Chapter 6

Conclusions and Future Works

Throughout the works in this research, several waveguide alignment techniques as well as some coding architectures for UV writing were developed and operated on a programming platform called LabVIEW. The study on the waveguide alignment techniques is to design an effective method to characterize and unleash the potential of a particular planar waveguide. While, the designs of coding architectures for UV writing is to develop a rapid prototyping technique for planar waveguide.

6.1: Alignment

Since the optical circuitry layout is not visible to the naked eye, the position of every single physical structure is therefore difficult to visualize. Here, the imaging and optical detection of the channel guide is greatly simplified with the application on interference pattern observed at the waveguide output. The interference fringes tend to be maximum in size when the launched signal leaves from core to air. Whenever this situation is encounter using this alignment method, physical structures such as guiding line and channels will be seen by moving the launch signal transversely. By fine movement of launch signal, position of input channel can be located easily as showed in the manual alignment procedure which has been practiced in this work. Another prospective technique for initial light seeking is the simple vision alignment system which developed using web-cameras in this work. However, there are hurdles to be dealt with before full and effective incorporation of this technique into waveguide alignment. First the parallax error exhibited by the web-cameras must be eliminated. Secondly, the optical circuitry layout of the optical waveguide must be known. This is crucial information as the pixel of image will be used as the coordinate system for the optical circuitry when the waveguide is aligns under the vision system.

The power detection method is then ready to take over the alignment task by refining the input channel’s position. Although the peak power detection algorithm used in this work does not plays the role as it should be, it still shows the potential for being deploy as the alignment technique. For this method to be fully functional, the effect of backlash of the stepper motorized stage must be reduced to a minimum. Other than that, the resolution on the motor movement steps should be increased to minimize the loss of important information. The final step before the peak power detection algorithm is fully optimized is the coding synchronization. This part is fairly important in order to preserve the accuracy on data obtained.

With the intention to eliminate the possibility of misalignment on the input optical signal; launch fiber can be glued to the input channel as soon as the channel is found. During the UV curing process, it is important to remember that the joint which already applied with UV curable epoxy must receive UV exposure evenly from all directions. This is to prevent the misalignment of input signal due to uneven contraction of UV curable epoxy during curing process to occur. The same procedure can also be applied to the output channels when they are found and having optimum output power at that instant.

In fact, the combination of instruments setup used for waveguide alignment is not ideal. Since a manual alignment stage is used as the platform for output signal coupling, there will be a large tendency for misalignment on output coupled signal if fiber is used to collect the output signal to detector as the movement of the stage is hard to control in high precision. As the best solution on this technical problem, planar optical device alignment should be performed using two identical motorized alignment stages to provide high reliable in position searching as well as power measurement.

6.2: UV Writing

UV writing coding architectures developed in this work are successfully implemented to produce the desired optical circuitries layout. However, the architecture developed with FOR loop function to produce straight channel design or other design. This is not viable especially when the design is to transfer to photosensitive glass. This is simply because the FOR loop function is time consuming when comes to command execution. The long processing time eventually leads to situation of hydrogen out-diffusing and hence reduced the photosensitivity if temporal photosensitive sample is used. In some cases, the excessive UV energy has the tendency to erase the positive refractive index change by inducing negative change in index of refraction. In order to preserve the photosensitivity behavior, FOR loop can be replace by other straightforward coding structure.

Design of the 1-by-2 optical power splitter can be extended to 1-by-X power splitter with any proper coding structure. Figs. 6.1 and 6.2 show example of different architectures for different splitter.

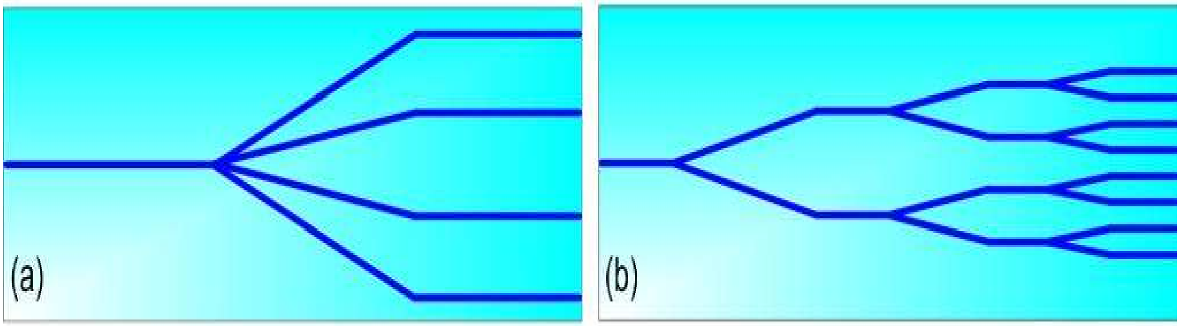

Fig. 6.1(a): 1-by-4 splitter circuitry with direct splitting structure;

(b): Cascaded 1-by-8 optical splitter

Apart from the slanted channel design for optical circuitries, s-bend structure is a better option in providing bending structure for planar waveguide. This structure has better performance in terms of power confinement as it works as a bended fiber within the waveguide. With the combination of s-bend and straight channel design, other optical circuitries can have more rigid structure. For instance, the slanted channel structure in the Mach Zehnder Interferometer designed in this work can be replaced by the s-bend structure (as shown in Fig 6.3). Yet, thing to be remembered in the coding design and development is the correct command candidate for commands execution.

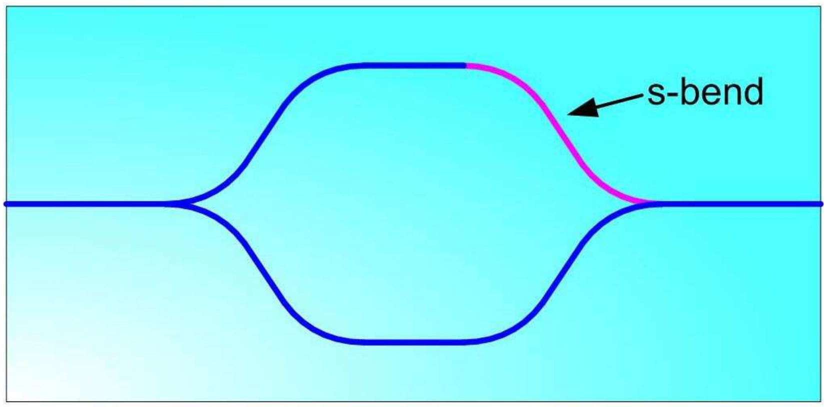

Fig. 6.2: Mach Zehnder Interferometer with s-bend structures

6.3: Future Works

Instead of developing active alignment techniques for optical planar waveguide, the optical planar waveguide can be designed to have groove structures on both the input and output during fabrication process. The purpose of having groove design is to directly place the optical fiber for signal transmission. This is a relatively easy alignment method as it does not require the search of the waveguide's input channel. Hence need no any complicated coding structure development. Other than the rapid prototyping on passive optical devices via UV laser writing, rare-earth doped planar waveguide laser can be fabricated as well. This can be done by having a pair of UV written gratings on both ends of a piece of rare-earth doped waveguide as to form a laser cavity as shown in Fig. 6.3. If this is achieved, than a planar waveguide containing multiple lasers shall not be a problem to realize. This type of waveguide lasers will sure find their applications in telecommunication and display technology.

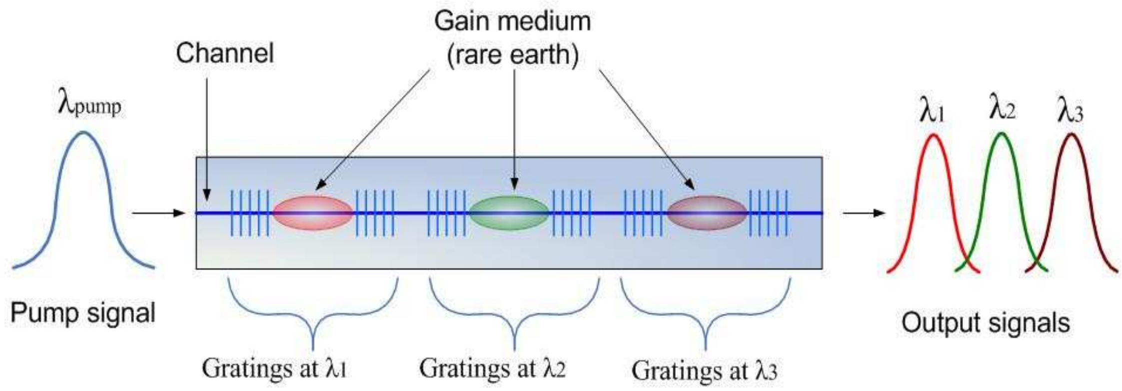

Fig. 6.3: Rare earth doped planar waveguide laser

The next focus of study in UV writing is the materials studies on the material characteristic towards UV irradiation. A good understanding on the material characteristics is essential to exploits the available characteristics into the reality. For instance, if the origin on the photosensitivity exhibited by the defects center can be clearly understand as opposed to many model currently proposed, there is no definite model for a good understanding on this subject matter. This would provide a better controlled on the refractive index and physical structures which yielded from the photosensitivity mechanism.