

Automated Portable Book Reader

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ABSTRACT

The invention is an Automated Portable Book Reader (APBR) device which takes the contents of any readable media on which it is mounted as an input and is capable of conversion of the said media into audio and/or visual and/or data format which can then be stored in the inbuilt memory and/or provided as the output with wired or wireless devices. The compact device is completely automated with regards to its operation which involves capturing the media, movement across the page and also turning of a page upon reaching termination point; processing; providing remote access capability; in its output functionalities which include audio and/or video rendering; and also in its data sharing capability with other APBR devices. The device is independent of the size of the readable material and adjusts its functionalities accordingly. LCD display provided with the remote provides the schematic forms of the readable/observable data during book reading. Software applications like dictionary, pace and voice controllers, language translation softwares and multimedia player can be installed onto the device, thus enlarging its future upgradation spectrums. Overall concern is to change current reading system for better and comfortable reading.

Keywords

Apbr, Ide, Ocr, Tts, Lcd.

1. INTRODUCTION

The traditional approach of understanding the contents in a book has primarily been reading of the book thoroughly. On the other hand, book recitals have also been used as a way of conveying the book's content. The human requirements for actual reading are more as it involves handling of the book physically and has other requirements such as sight and literacy of the reader. The source of light for reading a book, ergonomics, silent ambience etc. are important factors for prolonged reading of a book. Continuous reading of a book may lead to fatigue. Comparatively, it is less tiring to hear someone read a book to you.

Hence superior book reading system is invented so as to overcome all above mentioned problems and give highly automated, independent, portable, remote accessible book (irrespective of book size and dimensions) reading option which satisfies needs of all users such as illiterate people, students, visually impaired people, old people and any individual favors the option of auditory rendering of any readable media.

1.1 Brief Summary Of Present Invention:

In the above mentioned scenario, the invention provides a portable device to assist in reading and recital of a book of any page size through a wired/wireless scheme. The data transfer facility helps in storing the data so as to replay the

book once read and to avoid the reprocessing of book reading mechanism. The present invention depicts an automated, portable, remote controllable electronic book reading system. The device is completely independent of human effort because once the device is mounted on the book page it automatically moves on the page and turns the page when needed.

2. Related Work

Very few references to automating the rendering of readable media in audio/visual formats exists, none of them present a compact, hand-held, portable and remotely accessible electronic device with media translation having complete book reading system with audio and/or visual output with built-in automated page turning mechanisms, audio output, data transfer and Liquid Crystal Display (LCD) display.

US Application 2001/0317778 [6] depicts an electronic public library system for providing reading together of an electronic children literature item at two remote computers. The said system necessarily encompasses the computer systems, internet etc. which does not allow the system to be portable. Also the power requirements, number of components in the system are more. US 7,422,434 [3] relate to personalized reading of a book involving storage of a book recital and playing of the same at a later time.

Some systems have been presented where pre-recorded audio format of a book is stored and then reproduced as needed e.g. US patent no's: 4445196 [1], 4855725 [2] and 4985607 [7]. Some systems depict electronically available text material which are converted and rendered in audio format (US patent 5475398 [4], 5956048 [5]). Patent no. PCT/CN 00/00579 [8] discloses a system wherein a decoded form of a text is stored in the diskette of the device after validation through an internet connection with the help of magnetic card. System reads encrypted data provided by means of internet as such no physical/actual reading by means of system.

2.1 DETAIL DESCRIPTION OF THE INVENTION:

Automated Portable Book Reader (APBR) is electronic device having 2 integrated cameras, one per plate which are connected using a belt driven by a motor that the control unit controls. The cameras can change their positions to take the next picture. Camera present above page (say camera1) captures images from front side of page, and other camera below page (say camera2) captures images from back side of same page so that both the pages are processed simultaneously and in single move only. At initialization, the control unit calculates and saves values of:

1) Number of images to be captured to read a complete line (n) of current book.

- 2) Time (t1) for which motor 1 to keep ON so that camera goes to next correct position on same line.
- 3) Time (t2) for which motor 2 to keep ON so that device goes to immediate next line on same page.

(Note that: Different books can have different values of n, t1 and t2 depending on dimension and properties of book.)

Both cameras start capturing under the control of the control unit. Images taken by camera1 are immediately sent for further processing and images taken by camera2 are stored in memory. These images are sent for further processing as soon as the front page is read i.e. after satisfying Page-End Test [1]. Thus in one movement of the device from the top of the page to its bottom, both the front and back side of the page is covered. The front page goes through the following processes:

- 1) Checking of Page-End Test [1], Line-End Test [2] and Diagram-Present Test [4].
- 2) Character identification and word formation
- 3) Conversion of textual content into audio and schematic content into digital format which then is rendered as output either in audio format or digital format
- 4) The audio output can be rendered either in wired mode or wirelessly through audio rendering devices whereas the schematics can be viewed on the LCD display present on the remote.

If the Page-End Test is satisfied, automatic Page-Turning Process is initiated by the control unit. The Page-Turning Process is shown in figure 4 and described in details in description of figure 4. If Last-Page Test is satisfied (i.e. If there are no more pages to be read), an interrupt signal is sent to the device and it stops, indicating the end of the book.

If Line-End Test is satisfied, then control calls Line-Changing Function which results the device to move onto the next immediate reading line. This is done with the help of motor2. If Diagram-Present Test is satisfied, then the schematic will be sent to the display on the remote and the user will be prompted about the same. The remote is as shown in figure 5.

Due to the wireless capability of the device, various audio rendering devices can be connected with it, which gives the user the option of listening to the book reading in private or in public.

The LCD display on the remote is used to display schematic diagrams present in the readable material. It also shows reading status such as page number, line number, schematic number etc. according to user configuration. It also provides an interface during data sharing and storing activities.

Remote controllability makes the device comfortable and easy to use and allows user to access the device from anywhere under its range. The different controls provided on the remote include ON/OFF, Navigation Buttons, Pause/Play, Volume +/-, word + / -, line + / -, Dictionary meaning, Language translator etc.

Inbuilt dictionary application is pre-installed on the device and other compatible applications can also be installed later like multimedia player, language translator, pace controllers etc.

The storage and sharing capabilities of the APBR reduces efforts in case of repetitive reading of the same book.

APBR device can operate on battery and/or solar energy. Thus the APBR is a multifunctional system which satisfies many diverse needs of the user in efficient manner.

2.2 TESTS:

2.2.1 Page-End Test:

When device comes at the end of a page, the image captured by the camera may show either a partial page or no page at all. This image can easily be segregated from the others and using this we can check for page-end.

2.2.2 Line-End Test:

Line-end test is satisfied under 2 conditions:

(Supposing that image1=image captured by camera1, image2=image captured by camera2 and n= no. of images per line)

- 1) n (pre calculated initially) images are taken for current line that is $image_no = n$ &
- 2) paragraph finished from both sides of page at the same time that is $Image1=blank$ $image=image2$

Here identifying the 1st condition is easy and can be done by maintaining one variable (say image_no) which is set to zero at beginning of every line & incremented after every image. Test is positive if $image_no=n$. 2nd condition is only checked if image1 is a blank image i.e. next part of current line is blank and/or there is a paragraph change. If image2 is also blank, then further images are not taken on the same line as data on that line is absent. Thus, Line-End test is satisfied when images captured by both cameras are blank.

2.2.3 Last-Page Test:

If during the page turning process, no new page is brought into the gap 510, an interrupt is sent to the control unit. The last-page test is satisfied in this case.

iv. Diagram-Present Test: Every image taken by the cameras is split into characters which are then compared to the database which contains all alphabets, numbers and special characters.

If no match is found then the diagram present test is satisfied.

2.3 DRAWINGS:

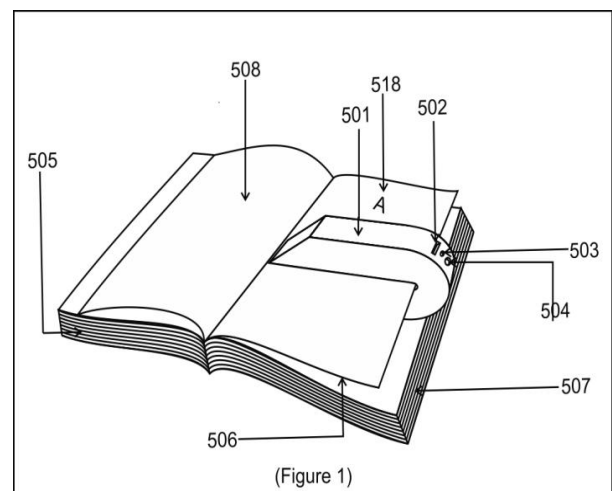
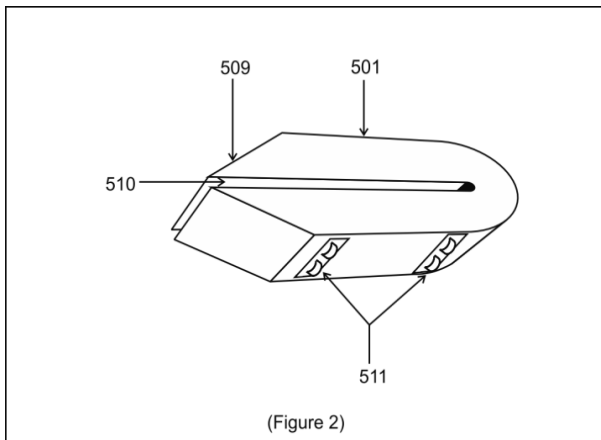


Figure 1 demonstrates orientation of APBR and shows how the device (501) will reside on book where the current

reading page (506) is present in the small gap (510 not shown here) between the two plates of APBR. 502 shows USB slot for removable USB devices for data sharing. 503 is for wired audio output and 504 is a remote signal receiver



The figure 2 gives the pictorial view of the device. 509 avoids the tearing of the pages and keeps the device attached firmly on the page and ensures it reaches the innermost character in the back part of the page. 510 is the space where the page to be read will pass through. 511 show two pairs of wheels which move 501 on the book. These wheels are driven by motor2 to make horizontal movement of device under control of control unit which decides the time for which the motor has to run thus determining the distance 501 should cover to reach the next line. In case the Page-Turning Process is executed, 511 makes 501 go back to the top of the page also.

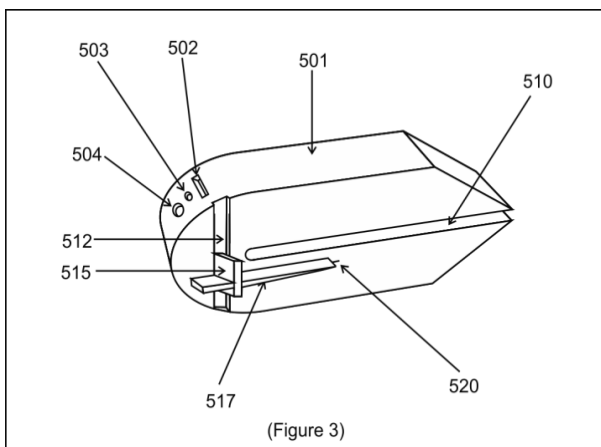
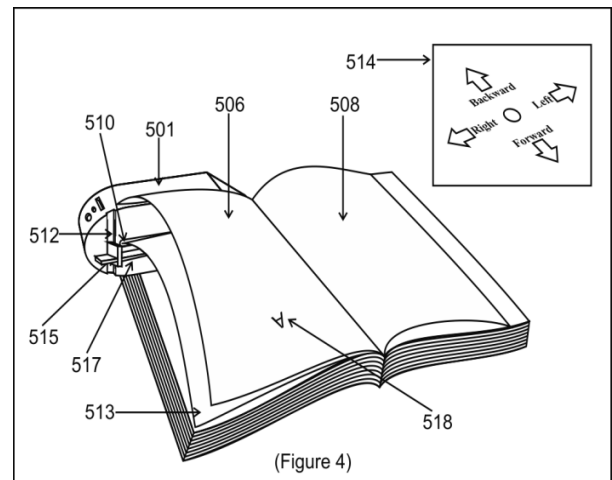


Figure 3 shows the inner section of the APBR device allowing us to look at the parts used for page turning. 502, 503, 504 are mentioned in figure 1 above. 512 is guide way created so that 515 can have up-down motion. 517 is thin plate tapering towards the inner edge; it can have to and fro motion possible in 515. The tip 520 at the end of plate 517 selects only 1 page from unread pages during Page-Turning Process.



If the Page-End Test is satisfied, the control unit sends saved images of back side of same page for processing and also starts Page-Turning Process. Figure 4 gives the pictorial view of Page-Turning Process and the details are as follows:

Box at the top right corner (514) gives the direction orientation. With the help of guide way 512, part 515 moves up and down. 515 holds thin plate 517 which can have to and fro motion in 515 controlled by the control unit. 517 is present below the page that has just been processed, it also helps in keeping the current page fixed in a position.

At the end of a page only a small part of page 506 is inside the gap 510, hence if 515 rolls up, 517 is also automatically rolled up. As a result the current page 506 comes out and the device moves forward causing 506 to move above the device 501.

Further, to bring the next unread page 513 in the gap 510, 517 moves to the right in 515. Then 515 is rolled down automatically causing 517 come down. As soon as 515 comes to its precise position 517 starts moving towards left through 515. Due to the little thickness, reducing width of 517, tip 520 (not shown here) and precisely calculated position of 515, only a single page 513 comes onto 517. Then 517 is moved up in line to the gap 510 by rolling 515 up. The entire process is controlled precisely by the control unit. The device 501 then moves in the forward direction resulting in taking the next unread page 513 in and the previously processed page 506 out. The process of page turning is thus completed. This is illustrated in figure 4.

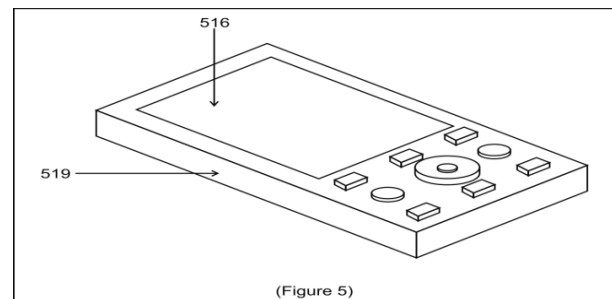


Figure 5 depicts the remote 519 and its control buttons. 516 is the LCD display which is used to display schematic diagrams present in the readable material. It shows reading information, provides an interface during data sharing and storing activities. The different controls provided on the remote

include ON/OFF, Navigation Buttons, Pause/Play, Volume +/-, word +/-, Line +/-, Dictionary meaning, save, Menu etc.

2.4 FLOWCHARTS:

The flowcharts are self-descriptive and gives overall flow of operations. Hence only few things are needed to describe.

Initially MAIN receives program control, under its control it checks different tests like:

- 1) Page-End Test
- 2) Line-End Test
- 3) Last-Page Test
- 4) Diagram-Present Test

These tests are described in TESTS section under Detailed description of Invention, these test results are either YES or NO. Main can also starts processes like:

- 1) Page-Turning Process [5]
- 2) Next-Image Process [8]

Main can also give a call to different functions like:

- 1) Ocr-Tts function [9]
- 2) Line-Changing function [7]

2.5 HARDWARE-REQUIREMENTS:

APBR uses following main hardware assembly:

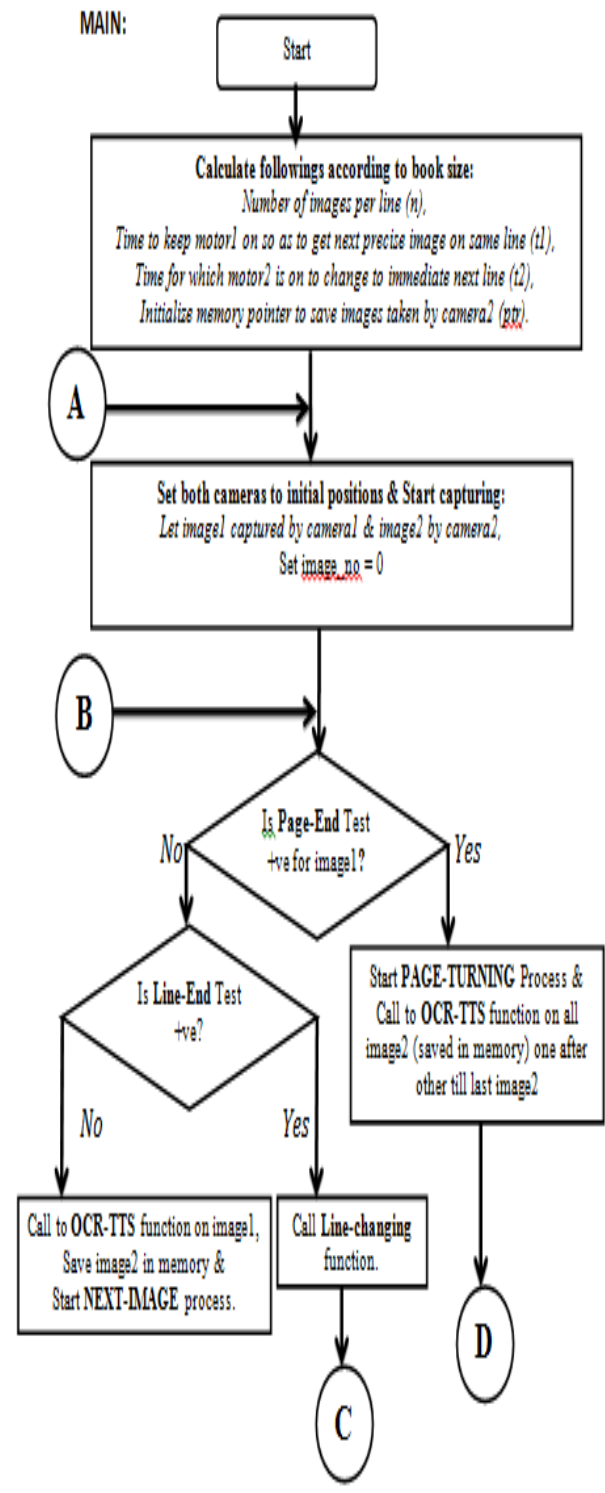
- 1) Microcontroller (AVR ATmega16)
- 2) 2 integrated cameras (OV 9653)
- 3) Language Processor IC (RC 8650)
- 4) 4 DC motors (3 volt)

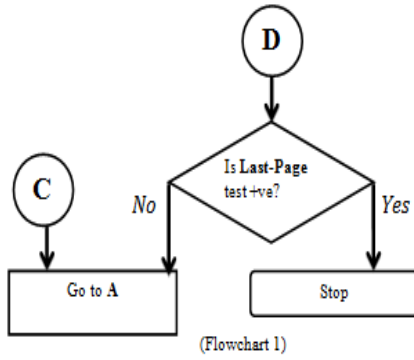
2.6 SOFTWARE-REQUIREMENTS & ALGORITHMS:

As whole operations are under govern of microcontroller all codes must be provided in HEX format because microcontroller understands Hex files only. As it is impossible to prepare Hex file manually, the alternative is to do C code and convert this into Hex file using suitable Integrated Development Environment (IDE).

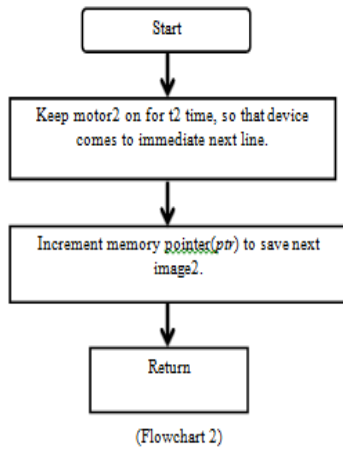
So C codes are to be developed first in AVR Studio or any open source like code blocks which is having facility to convert c code into Hex file format. Later this Hex file generated by above mentioned IDE can be burn on microcontroller using AVRDUDE or any other translator.

Once this all is set, to make image related operations in c OPENCV library is best option where we can do almost all image related operations. Opencv library can be downloaded and installed easily to use opencv library IDE must need to change some settings so as to enable it.

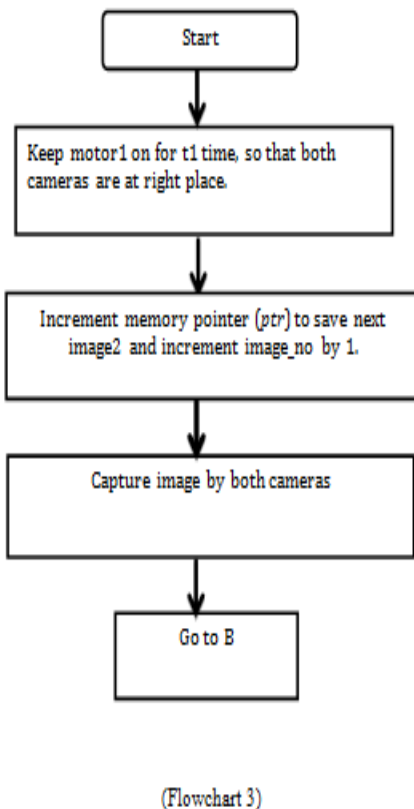




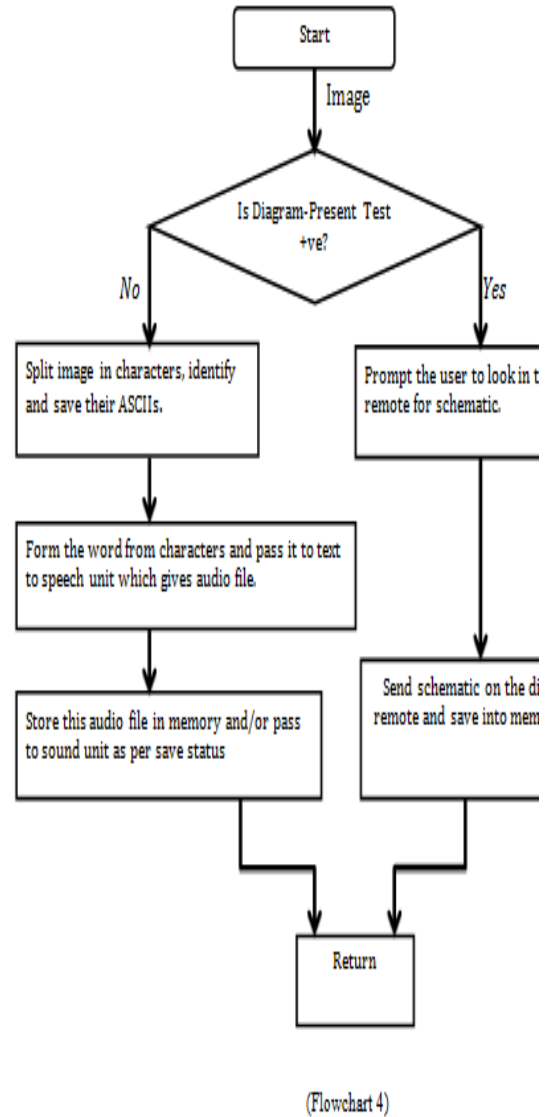
Line-Changing Function:



Next-Image Process:



Ocr-Tts function:



2.7 PROCESS DETAILS:

The actual part of processing of getting audio from image is divided into 2 steps:

- 1) OCR (Optical Character Recognition)
- 2) TTS (Text To Speech)

1) OCR: An image will be provided as an input to this module or program which will generate text file of characters present in image as an output. Algorithm is given as below

2.7.1 Prerequisite:

1) **Database:** Having information of edges and connected components features of each character, number and special symbol.

2) **Function: display-on-remote (character-info)**

This function displays present schematic (character-info) on remote.

3. ALGORITHM

- i) Read image from memory
- ii) Convert image to Binary form to reduce size
- iii) Get next character info from image by edge detection and connected components
- iv) Search this character info in database if found get its ASCII value else call display-on-remote function on return go to vi).
- v) Append this ASCII value in text file
- vi) If not whole image processed go to iii)
- vii) Go to i)
- viii) End.

This will end by an interrupt send by Page-End Test when end of book occurred.

3.1.1 TTS:

As text file is ready, an audio output is needed. It can be made easy with any Language Processor. In present work RC 8650 is used. RC 8650 is language processor which takes text file as input and generates audio file as output. This audio file can be played using speakers.

Hence finally image is converted to audio.

4. RESULTS

Invention is pending for patent.

5. CONCLUSION

Thus, this superior book reading system is invented so as to overcome all above mentioned problems and gives highly automated, independent, portable, remote accessible book reading option (irrespective of book size and dimensions) which satisfies needs of all users such as illiterate people, students, visually impaired people, old people and any individual favors the option of auditory rendering of any readable media.

6. REFERENCES

- [1] US patent 4445196 Dated 24 Apr 1984
- [2] US patent 4855725 Dated 8 Aug 1989
- [3] US patent 4985697 Dated 15 Jan 1991
- [4] US patent 5475398 Dated 12 Dec 1995
- [5] US patent 5956048 Dated 21 Sep 1999
- [6] US patent 2001/0317778
- [7] PCT patent publication number WO 02/48995 A1 Dated 20 June 2002
- [8] PCT patent publication number PCT/CN 00/00579