**New Payload Orientation**

**Robot**

**Piston**

1. Control Design:

Our aim is to keep the payload horizontal while moving on the inclined plane.

Mathematically,

This means when the payload will pass through an incline surface of some angle , then it should be tilted by same angle in opposite direction, so that the payload remains horizontal to the ground.

If a line is rotated about its origin , the arch length generated at given distance from origin is given by equation. For a small angle the arch length can be assumed straight line.

Let us consider cartesian system in the payload’s frame of reference.

**Y -axis**

. ()

**X -axis**

If the payload is rotated by very small angle only along x-axis then the arch length at any coordinate () is given by,

where is angle of rotation along x-axis

Similarly, if the payload is rotated only along y-axis then the arch length at any coordinate () is given by,

where is angle of rotation along y-axis

The combined arch length can be given by,

Where could be positive or negative depending upon its coordinate and direction of rotation.

For a given piston length , the mean length could be given by,

Then,

So, for number of robots having coordinates (), , in a compact form

Where

1. Piston design

A linear actuator mounted on the top of robot chassis has been used to change the piston’s rod height by moving it up and down. At the Rod’s end a small rectangular plate is attached via Spherical ball joint. The advantage of spherical joint is it will allow free rotation along all 3 axis while preventing the translation motion. It will give us passive control on rectangular plate mounted on it, by self-adjusting the plate orientation according to the roll and pitch of the surface planes. Also the rectangular plate will provide sufficient friction to avoiding the sliding motion of the payload.

Advantages:

No pre-information of slope angle is required.

Used to carry fluid.

Simulation results 1:-

Let there are 4 robots having coordinates

*Length = L4*

*Length = L3*

**Y -axis**

**X -axis**

*Length = L2*

*Length = L1*





