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AI-Based Hospital Room Recognition

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Abstract:

In this paper, we present an AI-powered system designed to assist patients and visitors in hospitals by detecting room numbers and announcing them audibly. This system utilizes a Raspberry Pi with a camera to capture images of room number signs, applies Optical Character Recognition (OCR) to extract textual information, and uses a Text-to-Speech (TTS) engine to broadcast the information via a Bluetooth speaker. The proposed solution enhances accessibility, especially for the visually impaired, by automating navigation without the need for human assistance. The system is cost-effective, portable, and can be integrated into existing hospital infrastructures.

Keywords: Raspberry Pi, Optical Character Recognition, Text-to-Speech, Bluetooth Speaker, Image Processing, Assistive Technology

Introduction

Modern hospitals can be complex for patients and visitors to navigate, particularly those with visual impairments or elderly individuals. Traditional signage systems offer limited accessibility. To address this, we propose a smart AI-based solution that leverages computer vision and speech synthesis for identifying and announcing hospital room numbers. This paper discusses the design, implementation, and evaluation of the system using affordable and accessible hardware and software platforms, including Raspberry Pi, Tesseract OCR, and gTTS.

System Overview

1 Hardware Components

- **Raspberry Pi 4**: Acts as the central processing unit.
- **Pi Camera**: Captures images of room signage.
- **Bluetooth Speaker**: Outputs voice announcements.
- **Power Supply and SD Card**: For booting and storage.

2 Software Components

- **Raspberry Pi OS**
- **Python 3**
- **OpenCV**: For image processing.
- **Tesseract OCR**: To extract text from images.
- **gTTS/pyttsx3**: To convert text to speech.
- **BlueZ Stack**: For Bluetooth device management.

Methodology

The system performs the following sequence:

1. **Capture**: Image of the room number is captured via the camera.
2. **Pre-processing**: Convert to grayscale, thresholding to improve OCR results.

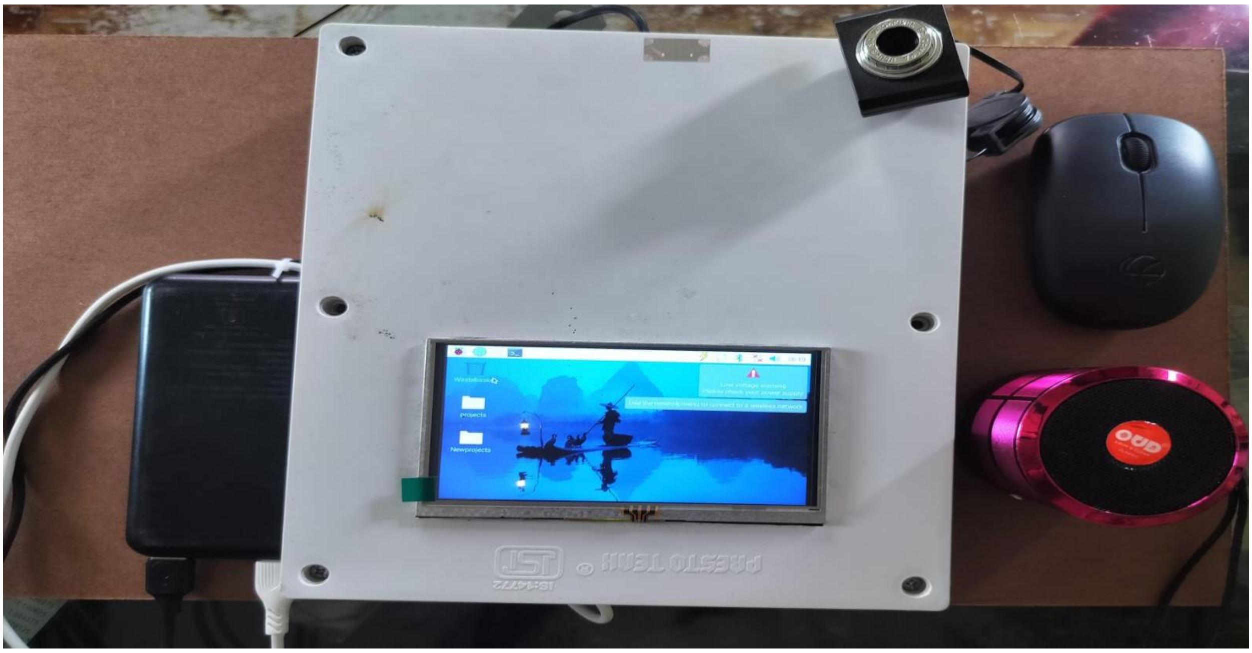
3. **OCR**: Extract text using Tesseract.
4. **Text-to-Speech**: Convert the extracted room number into spoken output.
5. **Bluetooth Output**: Audio is played via a paired Bluetooth speaker.

This modular pipeline allows real-time room detection and announcement with minimal delay.

Implementation

Python scripts were developed to automate each module. OpenCV handles the camera and image processing operations. Tesseract is called via Python bindings to extract the text. The gTTS library was used to generate .mp3 audio files, which are played using the mpg123 utility on Raspberry Pi. Bluetooth pairing was managed via the bluetoothctl tool.

Experimental Results



The system was tested with various room signage formats in indoor lighting conditions. Results showed:

- OCR Accuracy: ~90% under proper lighting.
- Audio Delay: Less than 2 seconds.
- Usability: Easy to operate with minimal setup.

The performance degraded slightly in poor lighting or angled signage, which can be addressed in future iterations.

Applications

- Visually impaired patient assistance
- Visitor self-navigation
- Smart hospital automation
- Elderly care facilities

Advantages

- Low-cost and scalable solution
- Improves accessibility and independence

- No need for changes in hospital infrastructure

Limitations

- Relies on clear and printed signage
- Background noise may affect announcement clarity
- Dependent on battery-powered speaker and camera light

Conclusion

The proposed system provides a viable AI-based solution for enhancing accessibility and automation in healthcare environments. With minimal hardware and software requirements, it demonstrates a practical application of Raspberry Pi and OCR technologies. Future enhancements may include multilingual support, facial recognition, and mobile integration.

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