Optimization and Fabrication of Pipe Transversing Rover

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Abstract- Innovating a pipeline inspection rover that can efficiently navigate through pipes using a unique mechanism. Our Project is made up of a wooden and PVC structure and features an ESP32 cam, DHT11, PIR motion sensor, and HC-SR04 ultrasonic sensor. Our primary focus is on developing a rover that can move smoothly through pipelines, and the sensors are secondary, meant to collect important data along the way. Our rover can easily navigate pipelines without human intervention and provide critical information to assist in pipeline maintenance. One of the unique features of our rover is that the sensors can share data from anywhere, regardless of limited area, and can be accessed from anywhere. This makes it a cost-effective solution compared to other pipeline inspection rovers. Our rover can measure temperature, and humidity, perform visual inspections, and test for living organisms. The 500 RPM DC motor Johnson 12V power supply can provide a rover battery life of 1 to 1.5 hours We believe that our pipeline inspection rover has the potential to revolutionize the way pipeline maintenance is done by providing reliable, efficient, and cost-effective solutions. Our rover's unique mechanism allows it to easily navigate through pipes and collect critical data along the way. With further development, we plan to integrate more advanced technologies to enhance its capabilities. Our goal is to create a reliable, efficient, and affordable solution to pipeline maintenance problems.

INTRODUCTION

In contemporary's fast-moving experience, effective and cost-effective answers are wanted to claim technical orders. In the metallurgy field, the inspection of pipes is an important facet of perpetuation, as damage or obstacle in pipelines can bring about dangerous situations and free time. In-pipe check rovers are an answer to this question, admitting engineers to surely inspect pipes for defects or damage outside of breaking up the apparatus[1]. The pipe examination grown for this project utilizes a curling movement pattern, admitting it to guide along the route, often over water through pipes more capably and efficiently[6]. Equipped with miscellaneous sensors, t can discover defects, cracks, and deterioration produced by miscellaneous factors in the way that strain stale, slink deformity, and water deterioration. This project aims to design and cultivate a reliable and economical in-pipe check that can assist in the sustenance and check of pipelines. Through the use of this technology, engineers can guarantee that pipelines are functioning right, growing adeptness, and lowering the risk of dicey situations. In this scenario, we made a rover that makes a more efficient and smoothest way to give data for maintenance which will help in reducing the future accidents that can be happened in the future.

LITERATURE SURVEY

In-pipe check rovers (IPIRs) have existed established in various fields, to a degree nuclear energy, plant manufacturing, drain, oil industry, etc. These rovers are used to check the interior of the pipelines for obstructions and damage. With the growing demand for the effective conveyance of fluids through the pipelines, the need for up-to-the-minute maintenance and examination has enhanced importance. Various movement patterns have existed projected for these rovers to increase their efficiency and support better examination results. [5]The IPIRs are outfitted with accompanying miscellaneous sensors to detect cracks, deterioration, and added defects generated by strain becoming older, glide deformation, water deterioration, etc. The use of state-of-the-art science, in the way that machine intelligence and artificial intelligence can be able to accurately define the dossier calm by these sensors. Several research studies have existed transported to better the design and effectiveness of IPIRs. Researchers have projected different movement patterns[2], in the way that wheel-located, move along on foot, and worm-stimulated, to improve the maneuverability and support of these rovers' indifferent pipe surroundings. Studies have still been administered to expand Wi-Fi capacity beginnings for these rovers, which can overcome the disadvantage of connected capacity beginnings, stop the blame, and grant longer check periods. Recent progresses in material wisdom have still led to the growth of inconsequential and sturdy matters for the explanation of IPIRs. These materials can endure the abusive surroundings inside the pipelines and supply better results.

DESIGN OF EXPERIMENT

DESIGN OF POWER CONSUMPTION BASED ON THE SELECTION OF COMPONENT

COMPONENTS :

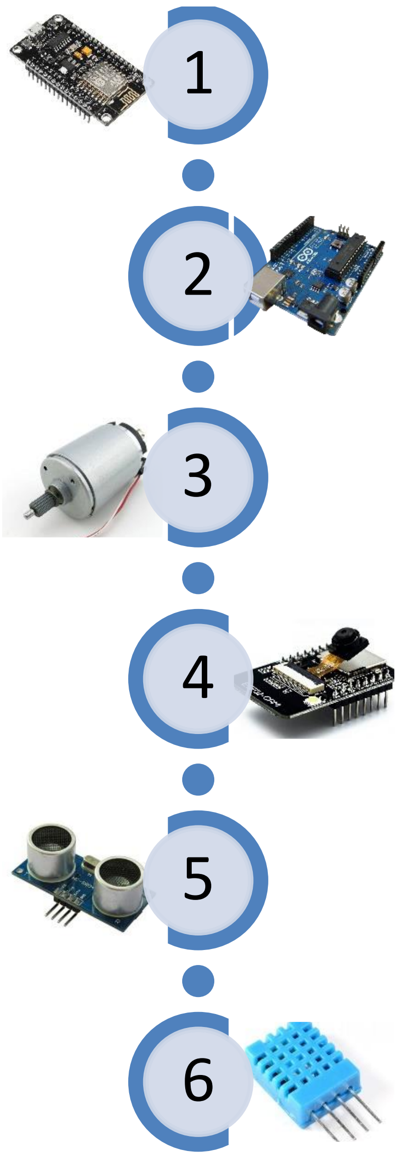

Fig (1.1) Primitive Model of Rover

1. NodeMCU: 80 mA @ 3.3V = 0.264 W
2. Arduino: 120 mA @ 5V = 0.6 W
3. Motor: 2.6 A @ 12V = 31.2 W
4. Camera: 200 mA @ 5V = 1 W
5. Ultrasonic sensor: 15 mA @ 5V = 0.075 W
6. Temperature and humidity sensor: 1 mA @ 5V = 0.005 W

Total power consumption = 33.144 W
Calculate the current draw from the battery:
Battery current = Total power consumption / Battery voltage
Assuming a 12V battery, the current draw will be:
Battery current = 33.144 W / 12V = 2.759A
Calculate the battery life:
Battery life = Battery capacity / Battery current
Assuming a 5000 mAh battery capacity, the battery life will be:
Battery life = 5000 mAh / 2759 mA = 1.81 hours
Therefore, with a 5000 mAh battery, the rover can operate continuously for approximately 1.81 hours before the battery needs to be recharged.
That is enough time for the inspection of some parts of the rover. The speed can be manually varied and it can be done fully automatically with the help of IoT modules.

DESIGN OF SPEED

Motor speed (N) = 500 rpm Gear ratio (GR) = 38:56 Motor voltage (V) = 12 V Motor current (I) = 1.9 A Torque constant (Kt) = 0.011 Nm/A Battery capacity (C) = 2300 mAh = 2.3 Ah Coefficient of friction (μ) = 0.3 Weight of rover (m) = 2.5 kg Acceleration due to gravity (g) = 9.81 m/s^2
Calculations:
Angular velocity of motor (ω) = 500 rpm * $2\pi/60$ = 52.36 rad/s
Torque produced by motor (τm) = Kt * I = 0.011 Nm/A * 1.9 A = 0.0209 Nm
Output speed of gearbox (ωg) = ω / GR = 52.36 rad/s * (56/38) = 77.18 rad/s
Torque at output of gearbox (τg) = τm * GR = 0.0209 Nm * (56/38) = 0.0308 Nm
Force exerted by motor on wheels (F) = τg / (d/2) = 0.0308 Nm / 0.01 m = 3.08 N
The force required to overcome friction (Ff) = μ * m * g = 0.3 * 2.5 kg * 9.81 m/s^2 = 7.3575 N Net force available to accelerate the rover (Fnet) = F - Ff = 3.08 N - 7.3575 N = -4.2775 N Acceleration of the rover (a) = Fnet / m = -4.2775 N / 2.5 kg = -1.711 m/s^2

Maximum speed of the rover (v_{max}) = $\sqrt{2 * |a| * d}$ = $\sqrt{2 * 1.711 \, m/s^2 * 0.01 \, m}$ = 0.0739 m/s = 7.39 cm/s

DESIGN OF CONTROL MECHANISM USING ARDUINO

```
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <DHT.h>
#include<Ultrasonic.h>
#define DHTPIN D2
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
#define PIR_PIN D6
#define TRIG_PIN D4
#define ECHO_PIN D5
char auth[] = "bOko-lZ1VdwreNZpNWXZrtU8F46-aSfg";//Enter your Auth token
char ssid[] = "Temp";//Enter your WIFI name
char pass[] = "temp@123";//Enter your WIFI password
Ultrasonic ultrasonic(4,5);
void setup() {
Serial.begin(9600);
Blynk.begin(auth, ssid, pass, "blynk.cloud", 80);
pinMode(PIR_PIN, INPUT);
dht.begin();
pinMode(TRIG_PIN, OUTPUT);
pinMode(ECHO_PIN, INPUT);
}
void loop() {
Blynk.run();
int motion = digitalRead(PIR_PIN);
Blynk.virtualWrite(V1, motion);
float temperature = dht.readTemperature();
float humidity = dht.readHumidity();
if (isnan(temperature) || isnan(humidity)) {
Serial.println("Failed to read DHT11 sensor!");
return;
}
Blynk.virtualWrite(V2, temperature);
Blynk.virtualWrite(V3, humidity);
long duration;
digitalWrite(TRIG_PIN, LOW);
delayMicroseconds(2);
digitalWrite(TRIG_PIN, HIGH);
delayMicroseconds(10);
digitalWrite(TRIG_PIN, LOW);
duration = pulseIn(ECHO_PIN, HIGH);
int distance = (duration*0.034)/2;
Blynk.virtualWrite(V4, distance);
}
```

DESIGN AND FABRICATION OF ROVER ELEMENT


Fig (1):Fabricated Rover

Went with the various vacant research documents from various websites and academies led us to two big means that are vacant in the information survey already making a new means that outweighs the former everything finished on the in-pipe transversing gives the main change. while verdict the machine we searched the various methods to devise the necessary translation motion and we wound up utilizing the this device.


Fig(2):Fabrication of Parts

We are selecting the material for the rotor and stator as forest and we will be making the advocate accompanying the material forest. it will help us to manage the complicatedness that will stand all along the making of bureaucracy. we had the plan to pick the material as PVC or texture at which point we made use of use the 3d publication electronics but it was discontinued by way of the requirement it demands perfect and correct ranges and the cost of making an original level example will create the projects cost much above pretended. The main cost of the project goes for the fittings for instance quick sensors and costs are greater. projected step, skilled maybe the issue of the circuit being charred or a seepage through opening occurrence in some component so that will help us to claim the flow of the project work.

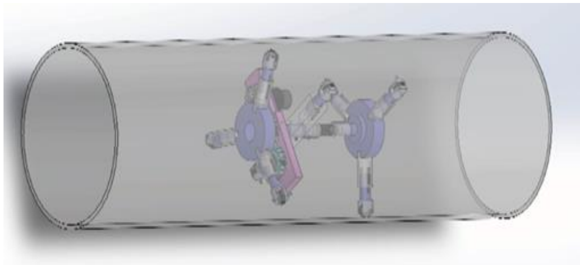

Fig (3):In-Pipe Rover

ANALYSIS

We, as a team of students, have conducted a comprehensive report and analysis on the inspection of pipes using a rover Standard conditions must be considered for the effective inspection of pipes using a rover. Several types of defects may occur during the inspection process, including cracks, corrosion, deformations, blockages, leaks, and welding defects. The rover should be equipped with multiple sensors, including fast sensors, magnetic flow sensors, and eddy current sensors, to enhance more advanced and accurate detection of defects like cup dents, material loss, and others.

The rover should have a maximum speed of 7 cm/sec and consume 1.81 hours of battery power without the intervention of any person. The weight of the rover should be around 2.5 kg with all the advancements. However, it's crucial to note that the intervention of Arduino may sometimes get disconnected, and the rover should always be online to receive power.

It's essential to perform regular inspections of pipes using the latest technology and equipment to ensure a smooth and effective conveyance of water, gas, and other fluids. By using a rover equipped with a wide range of sensors and artificial intelligence and machine learning algorithms, it's possible to detect even the smallest defects accurately and efficiently. This will lead to proper repairs and maintenance of pipes, ensuring the safe and efficient movement of fluids.

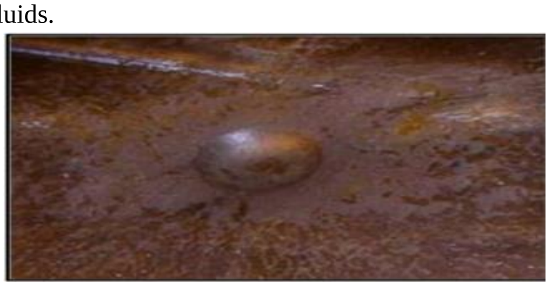

Fig (4):Cup Dent

Fig (5):Welding Defect   Fig (6):Material Loss

RESULT AND CONCLUSION

Robots play an alive part in pipe-network sustenance and repair. several ruling classes were planned to include particular tasks for pipes accompanying loyal diameters, and alternatives commit to acclimate the building movement of the difference of the inspected pipe. In this project inside pipe standard made or done by a machine whole region, part is projected. a vital style aim of those electronic plans is the skill to the central diameters of the pipes. The given model permits the custom of a tiny-crooked for an ocular exact likeness to the in-pipe review or alternative instruments required for breakdown discovery that appears inside the central few of the pipe (measuring schemes accompanying ocular maser, instrument, etc).The big advantage is that possibly exploited for fear of pipe width difference accompanying the easy machine. we are likely to cultivate a pipe review device that performs a task fated in near future applied to 46-50cm pipe. a valid model was grown to check the practicability concerning this device that performs a task for review of the within pipeline. The types of review tasks region wholes are entirely various. A standard style was thought-about for customized to new surroundings accompanying little changes. The occupancy of barriers inside the pipeline may be a bothersome issue. inside the projected machine the matter is solved by a spring work and growing the flexibility of the device.

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