The TRACALTOR: Automated Farm Area Calculator and Direction Monitoring

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ABSTRACT
The design aims for a cost-effective device in interest to the poor farmers of India in particular and any other country in general. The device is a combination of two parts namely; the area calculation and direction monitoring. The device is designed to calculate the area of the field being ploughed in different metric units in a click of a button while simultaneously assisting in the direction in which the user is heading and monitor for any path deviations. Majority farms require the plantation beds to be straight. The two parts are together displayed to the user on a screen and a series of colors are used to help keep a track on his navigation in order to achieve uniformity in the field being ploughed. The device aims for simplicity in usage and technique with respect to the user.

General Terms
Electronics, Automation, Controls, Embedded Systems, Microcontrollers.

Keywords
Arduino Uno, Area, Deviation, Direction Monitoring, Drip Lines, Hall sensor, Plantation beds, Ploughing, Tilling, I2C Protocol, Digital Compass, Magnets, LED, Disc Assembly, Blink, Pulses, Button, Debounce, Interface.

1. INTRODUCTION
The Tracaltor is a cost effective functional device that caters to the needs of poor farmers of India in particular and those of any other country in general. This word can be expanded to Tractor Area Calculator meaning a tractor that can calculate area. In addition to this, the device can do much more. It not only calculates the area of the field being ploughed but also assists the driver in the path which he is driving without the use of GPS element. Along with assistance it can monitor his path for any deviations from his straight path. The simultaneous calculation of area along with direction monitoring can be done in different metric systems for example in acres, square meters, and square yards etc. with a click of a button. This farm automated device can be conveniently placed in any kind of vehicle. This simple model is friendly for users who have limited resources and minimum basic education that is required in the field of modern farming. This device is capable for further add-ons and advancements based on the user's requirements that often vary from time to time.

2. INSPIRATION
In India the cultivating work is done based on trust. This trust is carried on for generations and is hard to be broken by the automated devices that are upcoming. It is required that these automated devices should be simple enough to fit into their lifestyles for convenience [1]. It is observed through the field research that a normal tractor-ploughed field has deviations in path. The farmers lay drip lines along these tilled paths. But the deviations caused by the moving tractor or any other farm vehicle in general lead to bent drip lines. There is a variation in the water pressure along the drip lines if there are any bends. This causes irregular plant growth and thus the deviated paths need to be corrected regularly to avoid such a problem. Often a third person has to guide the vehicle to travel in a straight line and further labor has to handle all the rectifications in proceedings.

An automated direction monitor and an area calculator can better help them to easily manage their work instead of re-visiting the left out piece of land. The area calculator continuously displays the area being ploughed to help the driver check against the total available farm area. This helps them to estimate the wastage as well as the time taken to work upon a certain piece of land in a particular interval of time. The direction monitoring system signals the drive up-on deviation from his straight path. This would save ample amount of time which would otherwise go in revisiting the deviated paths that need to be corrected.

3. DESIGN
3.1 Overview
This device calculates the area being ploughed by the farm vehicles as it moves ahead. It also monitors the direction in which the vehicle is moving. To calculate the area, we need to calculate the length being covered by the vehicle and then multiply this length by the constant breadth of the vehicle. To monitor the direction, we need to keep track of the vehicle's direction at all times and indicate the change in direction if there is a deviation.

Fig.5 shows a block diagram of the design. It consists of an ATMEGA328 Microcontroller which is interfaced with a Hall sensor and the digital compass. The microcontroller is connected to the power supply and stabilization circuit. The digital compass communicates with the microcontroller through the two wire interface (I2C protocol). The compass is programmed to be the slave here. The inputs from the hall sensor and the digital compass are taken simultaneously by the microcontroller and the outputs which are the area calculated and the direction are displayed on the serial LCD which runs through the serial communication protocol.

3.2 Hall sensor and disc assembly
The Hall sensor IC (MH183) is used as a switch in this design to calculate the length covered by the vehicle as it moves ahead. The number of rotations of the wheel can be calculated by using a series of magnets and a disc assembly.

Fig 1: The disc assembly with six magnets.

The disc assembly as shown in Fig.1 contains six magnets equally spaced thereby dividing the circumference of the wheel into six parts. The Hall sensor is placed close to the disc which is connected to the axle which is not driven by the engine. When the magnet approaches the sensor, the supply voltage gets switched on and off as the disc keeps moving. These pulses are given to the digital pin of the controller which adds them to get the length covered. The complete arrangement of the Hall sensor circuit is shown in Fig.2.

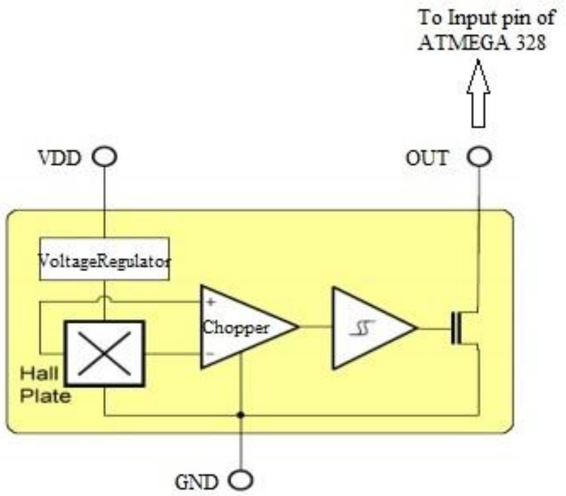

Fig 2: Hall sensor circuit. [8]

3.3 Debouncing the User buttons

Contact bounce is a common problem with mechanical switches and relays. Switch and relay contacts are usually made of springy metals. When the contacts strike together, their momentum and elasticity act together to cause them to bounce apart one or more times before making steady contact. The result is a rapidly pulsed electric current instead of a clean transition from zero to full current. The effect is usually unimportant in power circuits, but causes problems in some analogue and logic circuits that respond fast enough to misinterpret the on‑ off pulses as a data stream. The switch can be debounced either by software [9] or hardware circuitry. Debouncing the switch in software is very simple. The basic idea is to sample the switch signal at regular intervals and filter out any glitches.

4. CALCULATION OF AREA

The area is calculated by multiplying the length and the breadth. The concept of multiplying length and breadth does not apply to curved paths. In practice, in the case of TRACALTOR, the breadth would be the length of the farm implement which is attached behind the farm vehicle. This would be the constant path that gets ploughed. The front wheel rotation is taken into consideration for length measurement. The length is obtained from the disc as the vehicle moves ahead. The disc used, say for example in Fig.1, contains six equally spaced magnets placed along its circumference hence forming a magnet to magnet distance. The mag-net to magnet distance depends on the circumference of the front wheel of the vehicle. As the wheel keeps rotating, the magnets on the wheel activate the sensor. The pulses from the Hall sensor are counted by the microcontroller and multiplied by the breadth simultaneously to get the area covered. The resolution which is proportional to the number of mag-nets attached is controlled as per choice by varying the number of magnets. The calculated area is then displayed on the serial LCD. [6]

Pulse count = circumference of front wheel/number of magnets on disc assembly

Length= Length + Pulse count

Total area = Length * Length of the farm implement

5. DIRECTION MONITORING

Majority farms require the plantation beds to be straight. For this to happen the vehicles which makes the beds needs to go in a straight line. This device aims at making the vehicle achieve this purpose. The concept behind making this possible is by calculating the direction in which the vehicle is currently moving and indicate deviation if there is a change in direction.

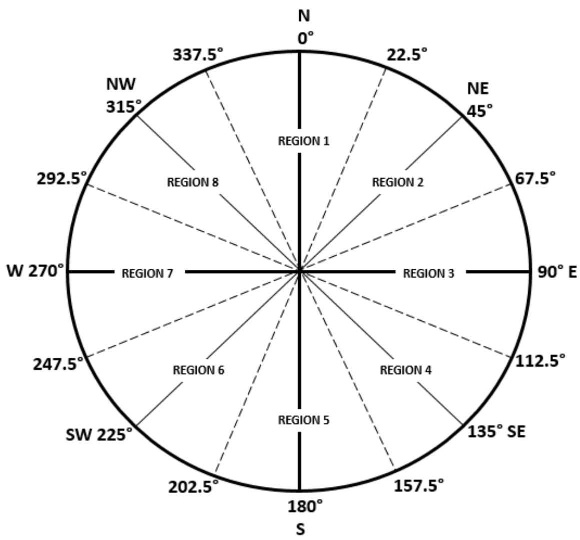

Fig 3: Directions The four regions indicate a specific direction

The digital compass HMC5883L [2] [3] gives the direction change with respect to the magnetic north. The compass transmits the readings on the I2C bus continuously which are then sent to the controller for further processing. The microcontroller is programmed in such a way that the entire range of 360 degrees is divided into eight regions as shown in the Fig.3, each indicating a specific direction. Each region is approximately 45 degrees in range. When the vehicle which is initially present in a region moves into any other region, the controller detects this change and the deviation is indicated through a series of LEDs as shown in Table.1.

Table 1. LED colors for specified direction ranges

Range (in degrees)	Direction	Indication (LED)
337.5-22.5	North	Red
22.5-67.5	North-East	Red-Blink
67.5-112.5	East	Blue
112.5-157.5	South-East	Blue-Blink
157.5-202.5	South	Yellow
202.5-247.5	South-West	Yellow-Blink
247.5-292.5	West	Green
292.5-337.5	North-West	Green-Blink

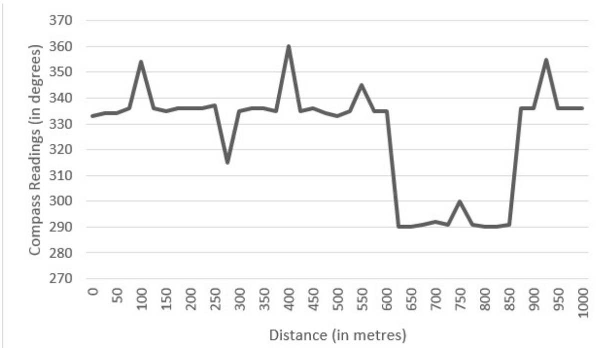

Fig 4: Plot showing Distance vs. Compass readings

For example, consider the vehicle to be in region 8 at 330 degrees initially i.e. at 0 meters as shown in the Fig.4. The driver knows that he is in north-west direction through the green blinking LED. If the vehicle deviates towards left and goes to an angle of 340 degrees on the compass at a distance of 100 meters, the driver is immediately indicated by the red LED. The change in direction is indicated by a rising edge as shown in Fig.4. If the driver moves back to his original path, the LED color changes to Green and the peak falls back. Similarly different LEDs are used to indicate different region changes.

6. THE ARDUINO UNO

The Arduino Uno [4] is a single-board microcontroller, intended to make the application of interactive objects or environments more accessible. It has 14 digital I/O pins which can be used to interact with various peripherals. The Arduino also has six analog pins which are internally connected to an analog to digital convertor (ADC) to measure a range of analog volt-ages. The hall sensor is given to any of the digital pins and the voltage is read. The digital compass communicates through the I2C protocol [5] [7]. The serial clock and the serial data pins are given to the analog pin 5 and 4 respectively. The microcontroller in this device is programmed to be the master. It communicates with the compass which is the slave here by sending a start command. The compass upon receiving the command starts sending data to the microcontroller. The compass data is received by the serial data (SDA) pin

7. CONCLUSION

The device helps the farmers to calculate area in different metric systems and monitor the path with simplicity. The device is found to be cost effective as it does not make use of GPS element thereby making it affordable. The device can be fitted onto any other type of vehicle. Primary modifications to this device can be achieved by interfacing other additional equipment like the hour meters etc. The serial LCD can be replaced by the graphical display to represent direction monitoring in pictorial representation. The GPS can be used for large fields which may revolutionize farming traditions in the years to come in India. IRNSS (Indian Regional Navigation Satellite System) can be used as an alternative for GPS elements in another 2 years. Tire slip rectification in paddy fields can be achieved using the technology used in ABS (Anti-Lock Braking System). .

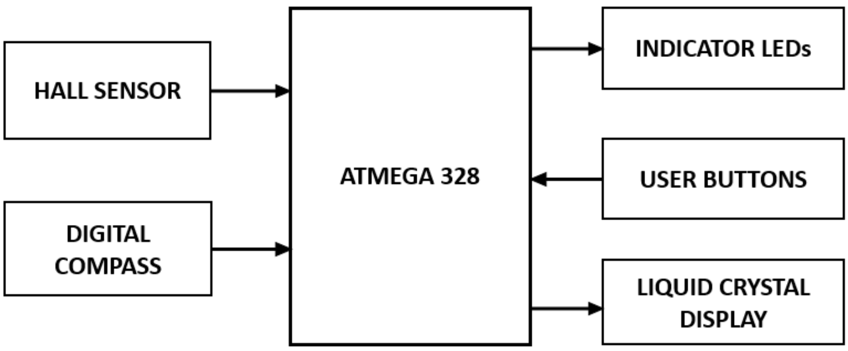

Fig 5: Block Diagram of TRACALTOR

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