Motivation & Feasibility

- **Motivation——Building video monitor system**
  - Early Warning System for school children in time of crisis
  - Automatic video feedback in extreme environment
  - Ensure safety in buildings, labs, etc.

- **Feasibility**
  - Currently motion cameras exist, but they are not widely used in the surveillance system.
  - With machine learning and image processing, the future surveillance system can decide area of focus and use our system to direct its focus without user interventions.
Hardware

- Adafruit 16-channel PWM / Servo HAT
  - Chip PAC9685 on the HAT provides PWM as set by I2C

- Adafruit mini pan-tilt kit with micro servo (SG90)

- Arducam 5 Megapixels 1080p Sensor OV5647 Mini Camera Video Module

- Raspberry pi
Software

- **WiringPiI2C library**
  - Cross compilation using CMake
- **Custom PAC9685 & SG90 Motor Driver**
  - Custom built for the project
- **OpenCV**
  - Cross Compilation
  - Running on raspberry pi
  - Raspberry pi has only essential library to reduce code size
- **CMake**
  - Build support tool
- **Multi threaded and Modular Control Software**
  - Image capture thread / Image Processing thread / Motor Control thread
  - Threads runs independently to maximize CPU utilization
  - Communicate through buffer objects that takes care of synchronization
Image processing

● Image matching
  ○ Detect camera (background) motion between two images.
  ○ Try optical flow method, but it was time consuming.
  ○ Use cross-correlation to get the moving vector between images

● Image segmentation
  ○ Segment background from foreground to find position of moving object.
  ○ Divide image into several area, mark areas with many differences between images (active areas)

● Camera control
  ○ According to active areas, calculate which point of current image should camera focus to.
  ○ Use given angle of view of camera, calculate how many degrees should camera move.
  ○ Generate control policy (absolute position) for camera control.
Result

- **Highly sensitive to moving objects**
  - Once moving object enter its view, camera can turn toward object immediately.
  - Detect the position of moving object within its view and always try to turn toward it.

- **Fast image processing which can deal with moving background**
  - Use a simplified correlation algorithm, only calculate it on the sum of each row and column, only to detect translation of view (since camera cannot rotate currently)
  - Calculate active areas, with decreases workload of segmentation

- **Stable and modularized design**
  - System has been running very stable.
  - Easy maintenance due to the modularization and code reuse.

- **Offshelves hardwares**
  - Economical & ease of use