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A STUDY ON ROLE OF INFORMATION TECHNOLOGY AND ELECTRONICS COMMUNICATION IN ADVANCEMENT OF AGRICULTURAL MECHANIZATION

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ABSTRACT :

The world has gone through tremendous developmental changes during last two decades due to the evolution of Electronics, Telecommunications and Information Technology. In the present scientific age, latest microcontrollers and electronics system offer numerous advantages for effective designing of complex applications particularly in the area of measurement and control. The contribution of Electronics, Communication and Information Technology is playing very significant role in agricultural sector which in turn provides basic needs to world humanity and to all other living beings with foods and fibers. Use of tractors and other farm machinery have boosted the agriculture production to meet the ever increasing needs of the world population. In the recent times, the applications of Electronics and Computers play a great role for enhancing the performance of the farm machinery system. Improvement in the performance of tractor has become the major focus of the researchers. Several fundamental equations have been evolved and acknowledged by many researchers. The ad vocation of Wismer and Luth theory 1974 was most noteworthy. They started experiments with dimensional analysis relating to wheel slip, soil strength, tyre performance, tyre dimensions and loading. The condition of fields was defined broadly as those observed in practical farming situations. Extremely slippery or hard surfaces were not covered under the theory.

The performance of tractor by slip control mechanism indicated that the fuel consumption reduced by about 24%. The slip meter performed satisfactorily as the measuring efficiency was found to be around 99.5 % and maximum error remained at 0.03%. The overall gain in tractive efficiency with SCS was about 11% as compared to DCS. The slip control system is also expected to reduce the operator's efforts in the use of tractor as it offers direction for adjusting depth control under different field conditions. It is observed that the soil conditions like soil moisture and soil salinity considerably influence the slip.

KEYWORDS : *wheel slip, slip control, draft control, depth control, tractive efficiency, measuring efficiency.*

INTRODUCTION

Technologies through Electronics, Telecommunication and IT are intelligent and can perform efficiently. It is now easy to integrate the technology directly with the management system. Modern technology in agricultural sector requires error free sensors, compatible actuators and powerful software for effective control and better output from the machinery. In addition to algorithms, acquisition, processing, transmission, conversion and storage of data, decision support systems are also necessary for obtaining optimum efficiency. These systems must become more and more independent from the involvement of the operator and be capable to carry out more complex decisions independently.

Economizing the operations of farm tractors is a critical factor in the agriculture domain. Tractors should be designed to work near their maximum efficiency by optimizing their weight, CG (center of gravity), tyre pressure and the operating speed. In the farming environment, it is required to measure the

instantaneous performance while carrying out various field activities. The challenges in performance measurement require robust setup, precise instrumentation and cost effective solutions. It has been always a difficult task to meet all such requirements in the tractors used by operators. The online performance measuring technique helps farmers to minimize the cost of operations by setting the operation optimally in an intelligent way. To encourage the farmers, the benefits of the optimization should be explained with practical results so that the technology can be well adopted by them. The efficiency of tractors can be defined as the maximum volume of drawbar work performed with respect to the energy used by burning of the fuel. For a tractor, drawbar work can be explained in terms of its speed and the pull.

The ideal tractor should convert the total energy provided by the fuel into the useful works for the drawbar operations. It is observed that the major part of the available energy i.e. 25-51% is lost in the process for converting the chemical energy by burning of fuel to mechanical energy in addition to the loss for translating the engine power to the implement system through the drive train mechanism. According to the study, about 25- 55% of the available energy from the burning of fuel is lost in the entire process in the soil interface. The wasted energy cause wearing of the tires and compacts the soil to an extent which may cause detrimental effect on the growth of corps.

OBJECTIVES

1. Development of online slip sensing and measurement device for 2WD tractors to provide guidance to the driver for maintaining slip within specified limit for achieving maximum efficiency.
2. Field testing and performance evaluation of slip meter and the slip control process.

MICROCONTROLLER

Microcontroller is an embedded system which represents a small computer on a monolithic integrated circuit. It consists of a processor, memory with programmable peripherals for its input and output. Program memory containing small amount of RAM is also integrated on the microchip. Unlike the microprocessors, the design of microcontrollers is meant for embedded applications. Microcontrollers are used in automatic products, such as control system of automobile engine, farm machinery system, medical electronics equipment, remote controls, home appliances office and workshop machineries. The uses of microcontroller reduce the size and cost of the device making it affordable for the general use.

Some microcontrollers have four bits words which operate at low frequency (4 kHz) and consume very low power. They are capable to retain functionality even during the interrupt. Some microcontrollers consume more power as they work with higher speeds like DSPs.

A microcontroller is an embedded system with the under mentioned features.

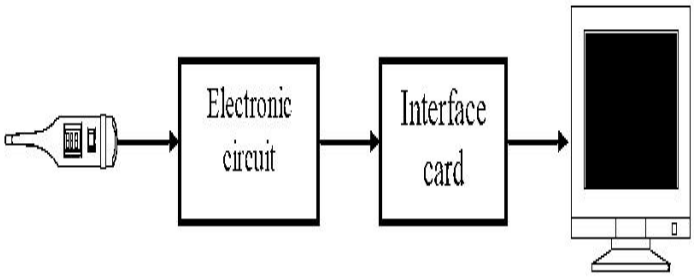
- CPU with 4-bit to 64-bit processors
- Flash memory or ROM, EPROM, EEPROM for operating parameter storage¬
- Volatile RAM
- Serial input/output
- Serial interfaces, Controller Area Network and Serial Peripheral Interface for system interconnection
- Clock generator (crystal, resonator)
- Analog-to-digital and digital-to-analog converters
- Debugging support and in-circuit programming system
- Peripherals like watchdog timers, PWM generators and event counters,

MAGNETIC PICKUP SENSOR

The magnetic pick up sensor contain a magnetic pole and sensing coil inside a compact cylindrical enclosure as viewed in Fig.1.1. When moving metallic targets disturb the flux of its permanent magnet, the

flux passing through the sensing coil of the sensor produces emf (electro motive force in Volt.) as per the Faraday's law of electromagnetic induction. The strength of emf would vary according to the size of target.

Fig 1.1 Magnetic Pickup Sensor and Measurement System



The working principle

Generally the targets rotate with the wheel in a close proximity of the magnetic pick up sensor which is positioned in the fixed part facing the targets. When the ring containing targets revolves with the axle of the wheel, the targets cut magnetic field of the sensor which is fixed to a non-moving part facing the targets. This action generates emf in the sensing coil of the magnetic pick up sensor. The target must be small and as light as possible to make the system compact and light. The gap is maintained to keep the separation of magnetic sensor from the target at approximately 1- 2.5 mm.

The interface card

The interface card is connected between the sensor and the microcontroller. The output of proximity sensor is analog in nature. To fetch a sharp digital information to the microcontroller, an ADC circuit is used in the interface card. The digitization is required as the computer system only understand discrete value rather than any varying signal. IC 0804 works as an 8 bit ADC circuit.

Liquid Crystal Display (LCD)

LCD is very essential element in embedded application as it facilitate for the display of the results. LCD in itself, without a driver, is incapable of displaying information received from the microcontroller. The LCD used here is provided with driver HD44780U. LCD driver is a link between the microcontroller and display system. Its module has 8-bit data interface and control pins. To display any characters, microcontroller can send data in 8-bit ASCII code to the data bus of LCD. The display used here is having 16 x 2 size meaning 2 lines each with 16 characters.

Working of a Draft Control System

Depending on the requirements, a force signal is obtained in the top or lower link of the hitch. The signal measures the draft or depth of the implements and the signal will be constant if the draft remains constant. The force is indicated by the displacement of the spring S1. Displacement of spring S1 facilitates the measurement of top force. The control valve B is actuated by this displacement. This causes the dumping of oil into or release of oil from the cylinder C. By the use of a hand lever H the top link displacement can be controlled. By this method, the working depth is set by the operator. The lower links are attached to a frame which is restrained from longitudinal movement by a control spring.

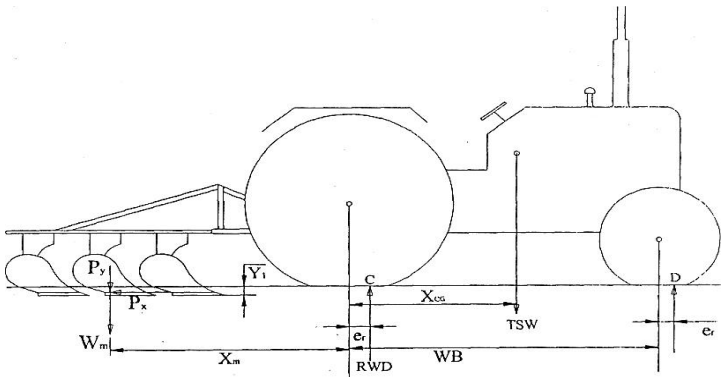
Theoretical depth of the implement in the ground depends on the altitude of the tractor and ground surface. This is the reason for the surface disturbances. The output from the implement is a force which adds up with soil force disturbances. The force of the implement is sensed by a spring available in the links of the

hitch. The displacement of the spring is increased by the mechanical linkage and is compared with the hand lever setting.

Dynamic weight on front and rear wheels

The dynamics of a tractor along with implement on a level surface in horizontal plane. The depth of operation is considered to be uniform. Centre of resistance has been considered to be located at a distance of two-third of depth of operation from the ground surface. The CG of the tractor is located without considering the driver. The center of resistance and center of gravity of implement are assumed to be acting in the same vertical plane. Vertical soil reaction is assumed to be 0.3 times the horizontal soil reaction.

Fig 1.2 Mechanics of Tractor-Implement in Dynamic Condition



SLIP SENSING AND CONTROL SYSTEM

Slip is determined by measuring two basic parameters. These are the theoretical and actual speed/velocity of the tractor under test. The theoretical speed is the speed at which the tractor moves a distance per unit time. The distance traveled is equal to the multiplication of number of revolution of drive wheel (rear wheel) per second and its perimeter. For the actual speed computation, the actual distance covered was calculated by multiplying the perimeter of front wheel with the number of rotation. For measuring the theoretical and actual speed, the RPM measurement is very essential. These physical changes in the form of RPM were converted to digital signal by using encoders and the same was transmitted to a microcontroller for calculating the speed and slip. The encoder consists of a magnetic sensor and a mechanically fabricated slotted iron ring to sense the speed of rotation of wheels. Magnetic sensor detects the iron target at an angular distance of 400. Ina complete revolution, 9 pulses were transmitted to the microcontroller for computation purpose. Three numbers of encoders were used to facilitate the calculation i.e. rear wheel1, rear wheel2 and the front reference wheel. With the available data, the slip meter calculates RPM and slip. As per the measured RPMs and slip, the microcontroller generates a digital display for monitoring purpose.

The Draft Control System (DCS) plays very critical role on hitch geometry during plowing operations. Without the availability of the draft control mechanism, when the implements hit a patch of hard soil, the wheels spin and sometimes, the cutting elements of plough break. Draft control mechanism senses the increased loading and raises the implements as per requirements to move along the hard portion of the soil and again return to the desired depth on disappearance of hard soil. The DCS used in the present development of tractors are not efficient as compared to the concept of Slip Control System. The existing DCS guides the operator to frequently manipulate the control lever for achieving the desired draft which results in lowering the efficiency of the tractor. To resolve this problem, it is desired to control the draft though slip control mechanism. In this study, an accurate wheel slip measuring instrument has been developed for 2WD (Two wheel drive) tractors which can be positioned near the dashboard to provide vii

necessary information and guidance to the driver for efficient controlling of the implements for the improvement of performance. The system measures the slip continuously in the field and provides online information to the driver to adjust the hydraulic control systems for maintaining the wheel slip within optimum range. The wheel slip is calculated by a microcontroller by sensing the theoretical and actual speeds of the tractor. By measuring the RPMs of the drive and non-drive wheels, the theoretical and actual speed can be determined. The system has been designed for use in any make and model of tractor. When the device is used in a different model/make of a tractor, the rolling radius and the optimum slip range of the tractor needs to be uploaded to the instrument through a computer interface available with the slip meter. The developed slip meter was deployed on test tractors and extensive tests were conducted to evaluate their performance.

A digital slip meter was developed for 2WD tractors for online measurement of the wheel slip in actual field condition. The measuring efficiency and maximum error of the developed slip meter were found above 99% and 0 02 % respectively

A radar sensing technique was employed to check and validate the actual speed of the tractor. There was no significant effect of front wheel skid in actual speed measurement technique. Maximum efficiency was better than 99%, accuracy was 0.49%

Since the slip meter is a compatible universal device for all make and models of 2WD tractors, the slip control method can be implemented in any make and model of 2WD tractors by uploading their wheel radius and the optimum slip range of the soil under operations to get the maximum tractive efficiency. The tractors with slip control process remained operational for 70-80 % of the time in the desired range of slip whereas, with the existing DCS, it could be operated with similar setting ± 2.5% draft and similar field conditions for 42- 44% of time.

COMPUTATION OF SLIP IN MICROCONTROLLER

All encoders are given power supply separately by the developed slip meter circuit. The output from the encoders feed to the microcontroller separately. Before the signal reached at the microcontroller, it was processed by a NAND 747S132 circuitry. The processed data is transferred to the timer pin of Phillips P89V51RD2 microcontroller. A software program is written in C ++ for the microcontroller to facilitate computation of speeds and slip. Microcontroller computes the RPM and Slip of the wheels and the results are displayed instantly on the LCD screen provided in front panel of the slip meter. The identifications of RPMs of rear wheel1, rear wheel 2 and front wheel are represented by Er1, Er2 and Ef respectively. The under mentioned equations have been considered for the calculations of actual and theoretical velocity and slip which is derived from the signal generated by the encoders.

CONCLUSION

The Steep increase in the price of petroleum fuels has adversely affected the management of vehicular operations. Consistent efforts have been made to maximize the fuel efficiency in all type of vehicles. In current scenario, the preference of vehicles is mainly based on their fuel efficiency. In agricultural sector, fuel consumption is also a major concern as 35% of the operational cost is attributed towards the cost of fuel consumption. Fuel efficiency is maximized by optimizing the tractive efficiency which can be achieved by matching the tractor with implement size and load for a given tractor.

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