub Use Case diagram for scanning image

### 

### Fig. 5.2.1.2 Sub Use Case diagram for viewing video

### Class Diagram

Class diagrams are the main element of object-oriented modeling. They are used to exhibit different objects in a system, their attributes, their operations and the relationships among them. In the diagram, classes are declared using boxes and each box contains three parts:

* The upper portion carries the class name.
* The middle portion carries the class attributes.
* The last portion carries the methods or operations that are taken or undertaken by class.



### Fig. 5.3 Class diagram

* + 1. **Interaction Diagram**

The interaction diagram shows some kind of interactions among the different elements in the model. This interaction is a part of the system's dynamic behavior.

This interactive behavior in UML is illustrated by 2 diagrams. They are Sequence diagram and Collaboration diagram.

### Sequence diagram

A sequence diagram shows how processes operate with each other and in what order. The sequence diagram shows the message flow in the system. It visualizes several dynamic scenarios. It shows the interaction between any 2 lifelines as a time-ordered sequence of events, such that those lifelines took part at the run time. Here, the lifeline is indicated by a vertical bar, whereas the message flow is indicated by a vertical dotted line that extends till the page bottom.



### Fig. 5.4 Sequence diagram for Scanning the image

### Collaboration diagram

A collaboration diagram indicates the interactions among objects in terms of sequenced texts. Collaboration diagram is represented by a combination of data taken from class, sequence and use case diagrams describing both the system's static structure and dynamic behavior.



### Fig. 5.5 Collaboration diagram for scanning the image

* + 1. **State Chart diagram**

The Statechart diagram shows the order of states undergone by an object within the system. It captures the software system's behavior. It models the class behavior, a subsystem, a package, and a complete system.



### Fig. 5.6 State Chart diagram for Scanning Image

### 

### Fig. 5.6.1 State Chart diagram viewing video

### Chapter 6

**METHODOLOGY**

The System follows the following methodology:

First the video that is being captured is divided into frames using python and then this image is compared to the images in the database and the most similar image is determined by applying orb technique in python. And some other modules that are used in image matching are given below.

**6.1 Importing Libraries:**

**6.1.1 Numpy:**

It's a library that includes multidimensional array objects as well as array processing algorithms. Numeric, the predecessor to NumPy, was designed by Jim Hugunin. Numarray, a new package with more functionality, was also built. In 2005, Travis Oliphant created the NumPy package by merging the Numarray and Numeric packages. A significant number of people have contributed to this open-source project.

**6.1.2 Operations using NumPy**

Using NumPy, a developer can perform the following operations:

* Mathematical and logical operations on arrays.
* Fourier transforms and routines for shape manipulation.
* Operations related to linear algebra. NumPy has in-built functions for linear algebra and random number generation.

**6.1.3 NumPy – A Replacement for MatLab**

NumPy is frequently used in conjunction with SciPy (Scientific Python) and Matplotlib (plotting library). This combo is frequently used as a substitute for MatLab, a popular technical computing platform. The Python counterpart to MatLab, on the other hand, is currently regarded as a more contemporary and comprehensive programming language.

NumPy has the extra benefit of being open source.

The NumPy module is not included in the standard Python distribution. Installing NumPy with the common Python package installer is a lightweight approach.

The best way to activate NumPy is to use an installable binary package customized to your operating system. These binaries contain the entire SciPy stack (inclusive of NumPy, SciPy, matplotlib, IPython, SymPy and nose packages along with core Python).

**6.1.4 OpenCv**

It focuses primarily on image processing, video recording, and analysis, including capabilities such as face detection and object detection. Let's begin by defining the phrase "Computer Vision" in this chapter.

**6.1.5 Computer Vision**

Computer vision is a discipline that describes how to rebuild, interrupt, and comprehend a 3D scene from its 2D pictures in terms of the structure inherent in the scene. It is concerned with utilising computer software and technology to mimic and replicate human vision.

Computer Vision overlaps significantly with the following fields:

* Image Processing: It focuses on image manipulation.
* Pattern Recognition: It explains various techniques to classify patterns.
* Photogrammetry: It is concerned with obtaining accurate measurements from images.

**6.1.6 Features of OpenCV Library**

Using OpenCV library

* Read and write images
* Capture and save videos
* Process images (filter, transform)
* Perform feature detection
* Detect specific objects such as faces, eyes, cars, in the videos or images.
* Analyze the video, i.e., estimate the motion in it, subtract the background, and track objects in it.

**6.2 Image Processing**

Image processing is a technique for converting an image to digital form and then performing operations on it to create a better image or extract relevant information. It's a signal distribution method in which the input is an image, such as a video frame or a photograph, and the output is an image or image-related features. Typically, an Image Processing system treats pictures as two-dimensional signals that are subjected to pre-determined signal processing algorithms. It is one of today's fastest-growing technologies, with applications in a variety of industries. Image processing is a major research topic in both engineering and computer science.

**Image processing basically includes the following three steps:**

* Importing the image via image acquisition tools.
* Analyzing and manipulating the image.
* Output in which result can be altered image or report that is based on image analysis.

***Low-level image processing algorithms include:***

* Edge detection
* Segmentation.
* Classiﬁcation.
* Feature detection and matching

**6.3 Feature Detection and Matching Modules:**

**6.3.1 Introduction:**

In the OpenCV laboratories in 2011, Ethan Rublee, Kurt Konolige, Vincent Rabaud, and Gary R. Bradski developed Oriented FAST and Rotated BRIEF (ORB) as an effective and viable alternative to SIFT and SURF. ORB was invented since SIFT and SURF are patented algorithms.

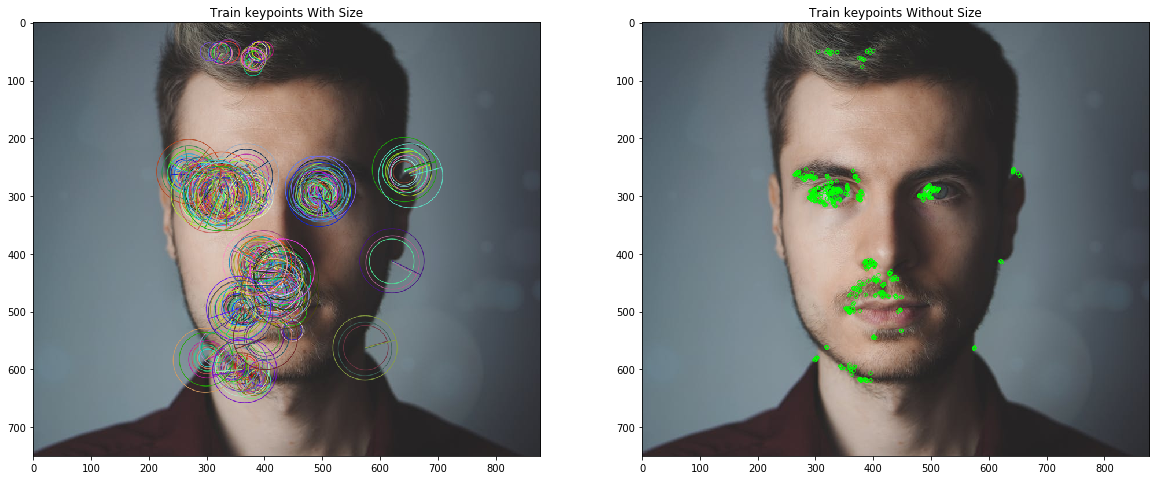


Figure 6.3.1.1 Figure train key points with Size

Figure 6.3.1.2 Train key points without size

In terms of feature detection, ORB surpasses SIFT (and SURF) despite being almost two orders of magnitude faster. The ORB descriptor is based on the well-known FAST keypoint detector. Both of these methods are appealing due to their high efficiency and low cost. The following are ORB's major contributions:

• The efficient calculation of oriented BRIEF features

• The inclusion of a quick and accurate orientation component to FAST

• A learning technique for decorrelating BRIEF features under rotational invariance, leading to higher performance in nearest-neighbor applications

• Analysis of variance and correlation of oriented BRIEF features

**6.3.2 ORB:**

ORB is a BRIEF-described modified FAST key point detector. It uses FAST to discover the most important points first. The Harris corner measure is then used to identify the top N points. The orientation is not computed by FAST since it is rotation variation. With the corner in the center, it calculates the patch's intensity weighted centroid. The direction of the vector from this corner point to the centroid determines the orientation. Moments are computed to improve rotation invariance. The descriptor BRIEF works poorly when there is an in-plane rotation. The patch's orientation is used to produce a rotation matrix in ORB, and the BRIEF descriptors are then directed appropriately.

**6.3.3 Fast (Features from Accelerated and Segments Test)**

For a given pixel p the fast algorithm compares the brightness of p to its surrounding 16 pixels. Those surrounding pixels are then sorted into three classes (pixels lighter than p, pixels darker than p and pixels similar to p). A pixel p is selected as a key point if it has more than 8 pixels darker or brighter than p in its surrounding. This Fast determines the edges in an image So keypoints found by fast gives us information of the location edges in an image.

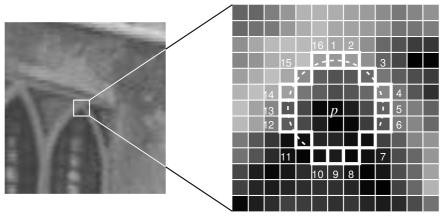


Figure 6.3.3.1 Features from Accelerated Segment

FAST characteristics, on the other hand, lack an orientation component and multiscale features. As a result, the orb method employs a multiscale image pyramid. An image pyramid is a multiscale depiction of a single image made up of a series of images, each of which is a different resolution version of the image. In the pyramid, each level has a down sampled version of the image from the previous level. Orb employs the quick method to detect key-points in the image after it has formed a pyramid. Orb effectively locates key points at a different scale by recognizing keypoints at each level. ORB is partial scale invariant in this way.

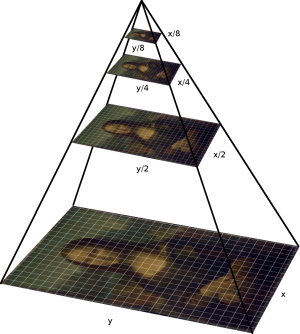
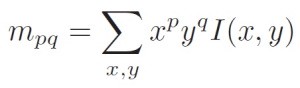


Figure 6.3.3.2 Example to ORB

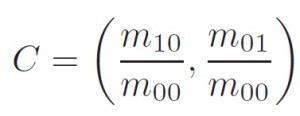
After locating keypoints, orb now assigns each keypoint an orientation, such as left or right facing, based on how the intensity levels fluctuate around that keypoint. Orb employs intensity centroid to detect intensity changes. The intensity centroid posits that the intensity of a corner is offset from its centre, thus it can be used to infer an orientation.

To begin, a patch's moments are defined as follows:



*ORB descriptor-Patch’s moment’s definition*

With these moments can find the centroid, the “center of mass” of the patch as:



*ORB descriptor — Center of the mass of the patch*

Here constructs a vector from the corner’s center O to the centroid -OC. The orientation of the patch is then given by:



*ORB descriptor — Orientation of the patch*

Here is an illustration to help explain the method:

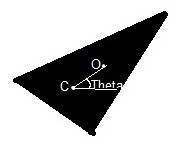


Figure 6.3.3.3 Binary descriptors

Once the patch's orientation has been determined, it can be rotated to a canonical rotation and the descriptor computed, resulting in rotation invariance.

**6.3.4 Brief (Binary robust independent elementary feature)**

Brief converts all of the keypoints obtained by the fast algorithm into a binary feature vector, which may then be used to represent an object. A binary feature vector, also known as a binary feature descriptor, is a feature vector that contains just the numbers 1 and 0. In a nutshell, each keypoint is represented by a feature vector, which is a 128–512 bit string.

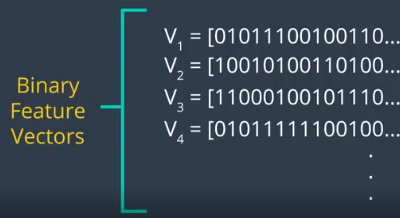


Figure 6.3.4.1 Binary features

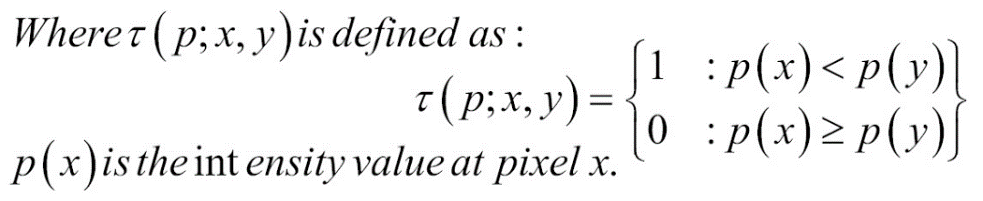
To prevent the descriptor from being susceptible to high-frequency noise, begin by smoothing the image with a Gaussian kernel. Then, in a defined neighborhood surrounding that keypoint, choose a random pair of pixels. A patch is a square of some pixel width and height that defines the defined neighborhood around a pixel. The first pixel in the random pair is selected from a Gaussian distribution with a stranded deviation or spread of sigma centered around the keypoint. The second pixel in the random pair is taken from a Gaussian distribution with a standard deviation or spread of sigma by two, centered around the first pixel. If the first pixel is brighter than the second, it assimilates the information.



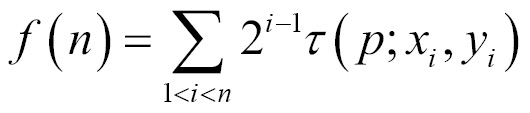
Figure 6.3.4.2 smoothed image patch

Select a random pair and assign the value to them once more. For a keypoint in a 128-bit vector, repeat this operation 128 times. For each keypoint in an image, build a vector similar to this. BRIEF is not invariant to rotation, thus orb uses rBRIEF instead (Rotation-aware BRIEF). ORB seeks to incorporate these capability while maintaining BRIEF's speed.

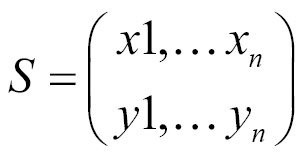
Consider an image patch that has been smoothed, p. A binary test is defined as follows:



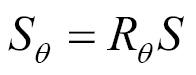
where p(x) is the intensity of p at a point x. The feature is defined as a vector of n binary tests:



For in-plane rotations of more than a few degrees, BRIEF's matching performance plummets. ORB presents a method for steering BRIEF based on the keypoints' orientation. The 2 x n matrix is required for any feature set of n binary tests at point (xi, yi):



It uses the patch orientation θ and the corresponding rotation matrix Rθ, and construct a steered version Sθ of S:



Now, the steered BRIEF operator becomes:



The angle is then discretized into 2/30 (12 degree) increments, and a lookup table of precomputed BRIEF patterns is created. The right collection of points S will be used to compute its descriptor as long as the keypoint orientation is consistent across views.

The rBRIEF algorithm is defined as follows by ORB:

1) Compare each test to all of the training patches.

2) Form the vector T by ordering the tests by their distance from a mean of 0.5.

3) Greedy hunt:

• Remove the first test from T and place it in the result vector R.

• Compare the results of the next test in T to the results of all tests in R. If the absolute correlation is larger than a threshold, it is discarded; otherwise, it is added to R.

• Carry on with the previous step.

**CHAPTER 7**

**FEATURE DETECTION**

**7.1 CODE**

import cv2

import numpy as np

#Getting the Image ready for feature detection

input\_image = cv2.imread('Phishing.jpg')

input\_image = cv2.resize(input\_image, (400,550),interpolation=cv2.INTER\_AREA)

gray\_image = cv2.cvtColor(input\_image, cv2.COLOR\_BGR2GRAY)

# Initiate ORB object

orb = cv2.ORB\_create(nfeatures=1000)

# find the keypoints with ORB

keypoints, descriptors = orb.detectAndCompute(gray\_image, None)

# draw only the location of the keypoints without size or

final\_keypoints = cv2.drawKeypoints(gray\_image, keypoints,input\_image,(0,255,0))

cv2.imshow('ORB keypoints', final\_keypoints)

cv2.waitKey()

**7.2 OUTPUT:**

**Diagram

Description automatically generated** **A picture containing text

Description automatically generated**

**CHAPTER 8**

**FEATURE MATCHING**

**8.1 CODE**

import cv2

import numpy as np

#Initilizing the ORB Feature Detector

MIN\_MATCHES = 20

detector = cv2.ORB\_create(nfeatures=5000)

#Preparing the FLANN Based matcher

index\_params = dict(algorithm = 1, trees=3)

search\_params = dict(checks=100)

flann = cv2.FlannBasedMatcher(index\_params,search\_params)

#Function for Loading input image and Keypoints

def load\_input():

input\_image = cv2.imread('piston-mech.jpg')

input\_image = cv2.resize(input\_image, (400,550),interpolation=cv2.INTER\_AREA)

gray\_image = cv2.cvtColor(input\_image, cv2.COLOR\_BGR2GRAY)

# find the keypoints with ORB

keypoints, descriptors = detector.detectAndCompute(gray\_image, None)

return gray\_image,keypoints, descriptors

if \_\_name\_\_=='\_\_main\_\_':

#Getting Information form the Input image

input\_image, input\_keypoints, input\_descriptors = load\_input()

#Getting camera ready

cap = cv2.VideoCapture(0)

ret, frame = cap.read()

while(ret):

ret, frame = cap.read()

#Condition Check for error escaping

if(len(input\_keypoints)<MIN\_MATCHES):

continue

#Resizing input image for fast computation

frame = cv2.resize(frame, (700,600))

frame\_bw = cv2.cvtColor(frame, cv2.COLOR\_BGR2GRAY)

output\_keypoints,output\_descriptors= detector.detectAndCompute(frame\_bw, None)

matches = compute\_matches(input\_descriptors, output\_descriptors)

if(matches!=None):

output\_final = cv2.drawMatchesKnn(input\_image,input\_keypoints,frame,output\_keypoints,matches,None,flags=cv2.DrawMatchesFlags\_NOT\_DRAW\_SINGLE\_POINTS)

cv2.imshow('Final Output', output\_final)

else:

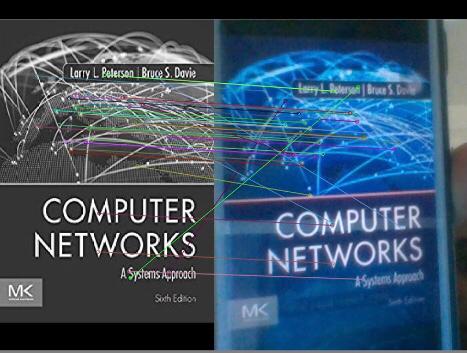
cv2.imshow('Final Output', frame)

key = cv2.waitKey(5)

if(key==27):

break

**8.2 OUTPUT:**

****

**Diagram

Description automatically generated**

**A screenshot of a computer screen

Description automatically generated with medium confidence**

**A screenshot of a computer

Description automatically generated with medium confidence**