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Development of an Improved Mini-Excavator

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ABSTRACT
The need to have an autonomous system for the smooth operation of an excavator, led to this research on the development of an autonomous miniature excavator. The process was achieved with the aid of an embedded system comprising of arduino-uno, bluetooth module, drivers, and motors. The three dimensional drawing was developed using AutoCAD design software, the bluetooth remote control was a bluetooth app used on android phones, and was configured to specification. The testing and performance of the device, showed that device had a smooth operation, all the moving parts functioned appropriately, and showed a really good performance. Hence, the result showed that the standard form of autonomous system can be adopted.

Keywords:-Arduino-UNO, AutoCAD,Autonomous, Bluetooth, Developed, Excavator, Improved.

I. INTRODUCTION

Excavators are pressure driven machine which comprises of scoop, stack, blast, container, and housing. The housing sits on the carriage with tracks or wheels. They are usually characterized by the movement from the steam scoops and frequently called power scoops. The scoop is the part of the machine that picks up or as if with a sweep of the hand in order to empty a content, make hollow space or dig out. The machine can be used to stack items like log of woods, sea salt, and also for blasting during mining operations. The main function of an excavator, involves driving the hydraulic pumps that provide oil at high pressure to the slew motor, rams, track motors, and several accessories.Most excavators which are water driven, involve using pressure driven liquid, with the aid of water driven engines. Hence, makes the water driven, different from the other excavators which use winches and steel ropes to achieve the development.

II. LITERATURE REVIEW

An excavator was designed and fabricated which uses wheels because the other excavator that uses chains might damage the tracks on roads if driven on roads. Hence, the fabrication of excavator with wheels aid easy movement(Rajesh, 2020). There was also a design aspect of an excavator arm using computer aided design (CAD) model in solid works software; in order to understudy the finite element analysis of the excavator CAD drawing(Fahim, 2016). In order to understudy the behavior of the various joints of the excavator, kinematic analysis was carried out of the whole assembly of the excavator. The analysis was done by measuring CAD models of the bucket and arm of the excavator and arm of the excavator and applied finite element analysis for strength and deformation evaluation(Anil, 2014). A detailed fatigue analysis was also carried out on an excavator arm under extreme condition of loading to study the behavior(Bhaveshkvmar, 2014). Stress analysis was carried out by optimizing the excavator parts link the boom and arm for weight reduction. Hence, it was discovered that the stress level did not increase due to the weight reduction(Bipin, 2007). Professional – Engineering CATIA, ANSYS was used to perform the modelling and finite element analysis of an excavator in order to understudy its behavior(Dhawale, 2014).For the process of studying the wheels of an excavator; measurement and comparison of natural frequencies of the two bucket wheels was carried out(Jakub, 2011).Finite element method was used to improve the thermal post buckling of composite plates that were previously subjected to mechanical loading(Rasid, 2011). Research showed that design and analysis of three-dimensional mini-excavator was observed and that the digging mechanism had sufficient durability which showed readiness for production(Solih, 2017). The control of excavation process was studied by the application of

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independent valves mounted on the excavator(Budry, 2003).

III. METHODS

The excavator frame is made up of acrylic material, which was cut to dimension using laser cutter machine. The arduino- unoas shown in figure 1, was used to control the mechanical mechanism of the excavator which is water driven. The control was achieved using arduino-uno, with the aid of a bluetooth module which helped in communicating with the Bluetooth app on the android phone, for easy navigation of the machine.

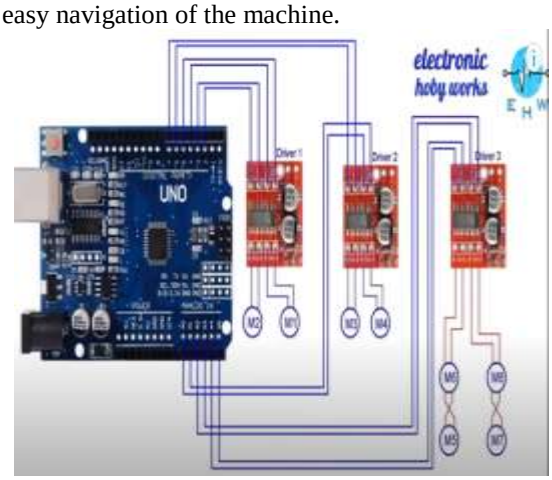

Figure 1: - Circuit diagram of the motor connection

The Control Program

The program shows the command functions used to communicate with the DC motors with the aid of the input called the bluetooth module and with the aid of the motor drivers.
chart;

```
voidsetup() {
pinMode(13,OUTPUT);   //left motors forward
pinMode(12,OUTPUT);   //left motors reverse
pinMode(11,OUTPUT);   //right motors forward
pinMode(10,OUTPUT);   //right motors reverse
pinMode(9,OUTPUT);   //Led
Serial.begin(9600);

}

voidloop() {
if(Serial.available()){
t=Serial.read();
Serial.println(t);
}

if(t=='F'){              //move forward(all motors rotate in forward direction)
digitalWrite(12,HIGH);
digitalWrite(10,HIGH);
}

elseif(t=='B'){          //move reverse (all motors rotate in reverse direction)
digitalWrite(13,HIGH);
digitalWrite(11,HIGH);
}

elseif(t=='L'){          //turn left (right side motors rotate in forward direction, left side motors doesn't rotate)
digitalWrite(12,HIGH);
}

elseif(t=='R'){          //turn right (left side motors rotate in forward direction, right side motors doesn't rotate)
digitalWrite(10,HIGH);
}

elseif(t=='P'){    //move up)
digitalWrite(9,HIGH);
}
elseif(t=='w'){
digitalWrite(9,LOW);// move down)
}

elseif(t=='S'){      //STOP (all motors stop)
digitalWrite(13,LOW);
digitalWrite(12,LOW);
digitalWrite(11,LOW);
digitalWrite(10,LOW);
}
delay(100);
}
```

The Block Diagram

Figure 2 is the block diagram which shows the communication channel from the bluetoothmodule; where there is communication between the bluetooth module and the bluetooth application on android phone. The module is connected to the Arduino-uno in order to serve as an input for the control of the motor drivers of the DC motors to navigate easily.

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Figure 2: - Block diagram

The Flow Chart

The flow chart as in figure 3, shows the different actions that take place between the input known as the bluetooth module and the output which is known as the DC motors. It shows the check for the forward, backward, left, right navigations, including the start and stop functions.

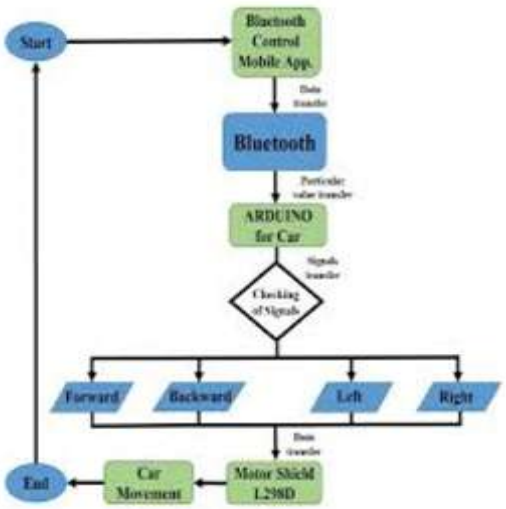

Figure 3: - Flow chart diagram

Three Dimensional Drawing of Miniature Excavator

Figure 4 shows the three dimensional drawing of the miniature excavator, which developed using AutoCAD design software.

Figure 4: - 3D Drawing of Miniature Excavator

IV. RESULTS AND DISCUSSION

Figure 5 shows the pictorial view of the miniature excavator. The testing and evaluation of the miniature excavator showed a good performance, as there was good communication between the Bluetooth remote control and the Bluetooth device module. Hence, there was easy movement of the excavator and all its moving parts conveniently.

Figure 5: - Pictorial View of Miniature Excavator

V. CONCLUSIONS

The development of the miniature excavator was useful for understudying an autonomous system, where the machine can be controlled with a remote control. There was good communication between the Bluetooth remote control and the Bluetooth device module on the machine. Testing and evaluation of the device, showed a good performance. Therefore can be adopted in a standard form.

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