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**2. Title of the project**: VINETRA PARIJANA – "SMART CANE AND SMART GLASS FOR VISUALLY IMPAIRED PEOPLE"

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**6. Introduction**

Vision is the beautiful gift that God has given to all living creatures. The human visual system plays an important role in recognizing information regarding surroundings. Since visual signal provides more data than auditory information, visual signals are more effective than auditory signals when the human being perceives information. People with visual impairments are the people who find it hard to recognize the smallest element with healthy eyes. The issues with visual impairment lie in the difficulties in self-navigation in unfamiliar outdoor environments. Use of the traditional cane, guide dogs, and mobility training are included in expertise and supports considered by professionals working in the field of orientation and mobility to help visionless people.

Typically, users tap the cane from left to right and as far ahead as the cane's length. The tapping technique helps users to recognize the ground surface in the user's environment. However, the problem with the standard white cane is that it has a limited detection range of obstacles at only a distance equal to the cane's length. Thus, this restricts the users' walking speed and leads the users to assess approaching obstacles outside of the range unconfidently. Outdoors could also be dangerous places for individuals with visual impairment.

This is because visually impaired people tend to expose to water puddles or wet walkways. Water puddles may cause visually impaired people to slip and fall. Further, they can get head or below-knee-level injuries when they slip and fall. It could be worse if other objects such as a rock in the water puddle obstruct their way.

This study provides another piece of work and future research direction by providing an alternative solution in the smart cane body of knowledge and development. The proposed smart cane integrates three devices: obstacle detection, water detection, and a GPS module to monitor the visually impaired location. Furthermore, this study contributes to improving the protection and safety of its user while navigating an outdoor and unfamiliar area. For a visually impaired person to recognize a subject around him depends on the subject to speak something. visually impaired people depend mostly on the auditory sense in recognizing information. Hence, visually impaired people are sensitive in the auditory sense and do not want to undergo disturbance in listening.

To solve this problem and constraints, we propose a system for face recognition embedded in a smart cane for visually impaired people. This system detects and recognizes the face of a human and then informs a visually impaired person of information about the person who is standing in front of himself/herself.

Research work in the domain of image processing is evolving rapidly; specifically in the banking sector. Along with the evolving technologies and the growth of the banking sector; the requirement to precisely and efficiently detect currency and its denomination is also growing in parallel. So, the necessity of a robust and efficient currency recognition system in applications like Cash Machines (ATMs), different vending machines, beverage and food dispensers, and being a helping hand for the visually impaired or visually impaired is at its apex.

Therefore, to help the visually disabled; we study different algorithms which can be implemented in a system for the detection of Indian currency using image processing. Generally, currency recognition is done using a camera or any image and the result is displayed on the screen, and also an audio output can be provided. One of the difficulties for people with visual impairment is the inability to identify paper currencies due to the approximation of paper texture and size between the different types of currencies.

The Reserve Bank is the only one which has the sole authority to issue bank notes in India. Reserve Bank, like other central banks the world over, changes the design of banknotes from time to time. Traditionally, anti-counterfeiting measures involved including fine detail with raised intaglio printing on bills which allows non-experts to easily spot forgeries. On coins, milled or marked with parallel grooves edges are used to show that none of the valuable metal has been scraped off. Reserve bank uses several techniques to detect fake currency.

One of the technologies to consider is objected acknowledgment innovation, later known as object detection. This term denotes a capacity to identify the shape and size of diverse objects, and the device's camera catches their position. The practice of detecting real-world object instances in still photos or videos, such as a car, bike, Television, flowers, and humans, is known as object detection. It lets us recognize, localize, and detect many things inside an image, giving us a better overall understanding of the scene. Image retrieval, security, surveillance, and sophisticated driver assistance systems are all examples of areas where it's applied. The main motto for object detection is to find things, drawing rectangular bounding box-like structures around them with distance. Object detection applications are emerging in numerous diverse areas of counting, recognizing people, checking crops, and real-time applications in sports.

This smart spectacle with micro camera setup proposed in this project is designed to support reading printable versions of any books, documents, or mobile texts by converting text to audio, which can be heard by microphones or speakers. This portable and economical smart spectacle is programmed with a raspberry pi module and the image processing technique helps in recognizing and extracting the text from the image Finally, the extracted text is converted into speech and can be heard by visually impaired and visually impaired people. The final hardware model is tested with two test samples, the first one is with a book page and another one is a mobile document. The designed smart glass converted both test samples into the right audio format. This project is very affordable to all categories of people and will be more useful.

## 7. Objectives

- Assistive technology to detect solid obstacles.
- Detect staircases and water bodies.
- Remote access by a family member using GPS.
- Image to speech for visionless people to hear the content of the newspaper, books, and magazines.
- Recognition of Indian currency with fake currency detection.
- Recognition of various day to day objects.
- Recognize their family members and friends.
- Sharing location to family member when a blind person falls.

## 8. Methodology

Smart Cane Module Smart cane is an innovative blind stick that is designed for visually impaired people for improved navigation. We here propose an advanced smart cane that allows visually challenged people to navigate with ease using advanced technology. The smart cane is embedded with light and water sensors along with an ultrasonic sensor.

**Block Diagram of Smart Cane**

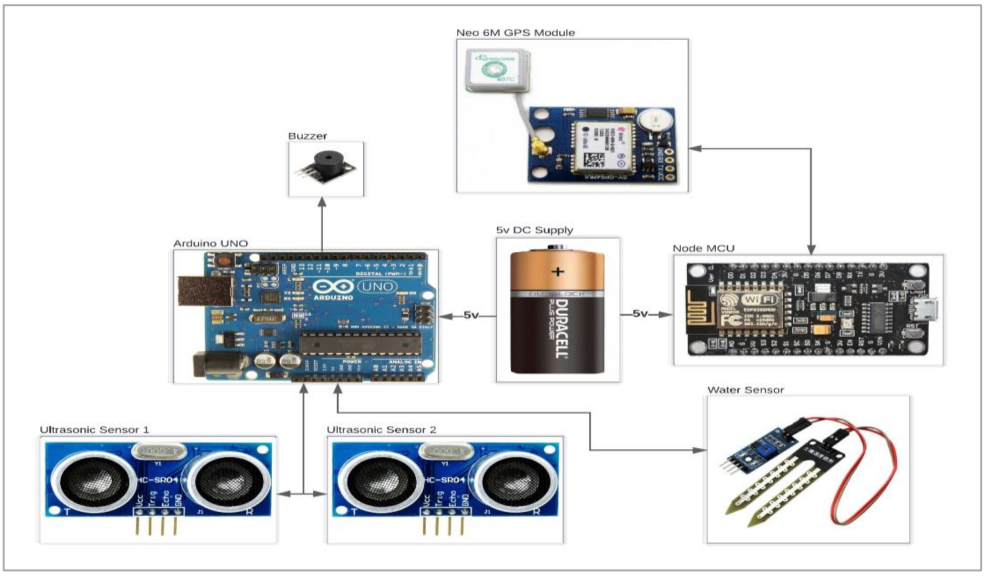


**Figure 1: Generalized Block Diagram of Smart Cane**

These Ultrasonic sensors use to detect obstacles ahead by using ultrasonic waves. The sensor passes this data to the microcontroller which processes this data and calculates if the obstacle is close enough. If the obstacle is close microcontroller sends a signal to sound a buzzer and if an obstacle is not that close then the circuit does nothing. It also detects water, and a sensor at the bottom of the stick integrates which sounds a different buzzer and alerts the blind.

**Working principle of Smart Cane**

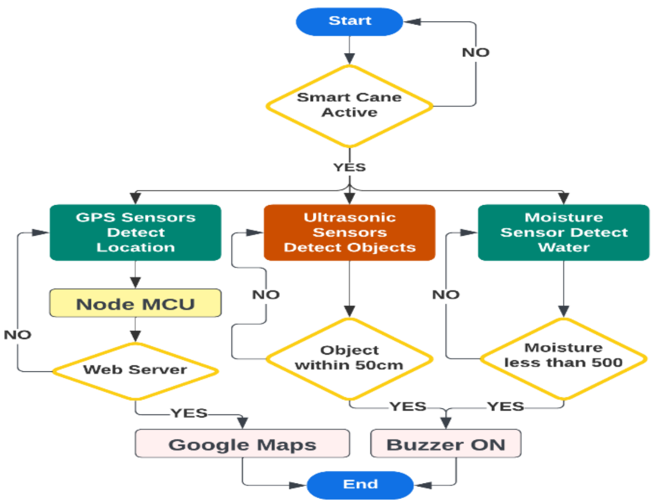


**Figure 2 : Flowchart of Smart Cane**

**Smart Glass Module**

Smart glass is an innovative design for visually disabled people for improved navigation. We here propose an advanced blind spectacle that allows visually challenged people to navigate with ease using advanced technology. This project is designed with MEMS and Respiratory and Temperature sensor which helps to monitor the person when he falls; the location of the user can be tracked and sent as a message to the relatives. We also have functions like object recognition, face recognition, character recognition, and finding the currency.

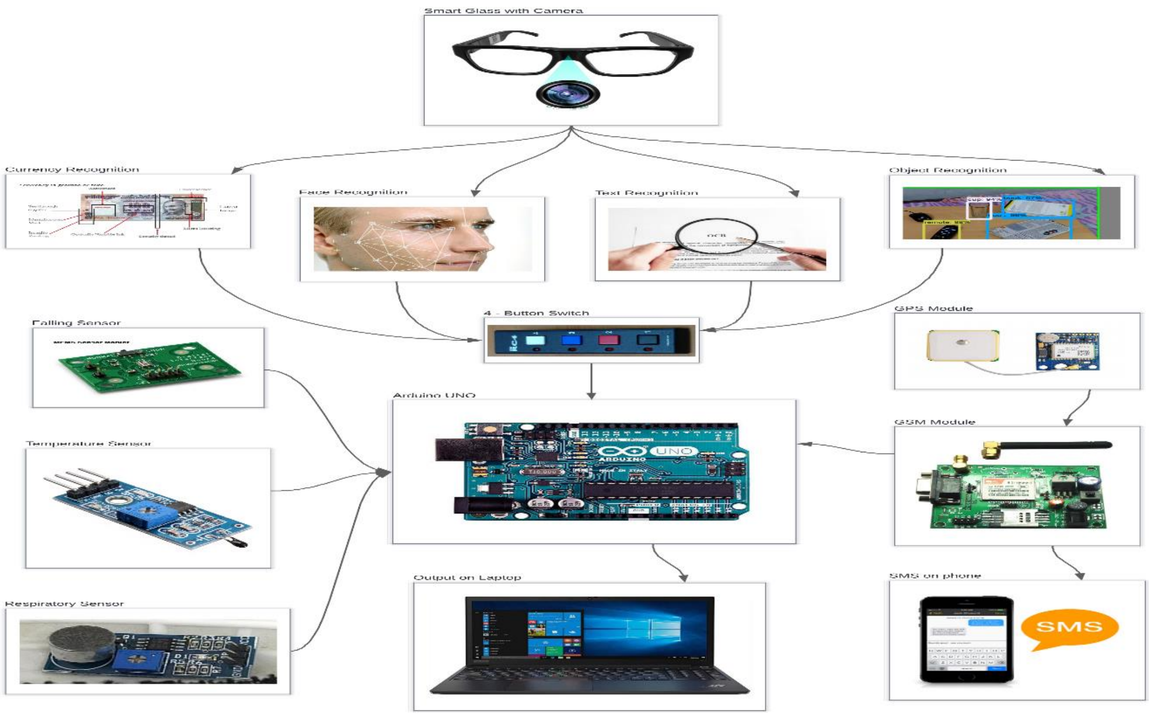


**Figure 5.3 Generalized Block Diagram of Smart Glass**

The advanced blind spectacle is an innovative design aimed at improving navigation for visually impaired individuals. The combination of MEMS (Micro-Electro-Mechanical Systems) technology, respiratory and temperature sensors, and various recognition functionalities adds significant value to the device. Let's delve into each component and its features:

➢ **MEMS Technology:** MEMS refers to the integration of mechanical elements, sensors, actuators, and electronics on a single microchip. In the context of smart glasses, MEMS technology can provide features like:

- Fall detection: The MEMS sensor can detect sudden changes in orientation or acceleration, allowing the device to identify when a person has fallen. This information can be crucial for timely assistance and notifying caregivers or relatives.
- Motion detection: MEMS sensors can detect movements, helping the device understand the user's gestures and facilitate navigation. For example, a user can tilt their head in a specific direction to control the navigation or zooming functionality of the smart glasses.

➢ **Respiratory and Temperature Sensors:** The integration of respiratory and temperature sensors adds health monitoring capabilities to smart glasses. These sensors can provide valuable information about the user's well-being, allowing for early detection of health issues. Features include:

- **Respiratory monitoring:** The respiratory sensor can measure the user's breathing rate and pattern. Any irregularities or abnormalities can be detected, and appropriate alerts can be sent to the user or their caregivers.
- **Temperature monitoring:** The temperature sensor can measure the user's body temperature. Unusual fluctuations or abnormal temperatures can be identified, enabling timely intervention and medical assistance.

➢ **Recognition Functionalities:** The advanced blind spectacle incorporates several recognition capabilities to enhance the user's navigation and interaction experience. These functionalities include:

- **Object Recognition:** By leveraging computer vision techniques and machine learning algorithms, the device can identify and classify objects in the user's surroundings. This information can be conveyed to the user audibly or through haptic feedback, aiding their spatial awareness and obstacle detection.
- **Face Recognition:** Smart glasses can employ face recognition algorithms to identify people the user knows or has stored in their device's database. This feature helps the user recognize familiar faces and can be useful in social situations.
- **Character Recognition:** With optical character recognition (OCR) technology, smart glasses can read and convert text into audio, allowing visually impaired users to access written information. This feature assists with tasks such as reading signs, labels, or documents.
- **Currency Recognition:** The device can recognize different currency denominations using image processing and machine learning techniques. This functionality assists visually impaired users in identifying and distinguishing between various banknotes.

➢ **Location Tracking and Messaging:** The smart glasses incorporate GPS technology to track the user's location. This information can be periodically sent as a message to predefined contacts or caregivers. In case of emergencies or when the fall detection feature is triggered, the device can automatically send an alert message with the user's location to ensure prompt assistance.

Overall, the advanced blind spectacle combines MEMS technology, respiratory and temperature sensors, recognition functionalities, and location tracking to provide visually impaired individuals with improved navigation, health monitoring, and increased independence. It has the potential to enhance their overall quality of life and facilitate their integration into society.

**Working Principle of Smart Glasses**

The advanced blind spectacle is an innovative device specifically designed to assist visually impaired individuals in navigating their surroundings more effectively. By incorporating various technologies and functionalities, it aims to enhance their mobility, safety, and independence.

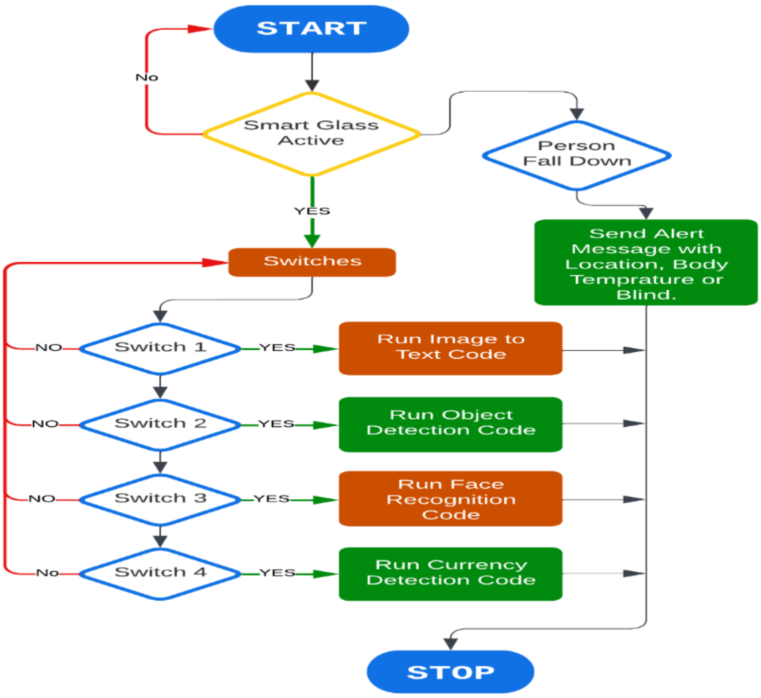


**Figure 3: Flowchart of Smart Glass**

### Obstacle Detection

Interfacing the program with infrasonic sensors, whenever the person wearing the smart glasses will encounter an obstacle within a specified range then the infrasonic sensor will immediately inform the person about the obstacle and the distance between the person and the obstacle to avoid collision. The information will be given through an audio output and for this, an earphone jack is also provided to connect to the audio.

### Text-to-speech output

As discussed earlier the facial recognition of a known or known person in front of the camera. The output of the facial recognition will be a text-to-speech output i.e., when a known person is detected by the camera then the name of the known person which is in text format will be converted into speech and the output will be heard in audio format through the earphone jack available. Similarly, for an unknown person the text will be converted into speech and the audio of a known person will be heard through the earphone jack.

### Facial Recognition

If any known person comes in front of the Pi camera whose image is already in our database, then the device sends the information to the Raspberry Pi that the known person is detected along with its name which we have stored in our database. And if any unknown person comes in front of the Pi camera whose image is not stored in our database, then an alert voice message goes to the Pi and the wearer hears a voice message i.e. unknown person detected. The Output of both cases goes to Raspberry Pi 3 and as per the coding certain decision will be taken and that output comes in terms of voice message.

**Proposed System**

The proposed system consists of a glass-type camera, mobile computer, and cane that equip Microcontroller, Bluetooth module, and vibration motor, the glass-type camera is aligned to the direction of the user's view. The camera is connected to a mobile computer via a wireless network. The camera sends the frontal view to the mobile computer. The mobile computer detects and recognizes the faces of the person. The recognized result is sent to the microcontroller of the cane using Bluetooth communication. The result of face recognition is given in the form of a number. The cane consists of a microcontroller. Microcontroller generates a vibration pattern using a buzzer according to the result of face recognition.

**Currency recognition systems based on image processing are as follows**

- Image Acquisition
- Pre-processing
- Edge Detection
- Image Segmentation
- Feature Extraction
- Comparison

Finally, the output is displayed as a pop-up or can also be given as an audio output for the visually impaired. Currency recognition always depends on the characteristics of the note belonging to a certain country and the process of extracting different properties or features of currency notes directly affects the ability of currency recognition. Various algorithms based on image processing are been proposed over time to extract the features. These features consist of a Security thread, Length/color of the note, RBI logo, identification mark, and other security features. Feature extraction plays the main role in the recognition of currency notes. Hence, different algorithms are used for feature extraction.

**Algorithm – ORB**

ORB Algorithm is to get the features of images because it may be a no-time algorithm regarding the time. In addition, ORB is strong and efficient for getting binary descriptors. It depends on the Oriented Fast and Rotated Brief Algorithm. The proposed application is implemented using the libraries of OpenCV run on the Android platform. OpenCV libraries are having high speed in displaying results.

**Algorithm:**

**Step 1: Pre-processing**

In this step, image processing operations are performed to arrange the currency image for the segmentation process.

**Step 2: Segmentation**

In this step, convert the currency image into a binary image that consists of two colors black and white.

**Step 3: ROI Extracting**

To extract the currency from the image, the two-pass connected component Algorithm is employed.

**Step 4: Feature Extraction**

In this step, the (ORB) Algorithm is employed to perform the subsequent operations for the best performance:

- ➢ A quick algorithm is employed to detect corners and interesting points in a currency Image.
- ➢ Harris corner detector is employed to assign a score for each interest point supported by the variation of intensities around the corner point.
- ➢ Compute the vector direction and also assign it because of the interest point orientation using the interesting point and centroid.

**Step 5: ORB Description**

After getting those interesting points of the image within the detector stage, we'd like to extract the feature description for these interest points. For this purpose, a quick algorithm is employed to make the feature descriptors with relation to a neighborhood shape sort of a rectangle or circle.

**Step 6: Matching**

In this matching phase, the best number of matches with the database informs that it matches the currency. And also provides audio messages for blind people.

**For Fake currency detection**

The best anti-counterfeit device we can buy for the money is an Ultraviolet counterfeit detection scanner. Best used in highly lit point-of-sale locations, the UV detector identifies the ultraviolet security features present in most currencies. By simply placing the bill in the detector, counterfeit currency is immediately identified, without the need for an employee to closely examine the bill.

**Blind Safety System**

This system sends a message to a guardian with body temperature, respiratory level, and location coordinates when a person falls.

➢ **Hardware setup:** Connect the falling sensor, temperature sensor, respiratory sensor, GPS module, and GSM module to the Arduino board as described in the previous response.

➢ **Arduino programming:** Write the Arduino code to read data from each sensor and send a message to the parent. Here's a high-level example of how the code can be structured:

- Initialize the necessary libraries for each sensor and the GSM module.

- Set up the pins and communication interfaces for each sensor and the GSM module.
- Continuously read data from the sensors and store the values in variables.
- Retrieve the GPS coordinates from the GPS module.
- Format the message with the body temperature, respiratory level, and GPS coordinates.
- Use the GSM module to send the message to the parent's phone number.

➢ **Sending the message:** When a certain event occurs (e.g., fall detected, specific temperature threshold exceeded), trigger the Arduino code to send the message to the parent. You can use conditionals or specific triggers based on the falling sensor or temperature sensor readings.

➢ **Receiving the message:** The parent will receive the message containing the body temperature, respiratory level, and location coordinates on their phone. They can take appropriate action based on the information received.

**9. Results**

**Figure 6.1 Smart Cane**

The smart stick is developed for visually impaired people and combined with various sensors and a GPS module to assist users in navigating their surroundings safely. Here is a brief description of the different components and their functionalities:

The smart stick is equipped with two ultrasonic sensors. These sensors emit high-frequency sound waves and measure the time it takes for the waves to bounce back after hitting an object. By analyzing the time taken, the sensors can estimate the distance to nearby obstacles. When an obstacle is detected within a certain range, the sensors trigger a buzzer to provide an audible alert to the user, indicating the presence of the obstacle.

The GPS module integrated into the smart stick enables tracking and location-based services. It receives signals from satellites to determine the user's precise geographical coordinates. The GPS module periodically sends the user's location information to a family member or caregiver, allowing them to monitor the user's whereabouts and provide assistance if needed.

The smart stick incorporates a water sensor at the bottom. This sensor is designed to detect water immersion. If the tip of the smart stick comes into contact with water, the water sensor detects the change and triggers the buzzer to emit a beeping sound. This feature alerts the user to the presence of water, helping them avoid potential hazards like puddles or bodies of water.

**Figure 6.2 Blind Person Using Smart Cane**

Overall, This smart stick provides valuable assistance to visually impaired individuals by detecting obstacles through ultrasonic sensors, ensuring their safety near water sources with the water sensor, and enabling location tracking through the GPS module.

This combination of features enhances the user's mobility, reduces the risk of accidents, and allows for better support and monitoring from family members or caregivers.

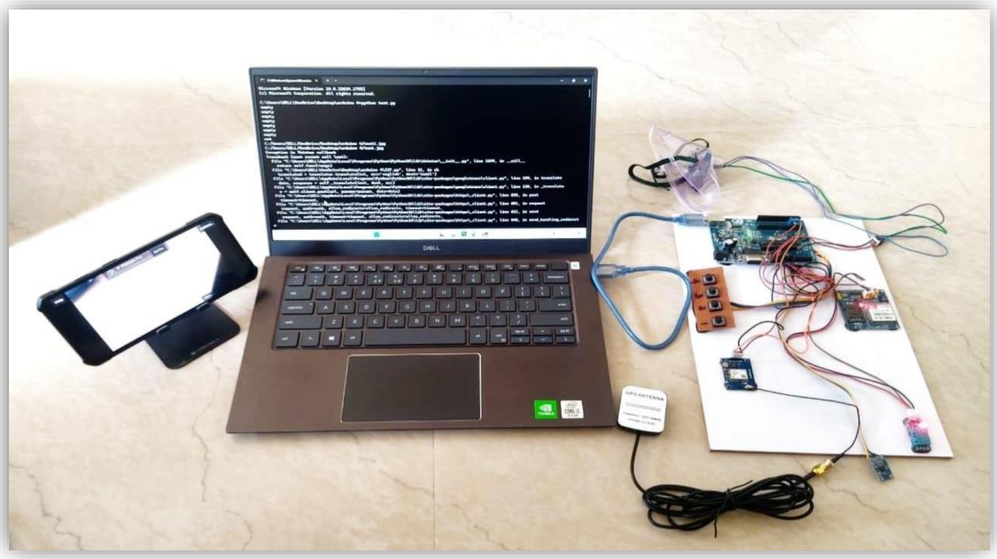

**Figure 6.3 Smart Glass Technology**

The smart glass for visually impaired people is an impressive project that integrates various technologies to provide enhanced functionality and support to the visually impaired. Here is a detailed description of the features and components.

## Object Recognition

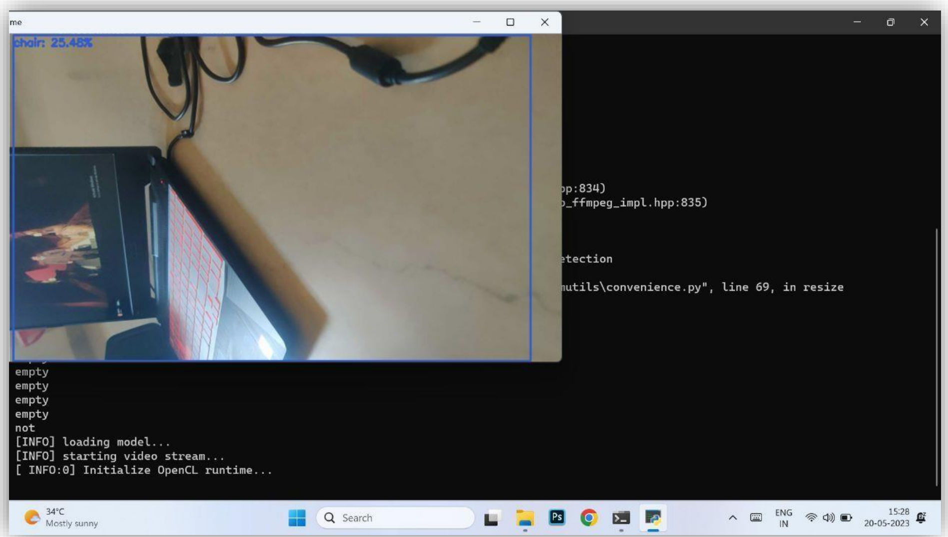


**Figure 6.4 Object Detection**

The smart glass utilizes a camera module attached to the motherboard to capture imagesof the user's surroundings. With the help of computer vision algorithms and machine learning techniques, the system can detect and recognize objects. This capability assists the visually impaired in identifying and interacting with their environment more effectively.

## Face Recognition

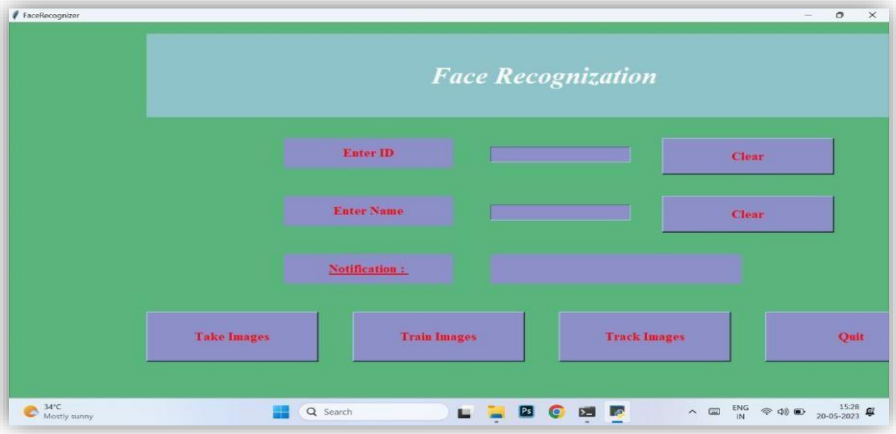


**Figure 6.5 Face Recognition**

Leveraging the camera module and advanced facial recognition algorithms, the smart glass can recognize and identify the faces of close ones and family friends. This feature helps visually impaired individuals in social situations by allowing them to recognize familiar faces and facilitate better interactions.

## Image-to-Speech Conversion

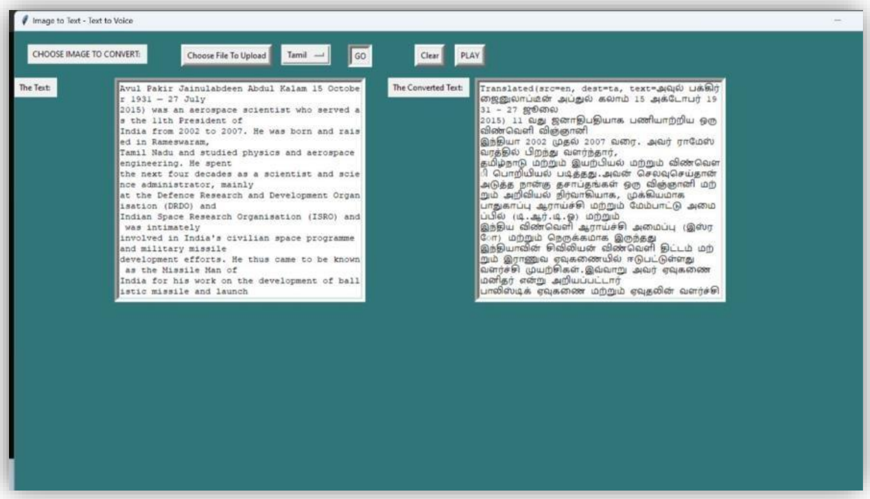


**Figure 6.6 Image-to-Speech Conversion**

The camera module captures text from newspapers, magazines, or other written materials, and the smart glass utilizes optical character recognition (OCR) technology to convert the text into digital format. The system then employs text-to-speech synthesis to read out the text to the user audibly. This functionality enables visually impaired individuals to access and comprehend written information more easily.

**Currency Recognition**

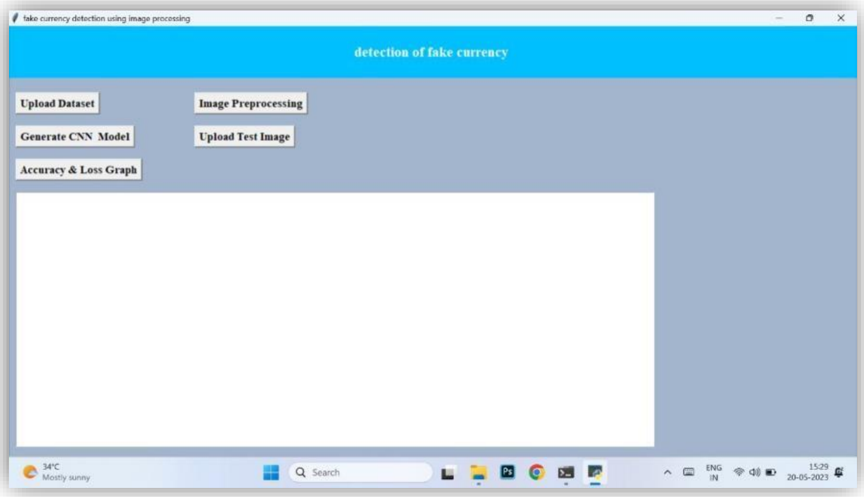


**Figure 6.7 Fake/Real Currency Detection**

The camera module, combined with image processing and machine learning algorithms, enables the smart glass to detect and differentiate between genuine and counterfeit currency notes. This feature provides an additional layer of security and assists visually impaired users in independently verifying the authenticity of banknotes.

**Blind Safety Monitoring System**

- **Fall Detection and Health Monitoring:** The smart glass incorporates a fall sensor (M.E.M. sensor) to detect when a person falls. Upon detecting a fall, the system activates the temperature sensor to measure the user's body temperature and the respiratory sensor to monitor respiratory levels. The collected data, along with the user's location obtained from the GPS module, is used to generate an alert message. The system then utilizes the GSM module to send the alert message, including the fall event, body temperature, respiratory levels, and location, to a designated guardian or family member via SMS.
- **GPS and GSM Modules:** The smart glass is equipped with a GPS module to obtain the user's precise location coordinates. This information is crucial for providing accurate location data in emergencies or when a fall is detected. The GSM module allows the smart glass to send SMS notifications, ensuring immediate communication with guardians or family members in case of an incident.

In summary, your smart glass project incorporates a camera module, object recognition, face recognition, text-to-speech conversion, currency recognition, fall detection, health monitoring, GPS tracking, and GSM communication capabilities. This comprehensive system provides visually impaired individuals with increased independence, safety, and access to information while keeping their guardians or family members informed in critical situations.


**Figure 6.8 Message Received from Smart Glass System**

## Conclusion

The Smart Stick for visually impaired individuals is a remarkable innovation that combines ultrasonic sensors, a GPS module, and a water sensor to enhance navigation and safety. The ultrasonic sensors detect obstacles and provide audible alerts, ensuring users can navigate their surroundings with greater confidence. The GPS module allows for real-time location tracking, providing peace of mind to users and their caregivers. Additionally, the water sensor helps users avoid potential hazards by alerting them to the presence of water. This project showcases the potential of technology to empower visually impaired individuals and improve their mobility and independence.

The Smart Glass designed for visually impaired people is an impressive and comprehensive solution that utilizes a camera module, advanced algorithms, and various sensors to provide a range of functionalities. The object recognition feature allows users to detect and identify objects in their environment, enhancing their understanding and interaction with the world. Face recognition enables users to recognize familiar faces, facilitating social interactions. The text-to-speech conversion capability empowers users to access written information from newspapers and magazines. The currency recognition feature enhances their ability to verify the authenticity of banknotes. Additionally, the integration of fall detection, temperature and respiratory sensors, GPS tracking, and SMS communication ensures the safety and well-being of users, providing peace of mind to both users and their loved ones. Overall, the Smart Glass project demonstrates the potential of technology to empower visually impaired individuals and improve their daily lives.

## 10. Future scope

There are several exciting possibilities to enhance the capabilities of the Smart Stick for visually impaired individuals. One potential avenue is the integration of artificial intelligence (AI) techniques. By leveraging AI algorithms and machine learning models, the smart stick's obstacle detection capabilities can be significantly improved. The system can be trained on extensive datasets encompassing various real-world scenarios, enabling it to better recognize and classify different types of obstacles, including moving objects and complex environments. This advancement would provide users with more accurate and reliable information, allowing them to navigate their surroundings with greater confidence and safety.

Another promising area for development is the incorporation of haptic feedback mechanisms into the smart stick. By integrating vibrational motors or tactile sensors, the stick can provide users with additional sensory information. For example, the stick can vibrate or offer different textures to convey the proximity and type of detected obstacles. This haptic feedback can further enhance the user's perception of their environment and improve their navigation experience.

Additionally, future iterations of the smart stick can include advanced navigation assistance features. By integrating turn-by-turn navigation functionality, the stick can guide users through unfamiliar environments. Leveraging GPS and mapping data, the stick can provide audio instructions, helping users reach their desired destinations more easily. This expansion of functionality would enable users to explore new areas independently and with increased confidence.

The future scope of the Smart Glass project is brimming with exciting opportunities to enhance its functionalities and provide even greater support to visually impaired individuals. One potential avenue for improvement is the enhancement of object recognition capabilities. Continuously refining the algorithms and training models can enable the smart glass to provide more detailed and accurate information about the user's surroundings. This can include identifying specific objects, reading text on labels or signs, or even recognizing colors. These advancements would greatly enhance the user's situational awareness and provide them with more comprehensive information about their environment.

Integrating popular virtual assistants, such as Siri, Google Assistant, or Amazon Alexa, is another avenue for future development. By incorporating these virtual assistants, users can interact with the smart glass using voice commands, creating a hands-free and user-friendly experience. This integration can significantly enhance the accessibility and usability of the smart glass, making it easier for visually impaired individuals to interact with the device.

Finally, the integration of augmented reality (AR) technology holds great potential for the Smart Glass project. By overlaying contextual information onto the user's visual field, the smart glass can provide additional details about recognized objects, offer directional cues, or even provide real-time guidance through visual overlays. This integration of AR technology would revolutionize the user's navigation experience, enabling them to perceive their surroundings with