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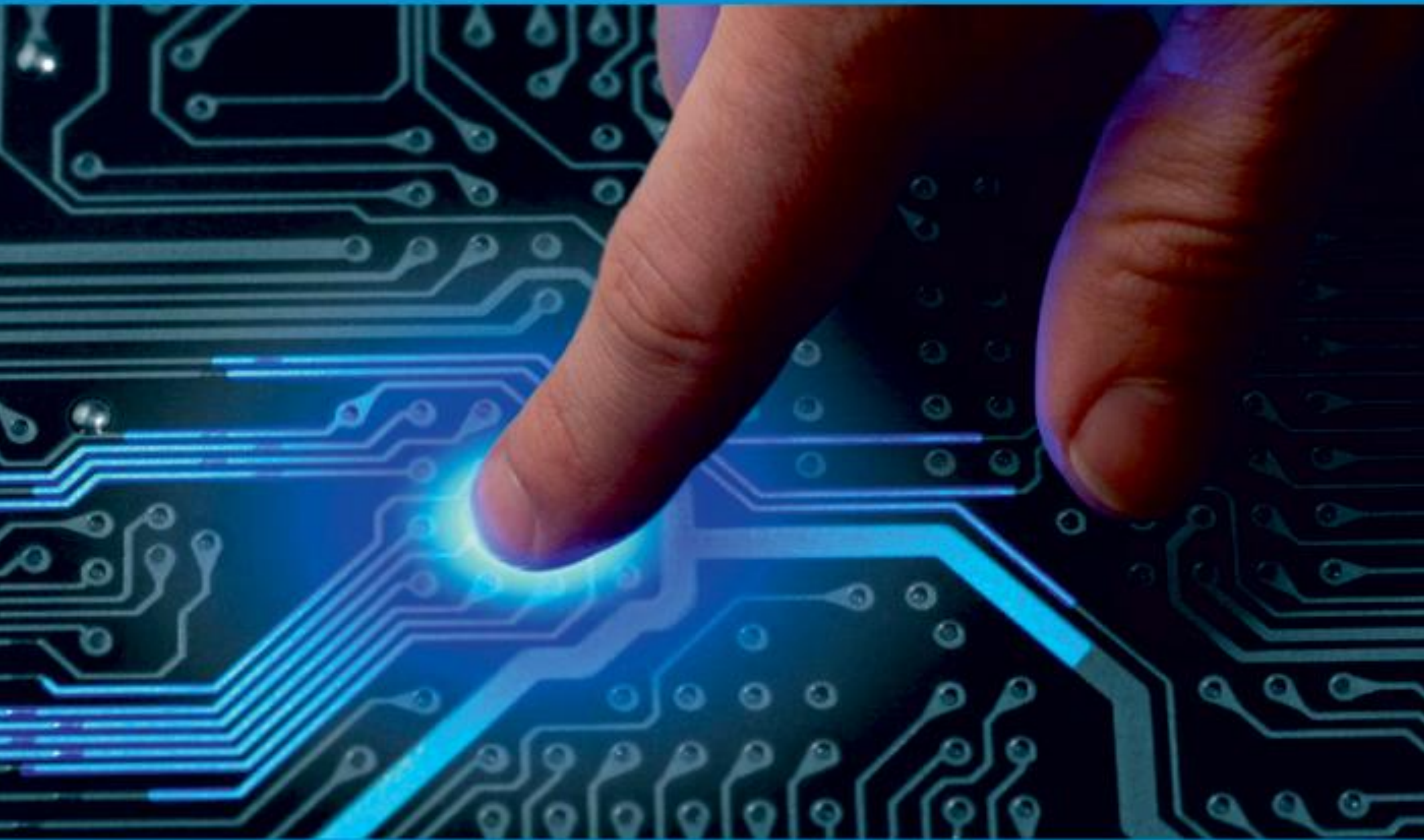

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Sight-to-Sound Human-Machine Interface for Guiding and Navigating Visually Impaired People

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ABSTRACT: Visually impaired people often find it hard to navigate efficiently in complex environments. Moreover, helping them to navigate intuitively is not a trivial task. In sighted people, cognitive maps derived from visual cues play a pivotal role in navigation. In this paper, we present a sight-to-sound human-machine interface (STS-HMI), a novel machine vision guidance system that enables visually impaired people to navigate with instantaneous and intuitive responses. The proposed STS-HMI system extracts visual context from scenes and converts them into binaural acoustic cues for users to establish cognitive maps. A series of experiments were conducted to evaluate the performance of the STS-HMI system in a complex environment with difficult navigation paths. The experimental results confirm that the STS-HMI system improves visually impaired people’s mobility with minimal effort.

KEYWORDS: sight-to-sound human-machine interface, visually impaired, mobility

I. INTRODUCTION

Our world is witnessing a growing occurrence of different disasters either natural or manmade almost daily and no society can claim immunity against disasters. Most countries have commenced focusing on their disaster management plan by emphasising disaster risk reduction and enhancing the readiness of different organisations in New Zealand, according to the Civil Defense Emergency Management Act 2002, the importance and emphasis on preparedness requirements and plans are highlighted (Ministry of Civil Defence and Emergency Management, 2002; New Zealand Legislation, 2017). Nevertheless, it is believed that these plans will be more effective, if the requirements and demands of all citizens from different groups are considered and addressed. In the other words, the plan requires all-of-society engagement and partnerships (Duncan, Parkinson, Keech, 2018). However, in most cases, there are some neglected communities like physically challenged people who require additional and often special needs. People living with visual impairment are unable to experience the world the way people with normal eyesight do. A fundamental challenge faced by this group of people is the inability to navigate between locations effectively like people with normal eye sight would. In non-disaster situations, these people have access to different assistive technological aids and supporting services; however, during disaster situations, these supporting devices and services may become either unavailable or inaccessible. Depending on the disaster type and severity, the aftermath can disrupt different infrastructures and the fundamental services provided by government that people rely on. This interruption can seriously impact the lives of citizens and people living with conditions. Furthermore, the situation is made even worse for physically challenged individuals. According to the American Foundation for the Blind, this group of individuals has been identified as a vulnerable group that is highly impacted by the influence of disasters (American Foundation for the Blind, 2016). The study discovered that Christchurch New Zealand’s 2011 earthquake and Japan's Honshu Island earthquake of 2016 affected people with visual impairment, and particularly the older adults. Today, many physically challenged individuals depend on assistive technologies to undertake their day-to-day activities. As a result, they will require additional support during and after disasters especially when the infrastructure and other services are unavailable. Different disaster management plans (Duncan et al., 2018; Ulmasova, Silcock, Schranz, 2009; World Health Organizations, 2011) have been put forward addressing groups with special requirements. Compared to the diversity of the problems and their population, this is still minimal (World Health Organization, 2017). The term ‘disability’ covers a wide range of disability forms; this study however, focuses on individuals living with visual impairment. A World Health Organization (WHO) report states that there are 285 million people with visual impairment worldwide. According to their statistics, of this group, 39 million are partially blind and more than 1.3 million are completely blind. In most industrial countries, approximately 0.4 of the population is unsighted and in developing countries, it rises to 1 (World Health Organization, 2017). Smart cap is an assistant for visually impaired

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that is design to narrate the description of a scene through pictures via webcam. There are millions of visually impaired people in the world. They are not able to experience the world which we people can. So our project "Smart cap for visually impaired people" will try to provide them the missing experience of the beautiful world. The blind people who live in our society faces numerous problems like People walking on the street, Approaching of vehicles Uncertainty of the roads, Numerous obstacle present on the street.

II. RELATED WORK

In [1] authors aims to develop an ultrasonic sensor based smart cap prototype as an electronic travel aid for blind people that can help them travel independently. The smart cap consists of ATmega microcontroller, Arduino board, three ultrasonic sensors, and a buzzer. In [2] paper proposes an Arduino Nano based obstacle finding stick for visually impaired people, which helps a blind person by detecting the obstacles using Ultrasonic sensors and android mobile application. It is able to inform the blind person about the circumstances & present condition of the path where he/she is walking. Human vision plays a vital role in awareness about surrounding environment.[3] The term visual impairment covers wide range and variety of 3 vision, from blindness and lack of usable sight; to low vision, which cannot be corrected to normal vision with standard eyeglasses or contact lenses. Visually impaired tools can assist them to enrich their lifestyle. Science and technology always try to make human life easier.[4] The people who are having complete blindness or low vision faces many difficulties during their navigation. In this paper, we design and implement a smart cap which helps the blind and the visually impaired people to navigate freely by experiencing their surroundings. Visually impaired people face lot of difficulties in their daily life. Most of the times they depend on others for help. Several technologies for assistance of visually impaired people have been developed. Among the various technologies being utilized to assist the blind, Computer Vision based solutions are emerging as one of the most promising options due to their affordability and accessibility. The main objective of the proposed system is to create a wearable visual aid for visually impaired people in which speech commands are accepted from the user[5].

III. METHODOLOGY

The proposed system will accept the input from the camera, the image captured from camera will undergo a process, after processing image the program will return the object name or the person name in the form of voice for blind person also an android application will be developed for navigation where it will accept the input in the form of voice and will guide the blind person in the form of voice about the path and navigation. The image captured by camera will undergo various processes such as:

1.RGB To Gray Scale Conversion: RGB to gray conversion is done on the progression of images. Now gamma correction is done on each of the captured gray image to achieve image enhancement.

2. Image Enhancement: The acquired image in RGB is first converted into gray. Now we want to bring our image in contrast to background so that the appropriate threshold level may be selected while binary conversion is carried out. This calls for image enhancement techniques. The objective of enhancement is to process an image so that result is more suitable than the original image for the specific application.

3. Edge Detection: Edge detection methods locate the pixels in the image that correspond to the edges. Edge detection is a basic tool in image processing, machine vision and computer envisage, particularly in the areas of feature reveal and feature extraction. In our project we use "CANNY EDGE DETECTION TECHNIQUE" because of its various advantages over other edge detection techniques.

4. CANNY EDGE DETECTION: The Canny Edge Detector is one of the most commonly used image processing tools detecting edges in a very robust manner. It is a multi-step process, which can be implemented on the GPU as a sequence of filters.

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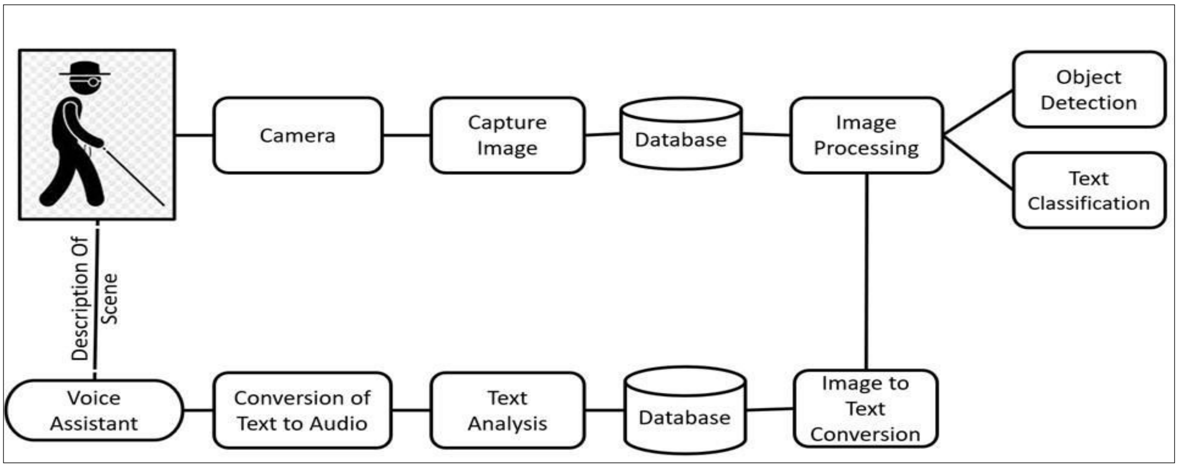

Fig 1: System Architecture

IV. PROPOSED SYSTEM

The proposed system shows the proposed STS-HMI system with integrated multiple functions using computer vision. Moreover, computer vision systems are becoming increasingly capable of comprehending scenes through object detection, localization, and classification. Furthermore, with more powerful computing hardware, computationally demanding machine vision algorithms can be executed in real time on mobile devices for assisting visually impaired people.

The STS-HMI system comprises two major components: (i) scene analysis for object detection, classification, and localization and (ii) a human-machine interface for guiding the visually impaired user. This section will explain how the STS-HMI system detects and locates various objects to build cognitive maps for navigation.

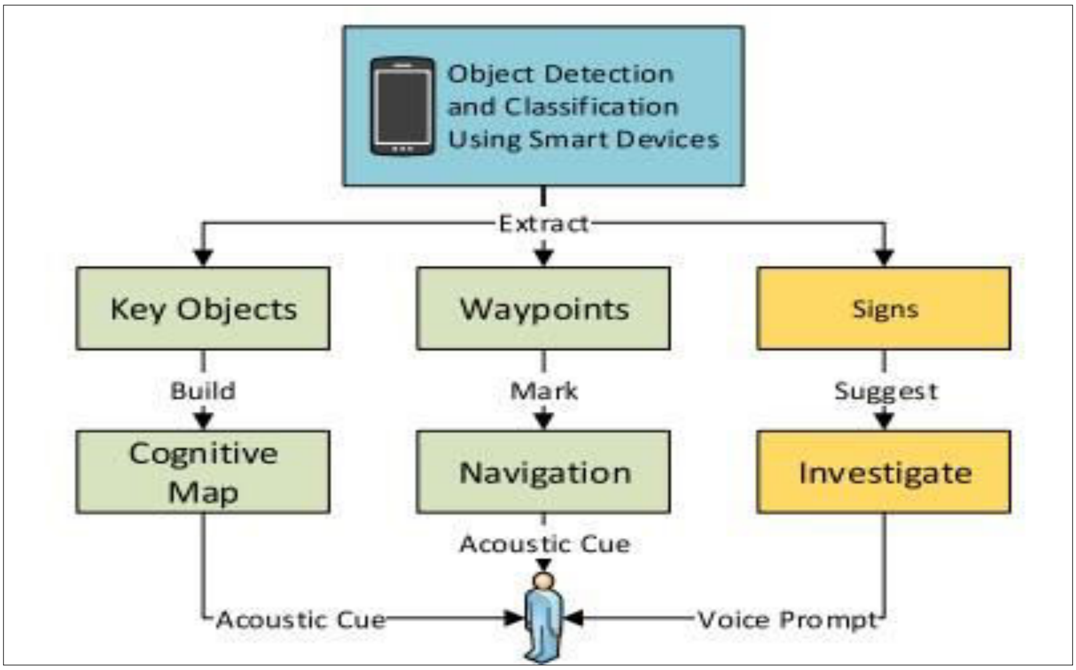

Fig: 2: STS HMI

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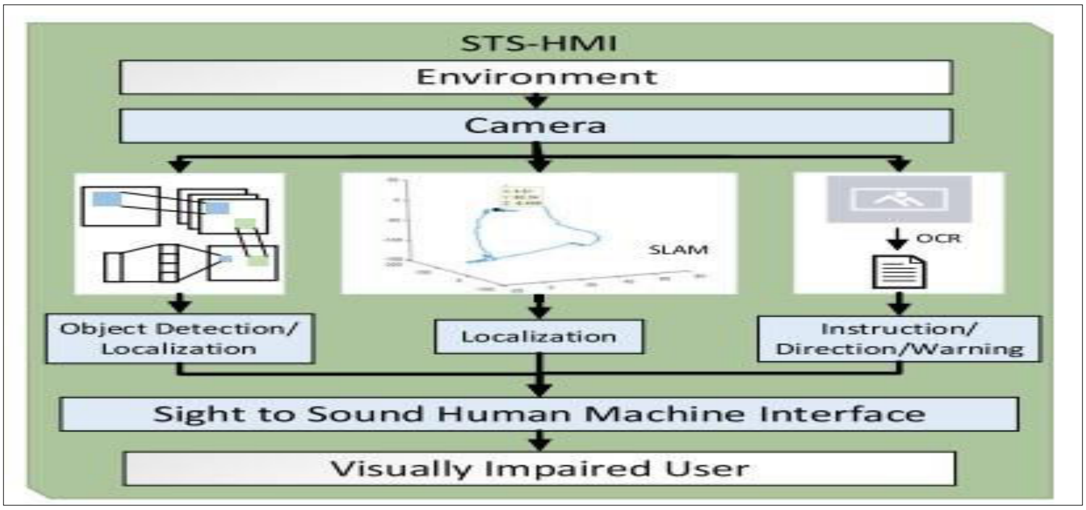

Fig:3: STS HMI

V. PSEUDO CODE – CNN ENCODER

- Step 1: Dataset containing images along with reference Dataset is fed into the system
- Step 2: The convolutional neural network is used a encoder which extracts image features 'f' pixel by pixel
- .Step 3: Matrix factorization is performed on the extracted pixels. The matrix is of m x n.
- Step 4: Max pooling is performed on this matrix where maximum value is selected and again fixed into matrix.
- Step 5: Normalization is performed where the every negative value is converted to zero.
- Step 6: To convert values to zero rectified linear units are used where each value is filtered and negative value is set to zero.
- Step 7: The hidden layers take the input values from the visible layers and assign the weights after calculating maximum prob-ability.

VI. APPLICATION RESULTS

A. Dashboard For Application

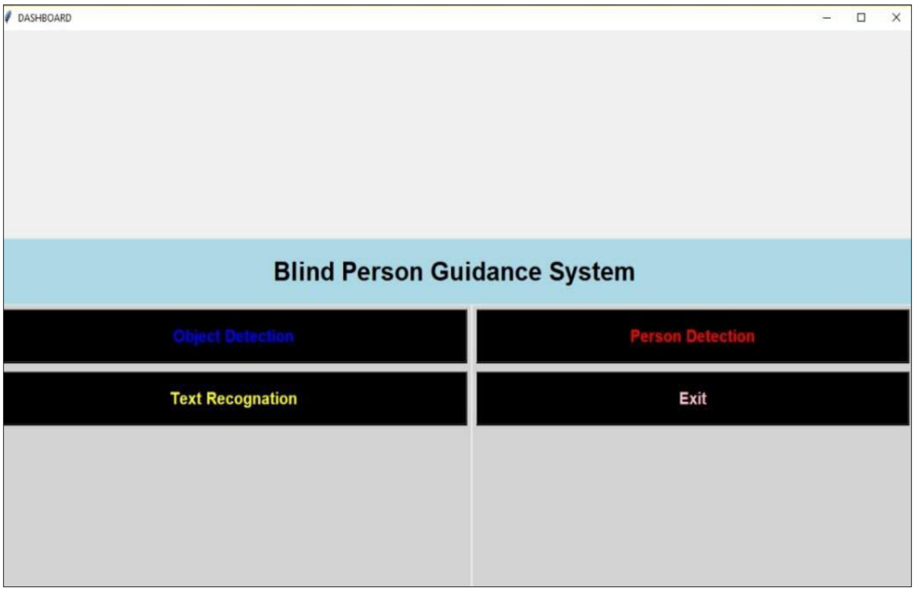

Fig : Application Dashboard

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B. Input for Object Detection

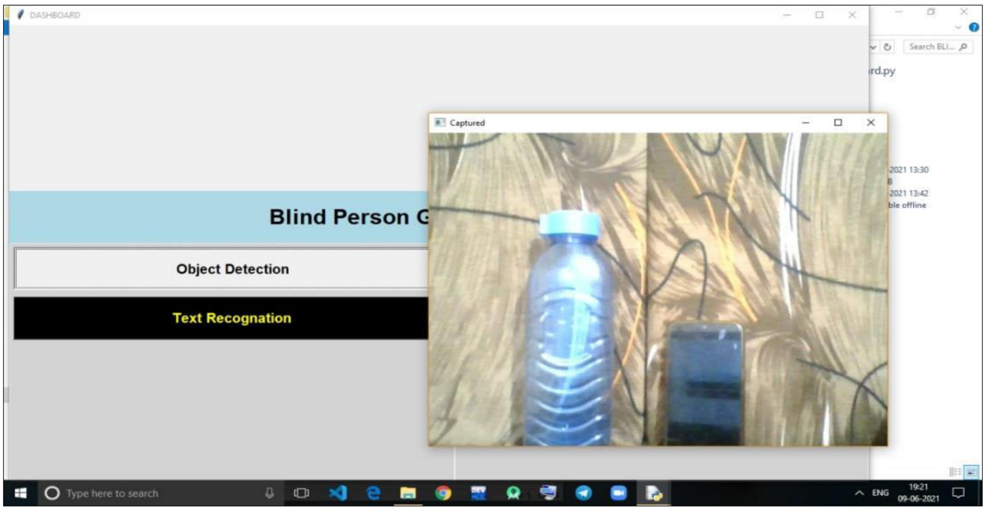

Fig : Input for Object Detection

C. Output for Object Detection

```
Python 3.6.8 (tags/v3.6.8:3c6b436a57, Dec 24 2018, 00:16:47) [MSC v.1916 64 bit (AMD64)]
Type "help", "copyright", "credits" or "license()" for more information.
>>>
==== RESTART: E:\js\BLIND_PERSON_TEXT_OBJECT_FACE_VOICE\user_dashboard.py ====
>>> saved
[39, 39, 39, 39, 67, 67, 67, 67]
[]
,bottle
[]
,bottle,cell phone
,bottle,cell phone
objects detected are bottle,cell phone
```

Fig : Output of Object Detection

D. Input for Text Recognition

Fig: Input for Text Recognition

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E. Output for Text Recognition

```
Python 3.6.8 (tags/v3.6.8:3c6b436a57, Dec 24 2018, 00:16:47) [MSC v.1916 64 bit (AMD64)]
Type "help", "copyright", "credits" or "license()" for more information.
>>>
==== RESTART: E:\js\BLIND_PERSON_TEXT_OBJECT_FACE_VOICE\user_dashboard.py ====
>>> saved
Do good
for others.
It will
come back
in unexpected

ways.

www.YourPositiveOasis.com
```

Fig : Output for Text Recognition

VII. CONCLUSION AND FUTURE WORK

The paper presents the STS-HMI system, a novel acousticcue-based navigation system for assisting visually impaired people. Existing navigation tools are task specific and limited. Hence, they are not suitable for object detection and navigation in a complex,environment. However, it is desirable to develop a portable integrated system that is capable of object detection, localization, and navigation for visually impaired people.These design objectives are achievable with advancements in computer vision and machine learning. The STS-HMI system creates a language that encodes information for intuitive navigation using binaural acoustic cues. By manipulating the frequency and amplitude of the cues, the system can convey the distance and aspect of objects to visually impaired people so that they can build a cognitive map. This approach is algorithm specific and does not require specific hardware and resources for scene analysis and human-machine interfaces.The STS-HMI system leverages neural networks and computer vision algorithms to detect and locate common objects. Then, this information is translated into binaural acoustic cues that enable visually impaired users to build cognitive maps for navigation. The experimental results support that the STS-HMI system is an intuitive and cost-effective mobile solution for navigating visually impaired people in difficult environments.

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