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The Role Of Electronics, Communication And Information Technology In Agriculture

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Abs tract:-*Electronics, Telecommunication and Information Technology play great role for the modernization of agriculture. This in turn provides comforts to the farmer while operating the farm machineries. Agriculture provides all living beings with food and fiber. Use of tractors and other machines have boosted the agriculture production in a great deal to meet the ever increasing needs for the food and fiber. Hence, the prediction of tractor performance has been a major focus for many researchers over last twenty years. The commercial draft control systems engaged in today's tractors are found to be inefficient due to the poor control mechanism. To overcome this problem, slip control mechanism was developed in place of draft control mechanism. To facilitate the same, an accurate wheel slip measurement device was developed for 2WD tractors. The display unit of the device was installed near front panel of the tractor to provide proper guidance to the driver for controlling the depth of operation. This system can be easily installed on any make and model of 2WD tractors by uploading the rolling radii of the front and rear wheels through computer interface. The measuring efficiency of the slip meter was found to be 99.5% with a maximum error of 0.19%. The developed system was installed on a test tractor and the performance data indicated that the fuel consumption was reduced to about 21.3 %. The slip meter performed satisfactorily and the efficiency was found to be about 99.5%. There was a gain in tractive efficiency (4-10%) with slip control system over the existing draft control system. It was found that the soil conditions like soil moisture and soil salinity also played very important role in influencing slip parameters of the tractor tyres.*

Keyw ords:wheel slip, slip control, draft control, depth control, tractive efficiency, measuring efficiency.

INTRODUCTION

There is a worldwide concern over thesteep rise of petroleum prices owing to heavy consumption of existing reserves. This has led researchers to find alternate means of energy production while constant efforts are made to modifythe designs of internal combustion engines to achieve improved fuel efficiency in all kind of vehicles. High fuel consumption by the tractor is a cause of concern in the agricultural sector which happens mostly due to the abnormal slip of the drive wheels. Wismer&Luth (1972) and Brixius(1987) suggested that wheel slip control plays animportant role in improving the tractive performance. The tractors operate at peak efficiency if their slip is maintained within an optimum range (Zoz, 1972). This is, however, not possible due to large variation of soil conditions.

The efficiency of tractors majorly depends upon the driver who manually controls the speed and depth of operation of implements attached to the tractors. Ismail et al. (1981) reported that driver sense the slip and move the depth control lever which takes considerable time. Providing the instant information to the driver has been identified as a valuable means for the improvement of tractor performance. (Jahns and Speckmann,1984). A slip meter provides instant information about the wheel slip to the operator. However, the utilization of this information depends upon operator's expertise to manually control the mechanisms as per the requirements. Therefore, the accuracy of slip meter plays an important role. From the literature survey, the information about a number of slip meters design have been revealed but those have not been commercially adopted by tractor manufacturers due to either high cost of production or lack of reliability. Hence, the major objective of this study is to develop a flexible, low cost and robust slip meter to display wheel slip on the dashboard of a tractor as an input to the driver for efficient control of implements.

1.REVIEW OF LITERATURE

Slip is calculated from two parameters i.e from the actual and the theoretical speed of the tractor. These speeds can be measured either directly by measuring the distance travelled per unit time or indirectly by multiplying the circumference of the wheel with number of revolution per second (RPS). The theoretical speed of 2WD tractors is calculated by measuring the RPS of rear wheels. However, the actual speed of the tractor is measured by the following three methods:

(1) By measuring the RPM of the non-powered wheel i.e. front wheel of the 2WD tractor (Lyne and Meiring,1977; Clark and Gillespie, 1979; Jurek and Newendorp, 1983; Raheman and Jha,2007, Pranav 2010). This method is quite simple and easy to adopt, but the actual speed depends on soil

conditions, weight transfer, skid of front tyre etc. In this method, the error in slip measurement found to be not more than ±2 per cent.

(2) By providing an additional or fifth wheel in a tractor (Zoerb and Popoff, 1967; Grevis-James et al., 1981; Erickson et al., 1982; Shropshire et al., 1983; Musonda et al., 1983). The actual speed measurement is independent of weight transfer, soil condition and skidding of front wheel. However, the use of fifth wheel poses difficulty in negotiating on undulating and rough terrains.

(3) By Doppler effect device or microwave radar (Reed and Turner, 1993; Thansandote et al., 1977; Wang and Domier, 1989; Grisso et al., 1991; Freeland et al., 1988; Khalilian et al., 1989): This method provides an accurate reading of actual speed but the device is very expensive, has unproven reliability and cannot be used when speed is less than 0.5 km/h.

3.DEVELOPMENT OF SLIP METER

The theoretical speed of the tractor is calculated by measuring the average RPM of the rear wheel 1 and 2, while the actual speed is computed by measuring the RPM of front wheel with the help of encoders which sense the revolutions (RPM) of respective wheels. The output signals from the encoders are sent to a microcontroller for computing the slip through suitable programming. Encoder no 1 and Encoder no 2 measure the RPM of the two rear wheels whereas; Encoder 3 measures the RPM of one of the front wheels. The slip meter displays the measured RPMs of all three wheels with the help of microcontroller. The actual forward speed (m/s) and wheel slip (per cent) are also displayed by the slip meter through suitable programming of the microcontroller..

Fig 1 Slip meter

3.1 Development of Encoder using Magnetic pickup sensors

Encoder is a device which encodes the mechanical movement of the wheel (RPM) into electrical pulses by a proximity sensor and a set of specially designed mechanical systems.For the development of encoders, inductive type proximity sensors are mounted near the wheels as shown in fig 4. A circular iron ring is fixed to the wheel rim. The iron ring for each encoder was specially designed and fabricated to facilitate the RPM measurement. The device has 9 projections (teeth like structures) at an angular distance of 400. . This was fixed on to the rim of the tractor wheel in such a way that in one single revolution of the wheel 9 projections passnear the inductive sensor.

The proximity sensor as shown in Fig 2 is a magnetic pickup device containing a permanent magnet, a pole-piece and a sensing coil all encapsulated in a cylindrical case. The device is powered by the 12V DC supply from the battery unit of the tractor. An object (targets) made of magnetic material, when passes close to its pole-pieceThis in turn generates a signal voltage. The magnitude of the signal voltage depends on the relative size of the magnetic target, its speed of approach, and how close it is from the magnet. Figure 2 shows the overall system configuration of magnetic pick up sensor. In a single revolution, the encoder generates 9 pulses. The outputs from the encoders are given to the slip meter comprising of a microcontroller which calculates the actual, theoretical speed and slip of the tractors by a developed program. Microcontroller has a RS232 port to interface a computer terminal. A computer can be connected for monitoring the the slip meter and also for the changing the databases (rolling raddi) when the system is utilized in a different tractor.

Three numbers of encoders are used in a tractor for measuring RPMof two of its rear wheels and one front wheel. The signals received from the rear wheel encoders were used to calculate the theoretical speed by multiplying the average RPM of rear wheel 1 and 2 with the distance traveled by the rear wheel in single revolution on a hard surface without load. Similarly, the revolution of the front wheel encoder is multiplied by the distance traveled by the front wheel in one revolution on test surface to get the actual forward speed of the tractor.

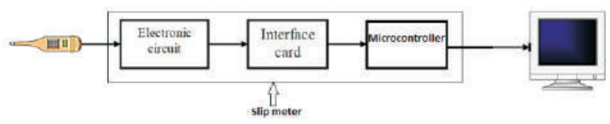

Fig 2 Block diagram of the Magnetic Pickup

Measurement System

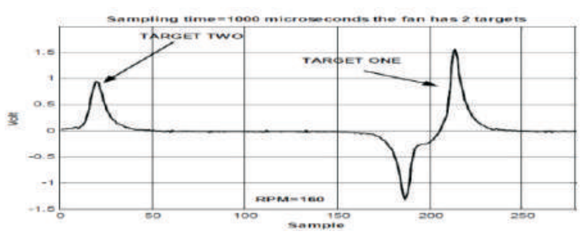

Fig 3 Output of Magnetic Pick up sensor

Fig 4 Proximity switch and iron ring fitted on a tractor wheel to measure RPM

3.2 The working principle of magnetic pick up sensor

Magnetic pickup signal is used to measure the speed of rotation (RPM) of the front and rear wheels of the tractor under observation. The principle of operation is based on Faradays'law. The sensor consists of a permanent magnet and coil. When a piece of metal moves in its magnetic field it cuts the magnetic flux and generate a pulse just like it happens in generators. The magnetic pickup sensor is fixed on the un-rotating part while the specially designed mechanical ring with 9 projections (target) is fixed on the rotating part i.e. on the rim of the tractor. When the mechanical device begins to rotate along with the wheel, the target (projections) cut the magnetic field and generates a signal on the output of the magnetic pickup sensor. The distance or air gap between the target and the magnetic pickup was kept at around 4-5 mm. The output wave form is shown in Fig 3

3.3 Development of Microcontroller

Microcontroller is consisting of CPU, RAM, ROM, I/O ports, timers and other ancillary circuits in a highly integrated silicon chip. It is deployed for a specific purpose and can be easily integrated with computer for re-programming, monitoring and changing database as per the requirements through a RS232 computer interface. The pulse output from the encoder is fed to microcontroller via a pulse shaping circuit 94LS132 for converting the analog voltage to digital signal which was fed further to the desired pin of Microcontroller, AT89S8252. The received pulses from rear wheel 1 and 2 were read as E_{r1} Er_2 and from the front wheel as E_f The program is written in assembly language.

The detected frequency in Hz was obtained from the relation:

60 f = NE Where f = Detected frequency in Hz.
N = Number of revolution per minute (RPM).
E = Number of targets.

$$Nf = \frac{Ef \times 40}{360 \times T}$$

$$Nr1 = \frac{Er1 \times 40}{360 \times T}$$

$$Nr2 = \frac{Er2 \times 40}{360 \times T}$$

Calculation of actual and theoretical speeds:

$$Va = d_f X \; N_f$$

$$Vt = dr \frac{Nr1 + Nr2}{2}$$

Calculation of wheel slip:

$$S = \left(1 - \frac{Va}{Vt}\right) \times 100$$

Where,
Ef= no. of pulses from front wheel in T seconds;
Er1 = no. of pulses from right rear wheel in T seconds;
Er2 = no. of pulses rom left rear wheel in T seconds;
Nf= rps of front wheel;
Nr1 = rps of right rear wheel;
Nr2 = rps of left rear wheel;
T = refreshment time i.e. 1.5 s;
Va= actual velocity, m/s;
Vt= theoretical velocity, m/s;
df= distance covered in one revolution by front wheel on test surface (2 π rf), m;
dr= distance covered in one revolution by rear wheel on hard surface(2 π rr), m; S = wheel slip, %.

The slip and actual speed of operation were displayed on the LCD screen of the meter with data transfer port via serialInput and parallel output ports. The detailed circuit diagram for measuring the slip and displaying it on the tractor dashboard is given in Fig. 5.

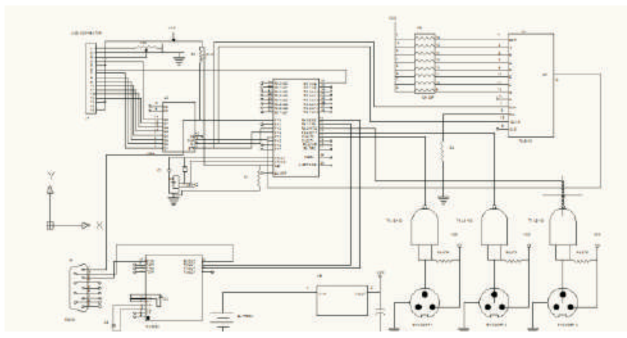

Fig 5 Circuit diagram of Slip meter

3.3. Generalized program for slip meter installation

The slip meter is versatile equipment which can be used on any make and model of 2WD tractors with a minimum adjustment. A window based graphical user interface is provided to input the required parameters (distance traveled in one revolution by rear wheel on hard surface without load and by front wheel in test surface) as and when shifted from one tractor to another. The input parameters are determined by either manually measuring the distance covered in one revolution of tractor wheels or, optionally for new tyres, by referring the tyre size from the manufacturer's database. The interface is written in visual C++.The main window of the program is shown in Fig. 6.

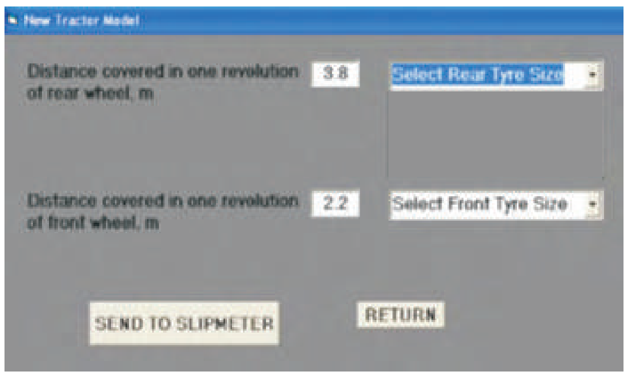

Fig. 6. Main window of program for computer–slip meter interfacing.

3.4. Installing magnetic pick up sensors on the tractors

The two proximity sensors used for measuring the rear wheel RPM are fixed near therear wheels. The positions of sensors are adjusted to remain close to the projections of the iron ring to monitor the revolutions, while the third proximity sensor and ring assembly is mounted in the same way near the front wheel. The outputs of all the sensors are fed to the microcontroller unit of the slip meter for the calculation and display of slip, RPM and velocity. The arrangements for installation of sensors are very simple and can be shifted to other tractors very easily. The front wheel sensor assembly on a test tractor has been shown in Fig. 4.

4.PROCEDURE FOR VALIDATION

The developed slip meter was validated in laboratory as well as in field condition with different tractor models.

4.1. Development of simulator for slip meter testing.

Arrangement was made to simulate different speed of tractors and validate the slip meter at different speed in the laboratory. Three electric motors with speed controller unit were used in the setup to simulate the two rear and front wheels of tractor. A tachometer was used to validate the measured RPM of the encoders. The RS232 computer interfacing was provided in the slip meter for transferring the indicated value directly to the computer.

The main purpose of this test was to ensure:-

1. Output of all encoders are indicated correctly by the slip meter.
2. Correct averaging of RPMs of two rear wheels
3. Display of actual and theoretical speed
4. Slip is calculated as per the requirement based on the programming done on the microcontroller.

4.2. Field testing

Several tests were conducted to validate the slip meter in actual filed condition. The tests were conducted by two test tractors out of which one with mould board (MB) plough and the other with a cultivator. The slip indicated by the slip meter was compared with the manually measured slip. The procedure for the manual slip measurement was based on measuring the distance travelled for fixed number of revolution of the drive wheels at load and no load conditions. The slip is calculated as follows:-

$$S = \frac{\mathrm{do} - \mathrm{dl}}{\mathrm{do}} \times 100$$

wheredo = distance traveled for fixed number of rotation at hard surface and no load condition, m; dl = distance traveled for fixednumber of rotation at load condition, m.

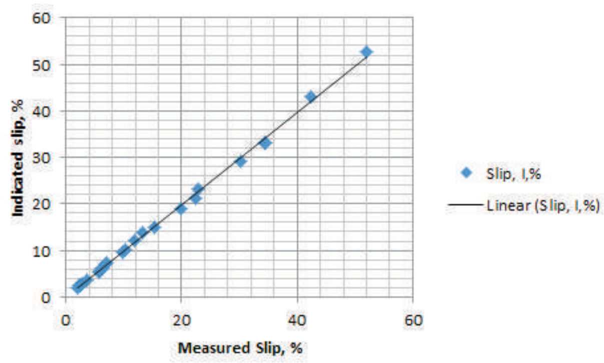

Fig 7 Comparison of Measured and Predicted Slip on 1:1 Line

5.VALIDATION OF SLIP METER

The developed slip meter was validated in laboratory as well as in actual field conditions.

5.1. Validation of slip meter in field

Slip meter was rigorously tested in the field for its accuracy. The average value of the indicated slip was compared with the manually computed slip for each set of readings. It is observed that the maximum variation between computed and indicated slip was ±2 per cent. Similar trends were observed for different tractor–implement combinations. Comparison of measured slip and indicated slips was analyzed with statistical parameters, namely, measured mean, indicated mean, and correlation for different tractor-implements combinations and presented in Table 1. The measured and indicated slips are also mapped in a 1:1 plot as shown in Fig 7. It was observed that slip meter was more suitable to measure the higher slip.

Parameters	Mean, RPM		Accuracy, Min and Max Deviation		RMSE, %	r	ME,
	Measured	Indicated	%	Deviation, %			
Actual speed, m/s	1.46	1.47	0.01	8.35 to .265	1.56	0.99	99.94
Slip, %	22.83	22.85	-0.03	9.53 to 9.87	2.78		99.65

6.CONCLUSION

The developed slip meter for 2WD tractor is a versatile instrument which can be easily fixed on any make/model of tractor with minimum mechanical adjustments. The microcontroller program can be changed as per the requirement by feeding the rolling radius via computer interface. It is a low cost device and easily affordable hence can be easily provided by the tractor manufacturers. It is expected that the development will result in achieving improved fuel economy for the tractor operations.

REFERENCES :

Brixius, W.W., 1987. Traction prediction equations for bias ply tires. ASAE Paper No.87-1622. ASAE St. Joseph, MI 49085.
Clark, J.S., Gillespie, J.R., 1979. Development of a tractor performance meter. ASAEPaper No. 79-1616. St. Joseph, Michigan.
Erickson, L., Larsen, W., Rust, S., 1982. Four-wheel drive tractor axle and drawbarhorsepower: field evaluation and analysis. ASAE Paper No. 82-1057. St. Joseph,Michigan.
Freeland, R., Tompkins, F., Wilhelm, L., 1988. Portableinstrumentation to studyperformance of lawn and garden ride-on tractors. ASAE Paper No. 88-1079. St.Joseph, Michigan.
Grevis-James, I.W., Devoe, D.R., Bloome, P.D., Batchelder, D.G., 1981. Microcomputerbased data acquisition system for tractors. ASAE Paper No. 81-1578. St. Joseph,Michigan.
Grisso, R., Taylor, R., Way, T., Bashford, L., 1991. Tractive performance of 18.4R46and 18.4R42 radial tractor tires. ASAE Paper No. 91-1589. St. Joseph, Michigan.
Ismail, S.M., Singh, G., Gee-Clough, D., 1981. Preliminary investigation of a combinedslip and draught control for tractors. J. Agric. Eng. Res. 26, 293–306.
Jahns, G., Speckmann, H., 1984. Agricultural electronics on farm machinery needsstandardized data transfer: a concept. ASAE Paper No. 84-1633. ASAE, St. Joseph,MI.
Jurek, R.L., Newendorp, B.C., 1983. In-field fuel efficiency comparisons of variousJohn Deere tractors. ASAE Paper No. 83-1563. St. Joseph, Michigan.
Khalilian, A., Hale, S., Hood, C., Garner, T., Dodd, R., 1989.Comparison of four groundspeed measurement techniques. ASAE Paper No. 89-1040. St. Joseph, Michigan.
Lyne, P.W., Meiring, P., 1977. A wheel slip meter for traction studies. Trans. ASAE 20(2), 238–242.
Musonda, N.G., Bigsby, F.W., Zoerb, G.C., 1983. Four wheel drive tractor instrumentation.ASAE Paper No. 83-1546. St. Joseph, Michigan.
Raheman, H., Jha, S.K., 2007. Wheels slip measurement In2WDtractor. J. Terramech.44 (2007), 89–94.
Reed, J., Turner, P. E., 1993. Slip measurement using dual radar guns. ASAE/CASE,paper no. 93-1031.
Shropshire, G.J., Woerman, G.R., Bashford, L.L., 1983. AMicroprocessor based instrumentationsystem for traction studies. ASAE Paper No. 83-1048. St. Joseph,Michigan.
Thansandote, A., Stuchly, S.S., Mladek, J.S., Shlosser, H., 1977. A new slip monitor totraction equipment. Trans. ASAE 20 (5), 851–856.
Wang, Z., Domier, K.W., 1989. Prediction of drawbar performance for a tractor withdual tires. Transactions of the ASAE, Vol. 32, No. 5. St. Joseph, Michigan.
Wismer, R.D., Luth, H.J., 1972. Off-road traction prediction for wheeled vehicles.ASAE Paper No. 72-619.
Zoerb, G.C., Popoff, J., 1967. Direct indication of tractor wheel slip. Can. Agric. Eng.9, 91–108.
Zoz, F.M., 1972. Predicting tractor field performance. Trans. ASAE 15 (2), 249–255.

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