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Self-Levelling Tripod

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Abstract - *This paper presents the idea of a self-levelling tripod. A regular tripod requires manual levelling, to make a horizontal orientation. This proposed design of tripod levels itself in the perfectly horizontal orientation without any manual efforts. This is achieved by rearranging of the legs by motors fitted inside each leg, and the gyroscope sensor to sense the orientation.*

***Key Words*: Automation, Dc motors, Arduino, Solidworks, Gyroscope, Self levelling**

1.INTRODUCTION

Photographers find it really frustrating to level the tripod whenever its orientation changes. This process results in waste of time and efforts. Wildlife photographers often shoot on uneven surfaces. They also find it really difficult to level the tripod on these surfaces. Also, there are some other applications in which levelling of the tripod is necessary. Currently, the entertainment industry is growing very rapidly. As this industry is growing, the demand for cameras and camera equipment's will be also high. New technology will be always added in the camera equipment's. Tripod is the most necessary camera equipment, so its demand will be constantly increasing. Due to the increasing demand of professional and 4k video clips, the market for tripods and monopods is also increasing. There has been rise in the trend of vlogging, and uploading on the social media platforms. This is a major boost to the tripod market. Online teaching is also becoming more and more common in these days. For uploading steady videos of teaching, tripods are in demand.

The current solutions for levelling a tripod include bubble levelers. The bubble level indicator is installed either on the tripod or the ball head. Then, according to the bubble level indicator, adjustments are done on the tripod to level it perfectly horizontal. We proposed a system, which can level itself perfectly horizontal on its own. We should be also able to increase or decrease its height, without changing its orientation. This tripod automatically adjusts itself in a perfectly horizontal orientation. This process takes place very quickly, and it also takes place without any human effort. This levelling is achieved by the rearranging of the legs of this tripod. All the three legs can extend, and retract. This motion is achieved by a DC motor fitted inside each leg.

1.1 Literature review

Automated Tripod leveling and parameter estimation for granular-fill Insulation distributing Robot [1]-In this paper, Milan Hurban and his team has given an approach to modelling, control design and parameter estimation for self-leveling tripod base.

Design of Remote-Control Tripod Dolly (iDolly) [2]- Hua Qian Ang a student from Royal Melbourne Institute (RMIT) University has presented paper in which she described design of remote-control tripod dolly, namely iDolly, a specialized piece of equipment designed to create smooth camera movement and ease equipment transportation.

1.2 Design of tripod

The design of the tripod was made in the Solidworks software. 3D model of all the parts and the assembly was made in Solidworks, and the assembly was simulated to obtain the results. Overall dimensions of the tripod when the legs are not extended – 125mm * 125mm * 827mm.Maximum height of the tripod (legs in the fully retracted state) – 1345mm.

Material:
There are 2 best possible materials for making this tripod:
1. Aluminium 1060 alloy
2. Carbon fibre

Both of these materials are light weight, and are mostly used for making camera tripods.

Fig-1: Design of the tripod

The components of this tripod can be mainly 2 parts.

Mechanical components:

1. The base of the tripod

The base of the tripod is basically the part where we attach the camera on it. The screw on the top of this part, is for attaching the camera. This part has a cavity in it to hold the circuits and gyroscope and the Arduino module. Below, it there is a removable cup-like structure to hold the battery of the tripod. This designed to be easy for removing for recharging the Li-Po battery present inside it.

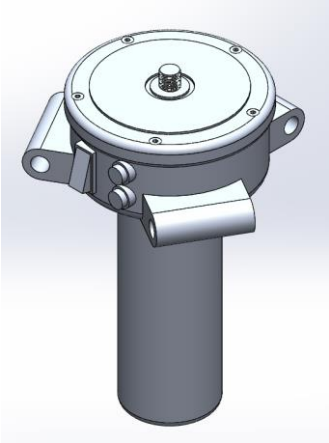

Fig- 2: Tripod Base

Fig-3: Exploded view of the tripod view

2. Legs of the tripod

The legs of the tripod carry the main mechanism of the movement of the legs. There are 3 components in the assembly of each leg. The motor casing, upper part of the leg, and the lower part of the leg. The motor casing, holds the DC motor. After that, there is the upper part of the leg, which is hollow and it carries the lower part inside it when the height is lowered. The lower part moves to and fro with respect to the upper part of the leg. The lower part actually touches the ground. There is also a threaded rod inside the leg. The function of this rod will be explained in the working of this tripod section. The type of threads used on this rod are "Bottle cap threads".

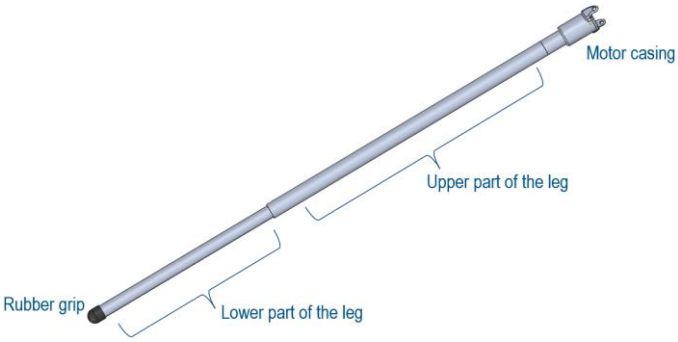

Fig-4: Parts of the leg

Fig-5: Motor case

Fig- 6: Motor case exploded view

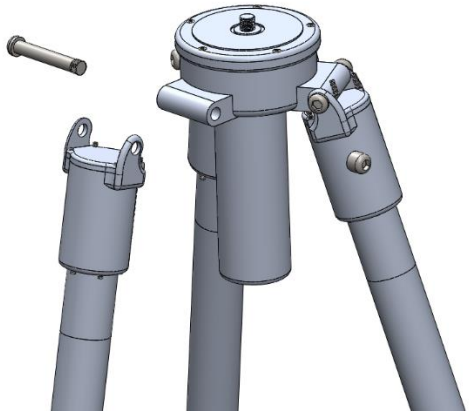

Fig-7: Base and legs exploded view

Electrical components:

1. Arduino mini

This board comes up with Atmega328 microcontroller. We can differentiate this board from others in terms of PCB layout, voltage regulation, size and clock speed, etc. Currently two versions of this board are available i.e., 3.3 V and 5 V. The difference is because of the presence of a voltage regulator on this board. We can check the label of regulator and if it is labelled as KB33 then it is 3.3 V model and if it is labelled as KB50 then it is 5 V model. If labelling is not given then we can check board version by measuring voltage between GND and VCC pins. KB33 runs at 8 MHz while KB50 runs at 16 MHz i.e., double frequency from KB33.

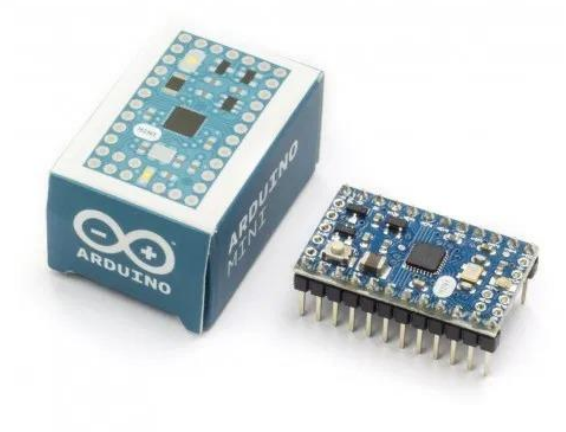

Fig-8: Arduino mini

2. Dc motors

Dc motor converts dc current i.e., direct current electrical energy into mechanical energy. DC motor contains a stationary set of magnets in the stator and an armature with more than one the windings of insulated wire wrapped around a soft iron core that concentrates the magnetic field. The windings mostly have multiple turns around the core, and in the large motors there can be various parallel current paths. In this project we have used 3 dc motors to rotate the threaded rod.

Fig-9: Dc Motors

3. Gyroscope sensor

Gyroscope sensor is a device that can measure and maintain the orientation and angular velocity of an object. These are more advanced than accelerometers. The gyroscope measures lateral orientation and tilt of the object and they are also known as angular rate sensors or angular velocity sensors. These sensors are installed in our application because the orientation of the tripod is difficult to sense manually or it takes too much time to level. It Measures in degrees per second, angular velocity is the change in the rotational angle of the object per unit of time.

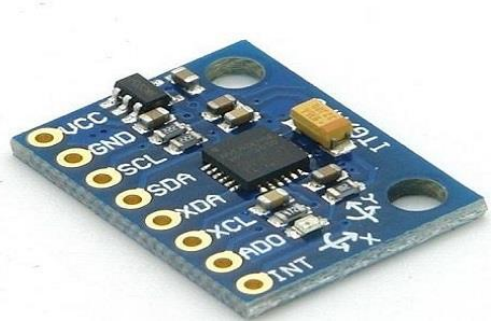

Fig-10: Gyro sensor

4. Li-Polymer battery

It is a rechargeable battery having li-ion technology. li-ion battery uses polymer electrolyte instead of liquid electrolyte. Hence it is called a Li-ion polymer battery. High conductivity semisolid (gel) polymers form this electrolyte. These types of batteries give higher specific energy than ordinary lithium battery and that's why they are used in applications like mobile, radio-controlled aircraft, and some electric vehicles where weight is the critical feature.

Fig-11: Li-polymer battery

2. Working

Mechanism of the tripod:

The tripod is able to rearrange the legs because of this mechanism. The mechanism used in the legs is called as the lead screw mechanism. In this mechanism, the rotary motion from the DC motor is converted into translatory motion of the tripod legs. The lower part of the tripod leg translates to and fro with respect to the upper part of the leg of tripod. Basically, in this mechanism, there is a threaded rod attached to the DC motor. There is another part having threads from inside which will be meshed with the threaded rod. The lower part of the leg will be attached to this part, and thus as the threaded rod will rotate, the lower part of the leg will be able to move.

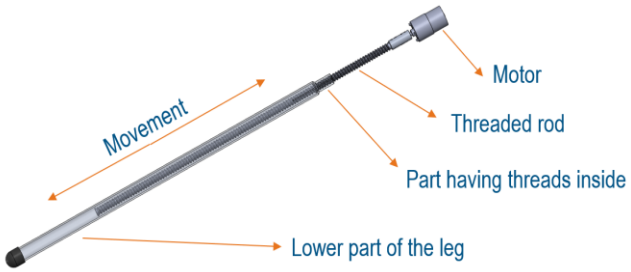

Fig-12: The mechanism

Self levelling:

Now, with the above-mentioned mechanism fitted inside each leg, we can adjust the orientation of the tripod. The gyroscope fitted in the base of tripod will sense the exact orientation of the tripod, and with the help of Arduino, the motors will get a signal, that how much they should rotate to make a perfectly horizontal orientation of the tripod. In this self levelling process, 1 leg will always show no change in the length, and the other 2 legs will rearrange themselves to get the desired orientation.

Height adjustment:

Once the tripod attains the horizontal orientation for the camera, then it can change the height according to the photographer's need. The height change process will ensure that, the orientation of the tripod will not change.

3. CONCLUSIONS

The assembly was simulated and the motion of the legs was tested in Solidworks. The motion of the legs was as expected. We also performed stress analysis some parts which carry most of the load. On each leg, the force applied was 20N.

1. Motor case

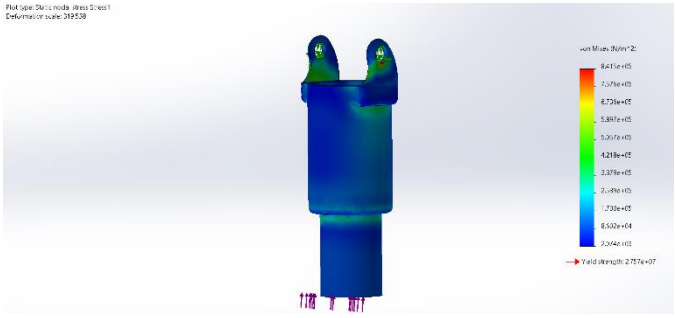

Fig-13: Stress analysis on the motor case

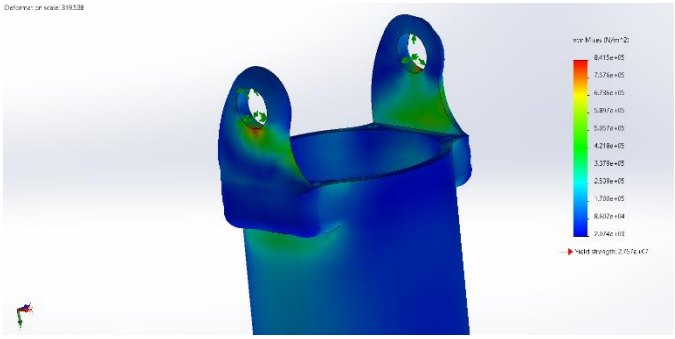

Fig-14: Stress analysis on the motor case

2. Lower part of the leg

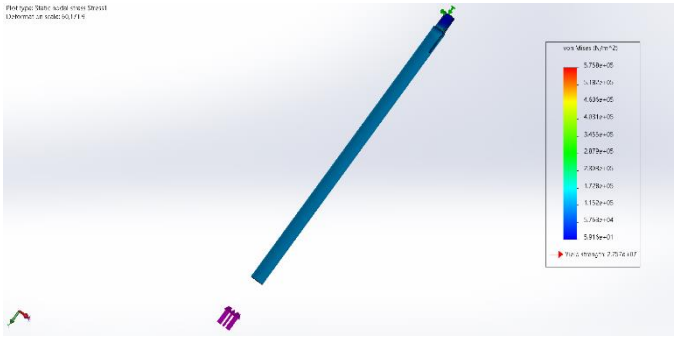

Fig-15: Stress analysis on the lower part of the leg

The stress distribution on both of these parts was uniform, and they were safe to carry the load.

The tripod automatically adjusts itself in a perfectly horizontal orientation. This levelling does not require any manual effort, making it very easy to use for the photographers. The tripod is also able to adjust its height without changing its orientation. This tripod can also be used for the land survey applications. So, this tripod is ultimately able to reduce the time and human efforts successfully.

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BIOGRAPHIES

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