Design and Development of Semi-Automatic Tractor for Agriculture Farming

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Abstract

Agriculture is the backbone for every nation, whereas, it needs a lot of manpower to cultivate a good yield. The first stage in agriculture is to make the land suitable for cultivation by ploughing. The traditional ploughing method is time consuming, thereby, farmers use tractors for ploughing. Ploughing through tractors, needs much of attention. To overcome the difficulties in ploughing through tractors, the operation of tractor is being automated. The existing automated self-driving tractors employ GPS (Global Positioning System) to track the ploughing path and to locate the areas, where the seeds need to be sowed. The major drawbacks in fully automated tractor is trajectory planning which needs complex calculation and accurate directions based on velocity, time and kinematics. These disadvantages can be overcome by designing and making a semi-automatic tractor with Dual Tone Multi Frequency (DTMF) technique to control the movement of the tractor through mobile. The DTMF uses GSM technology for the transmission and reception of signals. The signals generated by DTMF are transmitted with the help of mobile communication network. The signals generated by DTMF are decoded and processed in the Arduino microcontroller, which generates the signal to drive the tractor. The advantage of using DTMF is that it has infinite range of control and the system control remains simple and efficient and easy to operate.
Keywords: Dual Tone Multi Frequency; GSM; GPS; semi-automatic tractor

I. INTRODUCTION

A tractor is a self-propelled engineering vehicle particularly designed for delivering a high tractive effort at low speed, for hauling the trailer or machinery used in domestic applications. The farm tractor defined in history is for ploughing deeply in to the soil and do all the domestic work that the farmers of the world doing on the soil. Agricultural equipment's may be towed or mounted on to the tractor, and the tractor may provide a better source of power, if the implementation level is automated. A tractor is classified based on the structural design and its application as Wheel tractors, Crawler tractor and Walking tractor (power tiller). Nowadays, farm tractors are more helpful in providing muscle power needed for today's high output agricultural enterprises. There are numerous accidents happening due to farm tractors. Manufacturers are continually improving the structural changes to make them safer. But it is very difficult to design a tractor engine to recognize unsafe conditions. Tractor operator must aware of the hazards and to be better equipped to avoid a tractor mishap.

II. EXISTING TECHNOLOGY

Andrea Knierim et.al [1]. describes about Smart AKIS targets to collect and spread Smart Farming Technologies (SFT) based on the need of farmers. The methodology is collecting and storing the data provided by the farmers all over the world. Those data provided by the farmers are well analyzed and provides the right details about the crops, lands, seeding etc., Eaton et.al [3]. presented the ideas and works that are being undertaken in the field of agricultural automation and in the field of systems engineering. One of the consequences of a reduced labor force and more corporate styled farming is the need of autonomous and precision farming machinery with intelligent and autonomous sensors. Such autonomous machinery will form the backbone of future precision autonomous farming systems. For better productivity the autonomous farming system will have an interface with precision agriculture components that senses the environmental condition and the results can be processed to have a better farming system. Wang Hao et.al[7]. describes about the autonomous manoeuvres of a robotic tractor for farming which addresses the problem of motion control of an agricultural robot during the whole process of farming work; including manoeuvres to follow straight crop rows inside the field, and opera actions of lane change at the headland. A circle-back turning algorithm based on continuous primitives connected together was used at the headland to create reference paths. A proportional integral controller [6] was applied to calculate the steering angle while following the straight guidance paths.

III. Farming System

The farming system is driven by a set of inputs to obtain a set of outputs, most probably through a complex inter related system. Inputs driving the system may be the type of seed used, pesticides and fertilizers used in farming, the amount spent on fuel for agriculture equipment and as well as features such as land geometry and available resources on the farm. The farming system can be viewed as a complex system of systems as shown in Fig. 1.

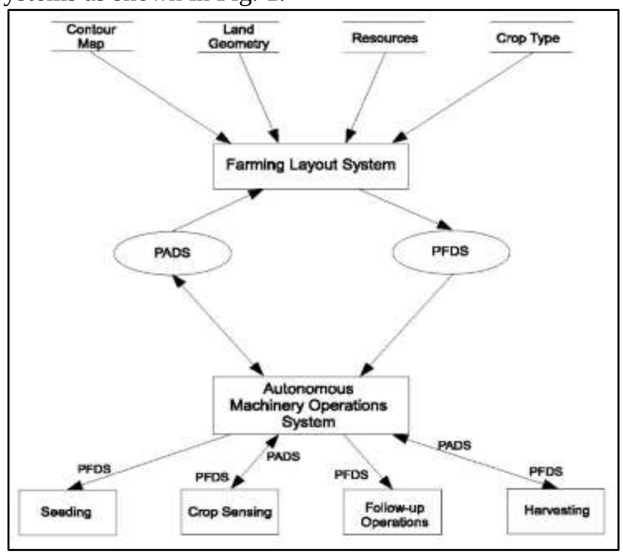

Fig. 1: Farming system architecture

In order to introduce and maintain a good farming system, a proper farm or crop layout is necessary, especially in broadacre farming. The contour mapping and land geometry data are necessary to design the optimal traffic direction for farm machineries in-order to reduce the effect of gravitational force and other external force on the farming machineries like seed sower in order to increase the accuracy as well as the efficiency of the machine being operated. In addition to land geometry and contour mapping details regarding the soil content is needed to decide what type of crop can be plotted and whether the crop can be plotted or not.

IV. Proposed Method for Driver Less Tractors

The proposed method for Driver less Tractor is shown in the following scenario Fig.2

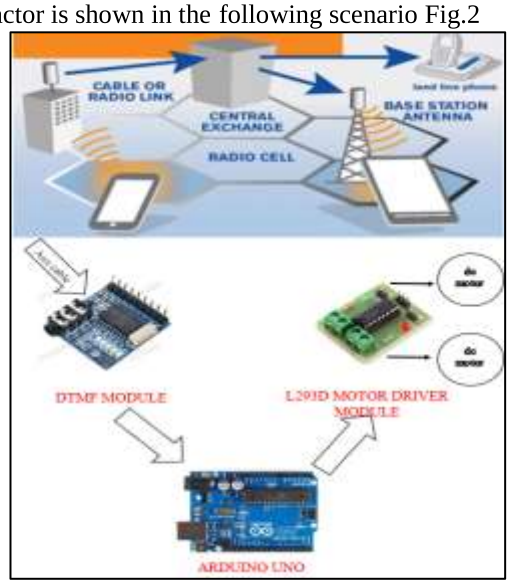

Fig. 2: scenario of Driverless tractor

Complete automation of the tractor operation is risky, when the automation algorithm fails it could cause severe damage. These disadvantages can be overcome by designing and making a semi-automatic tractor with Dual Tone Multi Frequency (DTMF) technique to control the movement of the tractor through mobile. Usually, farmlands are huge in size ranging from acres to hectares. The area is huge and controlling of robots or other automated vehicles in such large area becomes a tough task and it appears as a challenge. Usage of Radio Frequency based remotes for controlling the equipment is fine and it works well for short range. But when the area of control is in range of acres or hectares a better technology is needed. For such cases, Dual Tone Multi Frequency technique can be used. The circuit diagram of DTMF controlled tractor is shown in Fig. 3

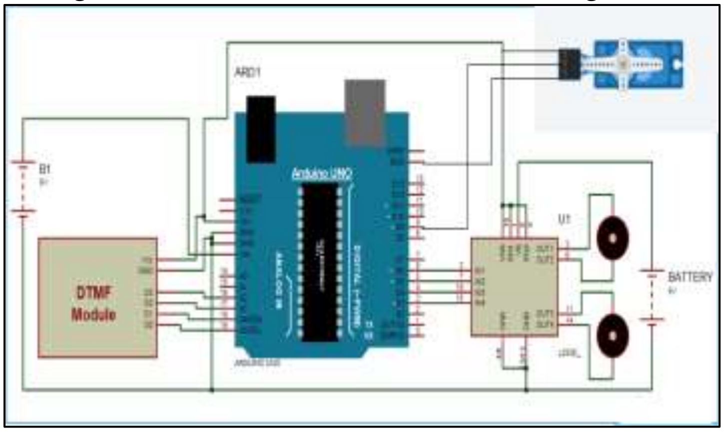

Fig. 3: Circuit diagram of DTMF controlled tractor

V. DESIGNING OF THE EQUIPMENT

DTMF (Dual Tone Multi Frequency) decoder circuit is used to identify the dial tone from the telephone line and decodes the key pressed on the remote telephone. Here for the detecting the DTMF signals generated. MT8870 decodes the DTMF signal to 5 digital outputs. The technique used in MT8870 DTMF (Dual Tone Multi Frequency) decoder IC is a digital counting technique for determining the frequencies of the limited tones and to verify that they correspond to standard DTMF frequencies. The function of Arduino is to get the information from the MT8870 DTMF decoder module, process it, and give the corresponding signals to the L293D motor driver to do the specific operation. The L293D motor drivers are quadruple high-current half-H drivers. L293D motor drivers are quadruple high-current half-H drivers. These devices have been designed to drive a wide array of inductive loads that includes relays, solenoids, DC and bipolar stepping motors, as well as other high-current and high-voltage loads. All inputs are TTL compatible and can withstand to 7V. L293D motor driver works on dual H bridge as shown in Fig.4.

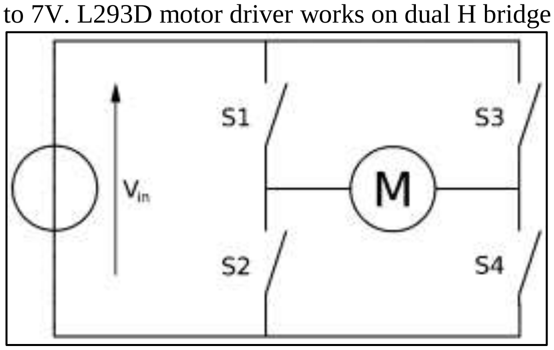

Fig. 4: H bridge circuit diagram

Table – 1
Working of H bridge circuit

S1	S2	S3	S4	Operation
1	0	0	1	Motor moves right
0	1	1	0	Motor moves left
0	0	0	0	Motor free runs
0	1	0	1	Motor brakes
1	0	1	0	Motor brakes
1	1	0	0	Short Power Supply
0	0	1	1	Short Power Supply
1	1	1	1	Short Power Supply

All inputs are TTL compatible and can withstand to 7 V. The 3D modelling of plow was made using tinker cad online 3D software. The design is fabricated through 3-D Printing as shown in Fig. 5 & 6

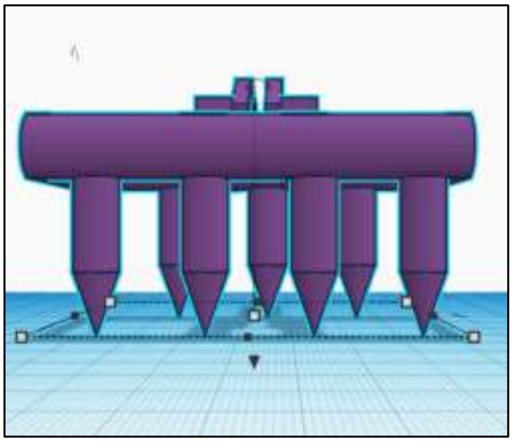

Fig. 5: Front view of Plough

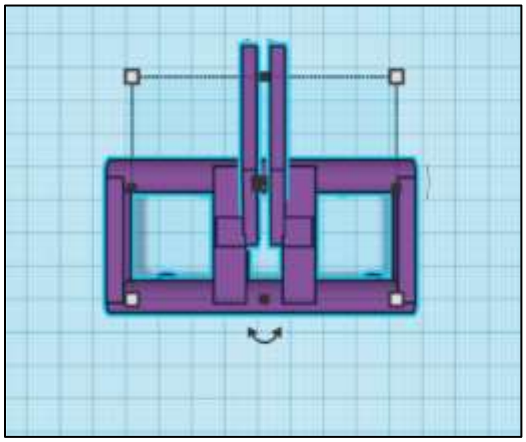

Fig. 6: Top view of Plough

The primary requirement for this project are two cell phones. One of the cell phone is placed on the vehicle and other cell phone is held in the hand. A call is made to the cell phone on the vehicle and the call is attended. Once the call is attended, the key to perform the required operation is pressed. The corresponding frequency is generated and it is transferred to the cell phone on the vehicle. The signal from the cell is transferred to the MT8870 DTMF decoder via an aux cable. In the DTMF the corresponding frequency is identified and it is decoded to a four-bit digital data. The digital data is now fed to the Arduino Uno R3 microcontroller where for different combination of inputs, different operations are performed. The Arduino sends the corresponding signal to the L293D motor driver and according to the signal passed, the tractor performs that specific operation.

VI. PSUEDO CODE

Start: Receive Dual tone from GSM Rx
Generate: Digital DTMF using DTMF module
Initialize : Input and output pins
Input: Analog DTMF signal
Output: Corresponding digital output
Generate : motor signals
Initialize:
Input (q1,q2,q3,q4 pins) and
output(M1a, M1b, M2a, M2b pins)
Check:
if(q4==0&&q3==0&&q2==1&&q1==0)
Set: motor1a=HIGH
motor2a=HIGH
motor1b=LOW
motor2b=LOW
Output: Tractor-forward movement
Check:
if(q4==0&&q3==1&&q2==1&&q1==0)

Set: motor1a= LOW
motor2a=HIGH
motor1b=LOW
motor2b= LOW
Output: Tractor-Right-turn
Check:
if(q4==0&&q3==1&&q2==0&&q1==0)
Set: motor1a= HIGH
motor2a= LOW
motor1b=LOW
motor2b= LOW
Output: Tractor-Left-turn
Check:
if(q4==1&&q3==0&&q2==0&&q1==0)
Set: motor1a= LOW
motor2a=LOW
motor1b= HIGH
motor2b= HIGH
Output: Tractor-Backward Movement
Check:
if(q4==0&&q3==1&&q2==0&&q1==1)
Set: motor1a= LOW
motor2a=LOW
motor1b= LOW
motor2b= LOW
Output: Stationary
Generate: Servo signal for ploughing
Initialize: plough pin(PWM pin-6)
Check: if(q4==0&&q3==0&&q2==1&&q1==1)
Set: plough.write(0)
Output: Tractor plow-down
Check: if(q4==0&&q3==0&&q2==0&&q1==1)
Set: plough.write(30)
Output: Tractor plow-up

VII. RESULTS AND DISCUSSIONS

The proposed system is open architecture so any one can make this type of system using any way or path. This is a semiautomatic robot requiring control signals only to decide the direction of movement works on open architecture principle and does lot of work in farms, so it reduces human labour. It works faster than human which definitely save the time. Fig. 7 shows the proposed prototype of Semi-Automated Tractor

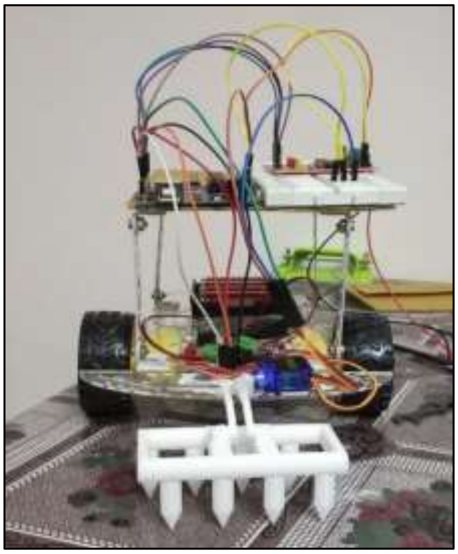

Fig. 7: prototype of Semi-Automated Tractor

The system observes different environmental conditions and take actions accordingly which humans can't do accurately. The sensors and electronic drives for making this system are easily available in market and cheap which reduces the cost of system. Some of the disadvantages of using remote control are noted

VIII. CONCLUSION

This project on semi-automatic tractor whose motion can be controlled with the help of DTMF technique. The proposed model has infinite range of operation and it works well irrespective of the hinderance the signal faces during transmission. Thus, the proposed system can be used in large farmlands and the control of the model doesn't demand skilled labour. The operation of the tractor is made easy and made user friendly so that the person with no previous knowledge can control the model with ease. A prototype has been designed with the above-mentioned features and it can be further developed into a product. Extensions are to be done in the area of real time soil monitoring to provide data regarding the nutrient and other properties of the soil. As a whole product, this will be of great use to optimize the available resources and to get maximum yield and maximum ROI.

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