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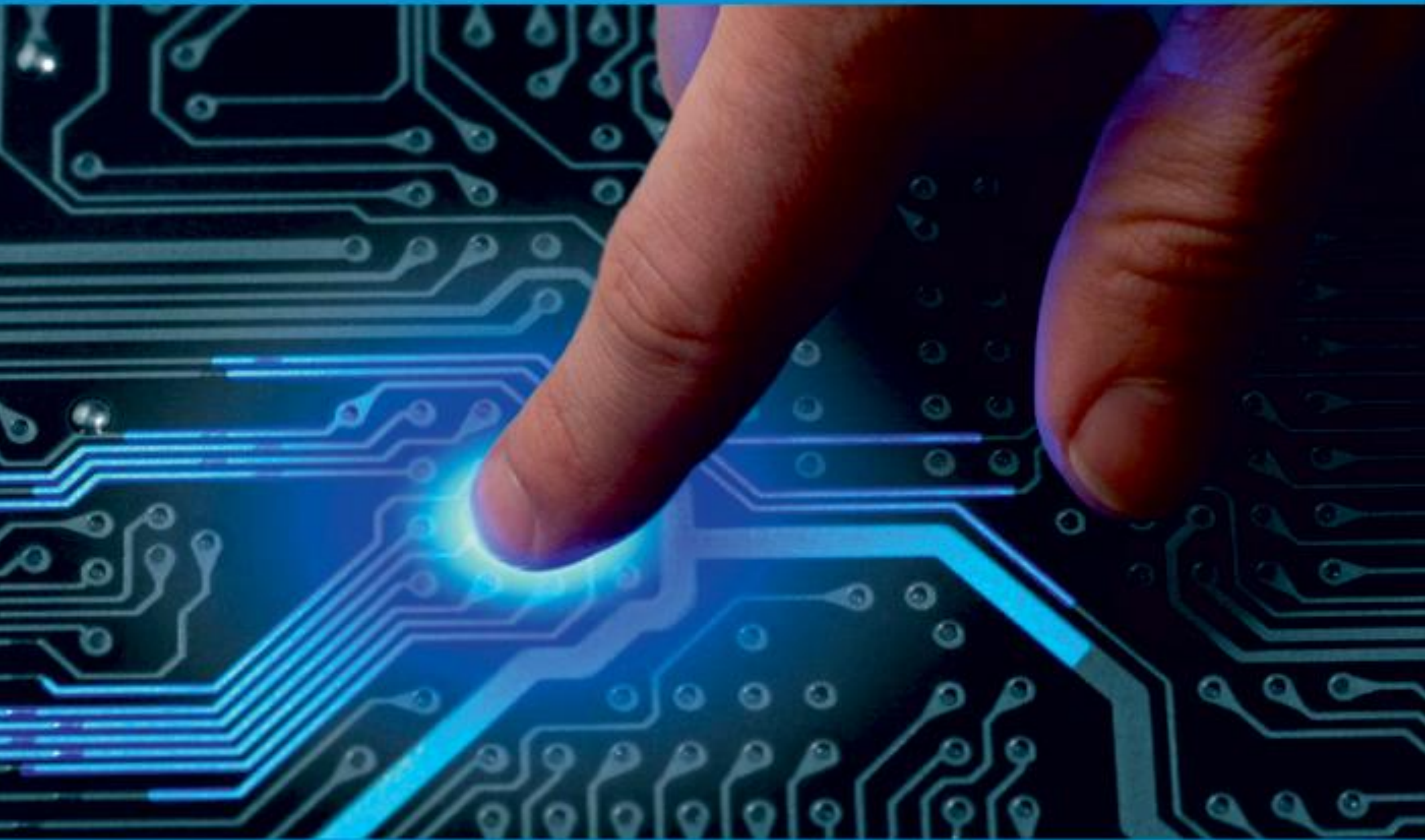

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Nav Cap: Visual Narratives for the Visually Impaired

Biju Balakrishnan[1], Gaurav Patil[2], Rohan Salvi[3], Prathamesh Shahapure[4], Rajendra Undire[5]

Professor, Department of Electronics & Telecommunication Engineering, SIES Graduate School of Technology, Maharashtra, India[1]

Undergraduate, Department of Electronics & Telecommunication Engineering, SIES Graduate School of Technology, Maharashtra, India[2-5]

ABSTRACT: Nav Cap presents an innovative system to deliver real-time visual descriptions for visually impaired individuals. Existing systems for assisting visually impaired individuals encompass various approaches, including camera detection, Optical Character Recognition technology, and machine vision techniques. However, limitations such as indoor functionality, reliance on external processing devices, and challenges in object recognition persist. Our project addresses these limitations by integrating a webcam into a regular cap, connected to a Raspberry Pi. The captured images are processed using Microsoft Application Programming interface (API) for recognition and stored in DynamoDB. Through Alexa integration, real-time scene descriptions are provided audibly, enhancing accessibility and independence for visually impaired users by overcoming the mobility constraints of existing systems.

KEYWORDS: Nav Cap, Visually Impaired, Amazon Web Services, DynamoDB, Amazon Lambda, Object Detection, Alexa Integration, Real-Time Feedback.

I. INTRODUCTION

The importance of aiding visually impaired individuals in understanding their surroundings cannot be overstated. With millions worldwide encountering daily hurdles in navigating an often-inaccessible world, the creation of innovative solutions like Nav Cap has become essential. This project seeks to narrow the divide between the visual realm and those with impaired perception, delivering immediate auditory descriptions to empower visually impaired individuals in their daily activities. Embedded within the backdrop of this endeavor is the harsh reality faced by visually impaired individuals, who frequently encounter obstacles in accessing vital visual information necessary for navigation and engagement. Despite advancements in technology, the absence of practical solutions tailored to their requirements persists as a significant challenge. Nav cap emerges as a promising remedy, inspired by the urgent necessity to enhance accessibility and inclusivity within the visually impaired community. The objective of this initiative is twofold: to confront the inherent challenges faced by visually impaired individuals in comprehending their surroundings, and to exploit technology's potential in bridging this accessibility gap. Through the utilization of cutting-edge technologies such as AWS Cloud, Alexa and Raspberry Pi, Nav Cap aims to furnish real-time auditory descriptions of scenes, delivering a transformative experience for visually impaired individuals. By adopting this innovative approach, the project endeavors to enrich the quality of life and foster inclusivity among individuals with visual impairments.

II. EASE OF USE

This review encompasses an examination of various studies published in both national and international research papers, as well as thesis. These works delve into understanding the objectives pursued, the types of algorithms employed, and the assortment of techniques utilized for pre-processing and data analysis within the context of aiding the visually impaired.

There are various object detection systems that can be used to help blind people become more aware of the objects and their surroundings. This system uses camera detection and OCR technology to assist visually impaired individuals in detecting and reading text, as well as providing information about their surroundings[1]. A Nav aid for visually challenged individuals in face detection and recognition. The device consists of a hat fitted with a webcam and a raspberry pi, which uses Open CV for image processing and predefined classifiers for face detection[2]. Additionally, an indoor navigation system has been proposed to assist the blind, where augmented reality markers have been used to

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mark specific locations in the home. This helps blind people when navigating inside the house [3]. The drawback for the system is that is efficient for indoor use only, and it is not useful for outdoor applications.The Nav Cap is a wearable visual guidance system for the blind that is designed to capture real-time video and store results in text format. It is built on a Raspberry Pi 3 module and is programmed with Python and the TensorFlow library. The system is powered by a NoIR camera and is capable of operating on a single Raspberry Pi 3 [4]. However, the system only recognizes products within the shop and lacks mobility due to the processing being done on a laptop or computer.A further system utilizes deep-learning and machine vision techniques, as well as a robot operating system (ROS), for a wearable device that consists of ultrasonic sensors connected to Nav glass and feeds the Raspberry Pi module to detect objects in the near future. The system is also equipped with a GSM feature for emergency calls [5]. This system has one downside - it uses a camera, so it's hard to tell apart objects based on their names. The iCap is a light weight and low-cost embedded system; an intelligent cap capable of detecting potholes, obstacles lying on the ground as well as hanging obstacles using a pair of ultrasonic sensors (HC-SR04) [6]. The Nav Assistive Cap for the Visually Impaired uses image processing, deep learning, artificial intelligence, and text-to-speech technology to narrate visual scenes and help visually impaired individuals better understand the world around them [7].The assistant uses voice recognition, natural language processing, and content extraction modules to provide a faster and more interactive solution than traditional assistive software [8]. The system consists of three main components: a Nav cap, an intelligent cane, and a mobile application. The Nav cap uses a camera and a deep learning object detection model to detect and classify surrounding objects [9]. This system aims to assist blind and visually impaired individuals in navigating their environment more safely and independently [10].In conclusion, the reviewed papers highlight advancements in assistive technologies for the visually impaired, utilizing methods like camera detection, OCR, and machine learning. The Nav Cap project integrates Raspberry Pi, Python, TensorFlow, and a NoIR camera but faces limitations in mobility and object recognition. To overcome these, the proposed system combines deep learning, machine vision, and cloud[AWS] for immediate response and enhanced navigation, promising improved independence and accessibility.

III. SYSTEM ARCHITECTURE

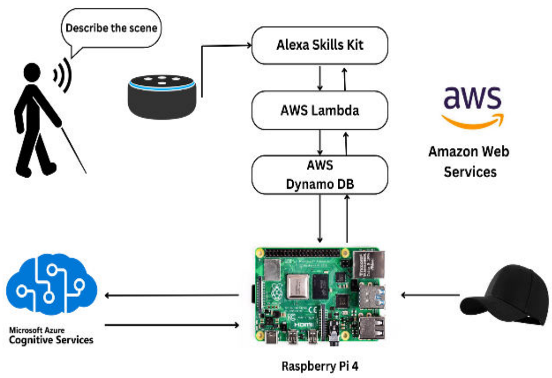

Fig. 1 Proposed system architecture

The system architecture encompasses several essential components, including the Amazon Echo, Raspberry Pi 4, and diverse online computer vision APIs. A conventional webcam, seamlessly integrated into a cap, establishes a connection with the Raspberry Pi 4. Within this setup, the system undertakes the task of capturing images, which are subsequently dispatched to Microsoft APIs for recognition purposes. The resulting responses find their repository in DynamoDB, a robust storage solution. When users solicit a scene description through Alexa, the orchestration of the system entails the Amazon Lambda function retrieving relevant data from DynamoDB. Subsequently, this data undergoes transformation into audible format, seamlessly delivered through the Alexa device. This comprehensive workflow delineates the proposed framework and operational sequence of the project, as depicted in Fig.1. This intricate architecture illustrates the seamless interaction between hardware and cloud-based services, culminating in an accessible and user-friendly system for visually impaired individuals.

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IV. IMPLEMENTATION AND RESULTS

In the Nav Cap project, the method implementation involves several key steps to ensure the seamless functionality of the system. Firstly, the hardware setup involves retrofitting a webcam and Raspberry Pi into a standard cap.

Fig. 2 Front and Side View of Cap

The set up of cap and camera can be seen in Fig.2 where a standard web cam is mounted on to a cap. After the initial setup and calibration of the camera and Raspberry Pi components, a crucial phase in the Nav Cap project involves establishing Amazon Web Services (AWS), which provides a robust and scalable cloud platform that supports essential components of the Nav Cap system. DynamoDB offers reliable data storage, while Lambda functions enable efficient event-driven computing, enhancing the functionality and effectiveness of the Nav Cap as an assistive technology solution for visually impaired individuals. Additionally, AWS services offer seamless integration with other components of the project, contributing to its overall reliability and performance.

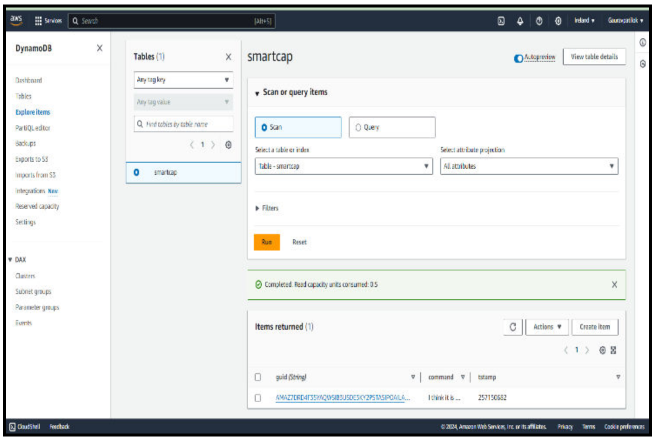

Fig. 3 AWS Dynamo Database Setup

In Fig.3, AWS DynamoDB emerges as a fundamental solution, recognized for its extensive storage capacity and advanced technological capabilities. Within the comprehensive framework of the Nav Cap initiative, DynamoDB plays a central and indispensable role, facilitating seamless storage and processing of data while ensuring the product's scalability.

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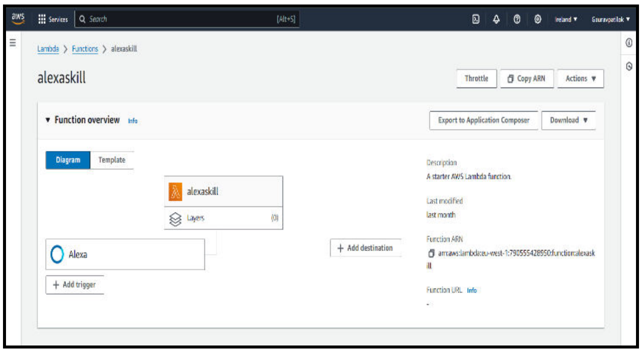

Fig. 4 AWS Lambda Function

Fig.4 shows functionality of the project, we have used Amazon Lambda as shown in, a serverless computing service by Amazon Web Services (AWS), revolutionizes traditional server management. Within the Nav Cap project, Lambda functions act as vital trigger points, responding dynamically to events such as changes in data. This event-driven approach enhances the functionality and effectiveness of Nav Cap as an assistive technology solution for visually impaired individuals.

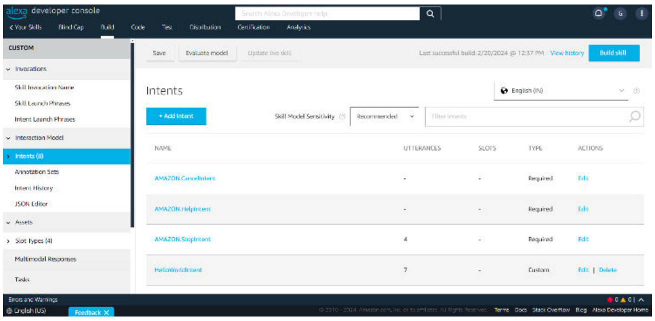

Fig. 5 Alexa Developer Console

The image illustrates setting up the Alexa which serves the output for the user we have used its developer console, which serves as an essential hub for the crafting the voice interaction to the Nav Cap. It allows users to design, build and test, define intents, utterances as shown in Fig.5. This platform is useful for developers as it streamlines the process of creating Alexa skills by providing intuitive tools and resources. It offers built-in templates and sample code to help developers get started quickly. Additionally, the console includes robust testing and debugging capabilities, allowing developers to iterate and refine their skills before publishing them to the Alexa Skills Store. Overall, the Alexa Developer Console empowers developers to build innovative voice experiences.

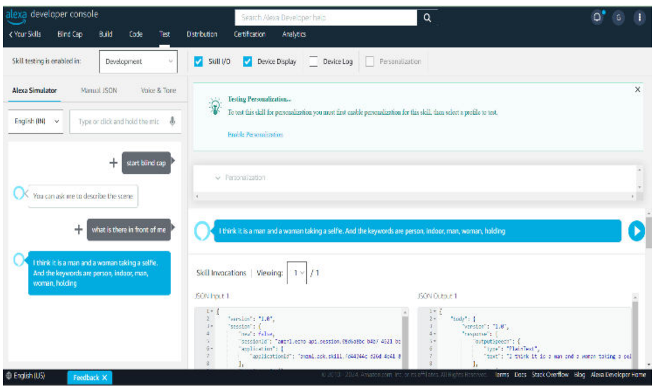

Fig.6 Testing Console

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Above Fig.6 involves manual testing of the product to ensure smooth running of the product. In console we can interact with out alexa custom skill so that we can get output from the cloud.

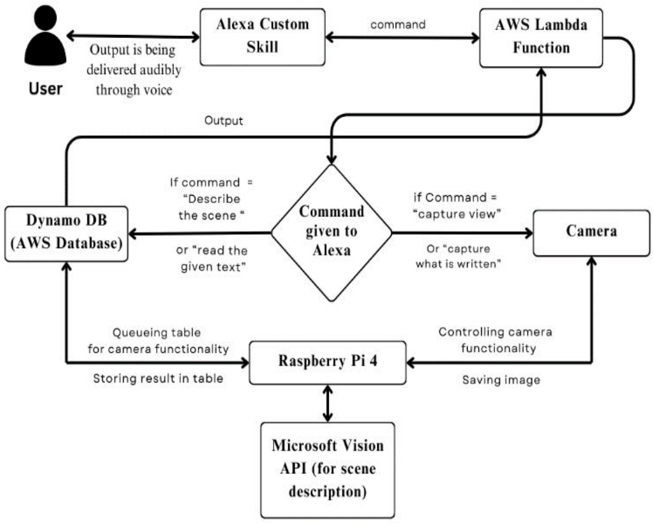

Fig.7 Flowchart of the Nav Cap

The flowchart depicted in Fig.7 illustrates the flowchart of the Nav cap. This system's functionality involves detecting objects in real-time, which is facilitated by utilizing a Raspberry Pi 4. Upon object detection, the image is securely transmitted to the Microsoft Vision API for analysis. Then analysis of the image is done using computer vision API and then the description of the images is sent back to the raspberry pi in text form with some additional words related to the image. This data is then saved into DynamoDB which is database where the images scene description is stored. When the user asks Alexa to describe the scene, the Alexa Skills Kit triggers Amazon Lambda function to fetch the data from the database. The correct text is played as audio on the Alexa device. Subsequently, this seamless integration enables visually impaired users to receive real-time auditory descriptions of their surroundings, enhancing their awareness and independence.

Fig.8 Prototype of Navcap

Fig.8 shows the prototype of the project comprises a cap with an embedded conventional webcam and Raspberry Pi 4. These components enable real-time image capture and processing. The webcam captures live scenes, which are then processed by the Raspberry Pi 4 for object recognition. Integration with online computer vision APIs facilitates scene analysis. The prototype demonstrates the feasibility of providing assistance to visually impaired individuals through real-time image processing and object recognition capabilities.

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V. FUTURE SCOPES

A. Integration of Natural Language Processing (NLP)
Incorporating NLP capabilities into the Nav Cap system can enable more natural and conversational interactions between users and the devices. This can provide improved comprehension of user commands and queries, as well as enable advanced language understanding for more contextually relevant responses.

B. Integration with Nav Home Devices
Integrating the Nav Cap system with other Nav home devices and platforms can expand its functionality and interoperability. This could include seamless connectivity with devices like Google Home or Apple kit, allowing users to control their Nav home devices using voice commands.

C. Interface with Public Transportation System
Implementing Nav cap with public transportation systems can enable the Nav Cap to provide real-time information and guidance for navigating public transit networks. By incorporating data such as bus and train schedules, station information.

D. Health monitoring and Emergency Response Feature
Introducing health monitoring and emergency response features into the Nav Cap can enhance users' safety and well-being. This may include features like fall detection, vital sign monitoring and automated emergency assistance in case of emergencies.

E. Personalization and User Preferences
Enabling personalized settings and user preferences into the system can cater to individual user needs and preferences. This may include customizable voice commands, preferred language settings and tailored audio descriptions based on user feedback.

V. CONCLUSION

The Nav Cap project represents a significant milestone in the realm of assistive technology for visually impaired individuals. By harnessing the power of advanced technologies such as AWS Cloud, Alexa, and Raspberry Pi, the system offers real-time visual descriptions of surroundings, thus enhancing accessibility and inclusivity. Through comprehensive testing, the effectiveness of Nav Cap in delivering accurate scene descriptions has been affirmed, showcasing its potential to significantly improve the quality of life for individuals with visual impairments. Furthermore, Nav Cap's seamless integration of various components underscores its versatility and adaptability in addressing the diverse needs of users. By providing a reliable and intuitive solution, the project underscores the importance of innovation in promoting accessibility and independence for individuals with disabilities. Looking ahead, continued research and development in this field holds promise for further advancements in assistive technology, ultimately contributing to a more inclusive and equitable society. Nav Cap stands as a testament to the transformative impact of technology in empowering individuals with visual impairments and paving the way towards a more accessible future.

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