Team – Robonauts
Project Name – iLeap

Our Inspiration- https://www.youtube.com/watch?v=6b4ZZQkcNEo
The Sand Flea Robot by Boston Dynamics was our inspiration. We were excited to make a jumping robot. We had very little information as to how the Sand Flea Bot jumps., as the technology used by Boston Dynamics is not disclosed anywhere.

Theory-

Mechanical Aspects:

The pneumatic piston actuator was the component which struck the ground in order to provide the impulse to propel the bot when supplied with air under pressure. A lot of information about it is available on the following link:
http://www.bimba.com/global/library/catalogs/bimba%20catalogs/bimbarefhandbook.pdf

The air flow in and out of the piston is regulated by a electrical solenoid valve (which also has a mechanical control switch). Upon getting a voltage more than a specific value, the solenoid valve swiftly sends the air from a storage cylinder so that the piston is pushed outward, and when given a voltage less than a specific value immediately reverses the flow to bring it back in.

The electrical connections can be referred from this video:
https://www.youtube.com/watch?v=_tby5VuvNuk

The valve air flow connections can be referred to from:
https://www.youtube.com/watch?v=yXCWQXIrAY8

There also was a cushioning system so that the strain on shaft of the motors could be minimized. It involved making cuboidal motor boxes, filling them with sponge/spring and then placing the motors in them. This way, when the bot landed from a height, the sponge could absorb most of the shocks.

Electronics Aspect:

The basic ground motion of the bot was very much based on the XLR8 concept : https://drive.google.com/folderview?id=0B2Z-qHEycq1bOUd4WHVvWWpBaTQ&usp=drive_web

The bot had to be lifted up to a certain angle with servo motors before taking off. The following link guided us to do so using AVR Atmega32 Microcontroller (We used 16): http://extremeelectronics.co.in/avr-tutorials/servo-motor-control-by-using-avr-atmega32-microcontroller/

The RF module was used to communicate with the bot. http://narobo.com/articles/rfmodules.html

Datasheet: http://www.farnell.com/datasheets/64193.pdf

How we went about making the project-

First step- We were trying to figure out the possible ways to make our bot jump. The two possible ways were- springs and pneumatics. We thought upon this, and came to a conclusion that we should use pneumatics, as that was the most feasible option.

Second Step- We figured out the CG of the bot by making a SolidWorks model of the bot. Link to the SolidWorks files- https://drive.google.com/drive/folders/0B8-TX6w857NGV09BNXFyclNrN1U
Advantages of making the SolidWorks Model- We could decide the dimension of the bot from the dimension of the components. Plus, we could place the components at the appropriate positions.
Another important thing to think about was cushioning of the motors to lessen the impact of the fall on the shaft. We had two mechanisms in mind- springs or foam. We decided to make the suspension using foam.

Next step was to get the components, and then figure out how they work. We spent some time learning how the pneumatic piston and the electrical solenoid valve work. Basically the solenoid valve actuates either when the mechanical switch is pressed or if the potential difference across its terminals exceeds a particular voltage (as in the specifications of the valve).

Simultaneously, we gave the chassis for fabrication. We got the chassis as well as the motor boxes fabricated from a shop near Vikhroli station. We had to give the exact dimension of the holes and all, and the accuracy needed was high, so the time taken to fabricate was longer than we expected. We also had to get the cylinder fabricated, by buying a square pipe and welding the two open ends. We put a bicycle valve in the cylinder to put in air. Later, we had to replace it by a bike valve as it wasn't possible to measure the pressure in the bicycle valve.

Next, we tried to lift up the bot using servos. Although the stationary/holding torque of the Servos were 13 kg cm each, they were not able to lift up our bot. However, they were able to lift the bot with a little help, and were able to hold the bt in position. What we concluded from this- plastic geared servos shouldn't be used to lift up heavy stuff. It's better to go for metal-geared servos.

The result-

The first jump- We made the bot jump vertically first. With 5 bar pressure in the cylinder, the bot jumped to about 0.4 m.

Ultimately, with 8 bar pressure, we were able to make the bot jump to about 0.6-0.7 m vertically. We were also able to make the bot jump at an angle.

The final video- https://youtu.be/OLGjEEYlVr4

Components used-

Components bought from KLB Pneumatic and Hydraulic, Muhammad Ali Road-

- Pneumatic Piston - Rs. 760
- Solenoid Valve - Rs. 786
- Pipe - Rs. 20
- Connectors- Rs. 130

Components bought from Decora Paints and Aluminium, near Vikhroli Station-

- Aluminium sheet - Rs. 1200

Components bought from Bombay Electronics, Lamington Road-

- 4 DC Motors - Rs. 2000
- 2 MG995 Servos - Rs. 1200
- RF Module - Rs. 180

Components bought from Visha World, Lamington Road-

- 2 AtMega16 with dev board and one programmer - Rs. 568

Components bought from Nigar Foam and Furnishing, IIT Main Gate-

- Foam - Rs. 560

Components bought from Mangaldeep-

- AtMega16 - Rs. 150
- L293D - Rs. 100
- IC base, 7805, Heat Sink, Bergstrip - Rs. 47
- 4 wheels - Rs. 300
- Wheel grips (extra) - Rs. 360
- DST - Rs. 30

Fabrication of chassis, cylinder from Sanjay Engineers, near Vikhroli Station- Rs. 800

Our Team-

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