Chapter 6

CONCLUSIONS

6.1 Summary of Results

This research achieves its aims to balance an MIP based on the inverted pendulum model. Two control strategies (state-feedback controller and LPV controller) have been designed to address the problem of balance control for the system. Through LQR and pole-placement controllers, we can find the feedback gain for balancing and rotating the MIP. The gain matrices obtained from simulation is implemented in the DSPIC micro-controller for control the MIP. The Kalman filter has been successfully implemented. The gyroscope drift is effectively eliminated allowing an accurate estimate of the tilt angle and its derivative for the MIP. While the stability of the system can be accomplished through the implementation of Pole-placement control, the LQR controller offers an optimal control over the system's input via the weighting matrix R. The arbitrary placement of control poles might cause the poles to be placed too far into the left-half plane and cause the system susceptible to disturbances. The LPV controller has performance and robustness better than LQR and pole-placement, when we change the mass or length to the CG of the MIP. But it is required the micro-controller with high frequency and large memory to implement this algorithm. We have built the interface and virtual reality in MATLAB for the users to use easily to simulate the MIP plant. Finally, we have successfully implemented the MIP with LQR controller that can control forward, backward, leftward and rightward via a remote control within 30 meters at a speed of 0.8 m/s and it can climb up the slope of around 20 degree.

6.2 Recommendations of Future Work

To make the MIP has more performance and robustness, certainly we need improvement. Some idea that can be applied to our system

- To Change micro-controller.
  In this thesis, we have used DSPIC to implement the LQR controller for running the MIP. With this micro-controller, we cannot implement the LPV controller, because of the performance and speed of DSPIC. It is interesting to change micro-controller from DSPIC to DSP and implement LPV controller to run the MIP.

- To Implement LPV controller with XPC-Target.
  Since the simulation result show that the LPV controller has the performance and robustness better than the other two controller. Future research on implementing LPV controllers is strongly recommended for the balancing MIP system as it will improve the robustness of the system.