Case 9: Plough Depth Sensor for bullock drawn plough and tractor/power tiller
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Problem Statement

Optimum depth of tillage operations is required for better yield of crops. Soil profile including moisture content, compactness and texture affects the depth of operation. Farmers using the bullock drawn plough try to maintain the depth of operation based on their experience, however it is very difficult to know the variation until it is too much. Therefore, there is need of developing a low cost sensor and alarm system, which may give alarm, if there is variation in depth of operation. The farmer can accordingly adjust the depth of ploughing by adding/removing weight on the plough or changing the angle of beam.

There is need of developing a low cost sensor which can be used to sense depth of operation irrespective of tillage implements (plough, harrow, cultivator, seed drill, etc.) and alarm in case the variation is beyond the pre-set limits.

Sensor Guidelines

1. The sensors and alarming system should be low cost, robust enough to work in agricultural fields.
2. The attachment should easily be fitted with the existing tractors and its attachments (tillage implements)
3. The unit should consume minimum power; preferably it should have its own power source
4. The unit should have provision of setting the optimum depth of operation and allowable variation, which user may adjust according to type of crop
5. The unit should be compact in design and light weight.
Summary

Problem Statement

Every crop yields maximum when its seeds are sown at an optimum depth. The ploughing and sowing operations usually begin by setting this optimum depth in tractors and bullock carts. The problem is that there is no way for a farmer to know if this depth fluctuates. Therefore some of the farmers rely on their experience and some of them prefer to sow by hands instead. So the goal of this project was to create a feedback system that would alert the farmer about the changes in depth.

Introduction

The depth of the operation is a function of terrain and soil compactness. From the pre-existing literature we could convince ourselves mathematically that fluctuations in plough depth are proportional to fluctuations in ground clearance. Hence we reduced our problem of plough depth sensing to measuring the distance from a point on the tractor/bullock-cart to top layer of soil.

Prototyping

We spend next few days in NIF Workshop creating a mechanical device that would reciprocate on terrain changes. Idea was to sense this reciprocating motion and trigger the alarm. It was only a matter of time and our interaction with Ted Moallem (Founder / Co-Director, BlindLead) that we started to realize the design flaws. By moving to a mechanical system we lost the precision and adjustability.

Meanwhile Mr. Ankur Bal from STMicroelectronics advised us to use a Time of Flight (ToF) sensor. The ToF sensor measures the time taken by a photon to travel back to receiver and is unaffected by the reflectance of the surface. ToF sensor solved both the problems that we were facing with an ultrasonic sensor. It has a very high sampling rate and it worked with soil. Dr. Boami & Professor PVM Rao suggested us to collect the data and find a correlation among the ground clearance and plough depth. We assembled the circuit, housed it inside an acrylic casing, deployed it on a tractor and collected data. Ground clearance was measured by our ToF based system and plough depth was measured manually with a scale. After plotting and analysing the data we got encouraging results.

User Feedback

The most crucial part of any project is to get the user’s feedback. Hence we went to the people from whom we learned the problem, i.e. farmers and let them use our final prototype. They enjoyed using our product; we realized some shortcomings of the project for ourselves. Quite a few farmers wanted to have a display of the precise value our sensor was generating. One of them said, ‘This should come by default with the tractor’.
Regions of high mechanical resistance in the soil may arise naturally, by compaction from heavy farm machinery, or by the formation of plough pans. Compacted soils with high strength reduce growth rates of crop roots and thus limit the acquisition of water and nutrients by the plant. This may affect crop yield and require tillage practices to reduce soil compaction. Although conventional methods of crop management provide similar soil conditioning across the entire field, different parent material, topography, and past management can cause a significant variability in soil compaction. Depth of ploughing affects both perennial weed infestation and yield levels consistently. Depth of ploughing and sowing depends on the crop. Every crop has optimum depth of sowing. If the seeds are sown deeper then the tillering is delayed. Therefore, sensing the depth of tillage operations is important as it provides a feedback to the framer to correct for any irregular tillage that might have occurred.

Methods developed for online depth sensing till now use ultrasonic sensors to find the depth of ploughing. One of the challenges associated with the ultrasonic sensors is that they cannot accurately measure the distance in presence of dust particles and grass on farm. In another method, a swinging arm type of frame height sensor was designed to measure the distance variation between the soil surface and the frame of sensor system.
**Mind Mapping**

The preliminary mind map was constructed with the prior art search of the problem statement. We considered the need, methods, sowing mechanism, error tolerance, and reason for depth variations. We also thought about the tools used in farming, crop selection, and depth of sowing.

*version 1*

Prof Anil Gupta gave feedback on the Mind Map. He suggested us to include Hindrances that affect the soil, the complementary problems associated with our project like seed counting and even spacing, and the type of sensors.
version 2
Farming Tractor Implements

1. MB Plough

![MB Plough Image]

2. Cultivator

![Cultivator Image]
3. Harrow

4. Manual Seed Drill
Field Visits

The team went to villages around Grambharti for field visits.

Field Visit 1: Amrapur

Person met: Surendra Singh Rathod (9924510631) and his son Jayaraj (9924477831)

Q: What crops do you grow?

A: Almost all the seasonal crops. It depends on the season. Right now we have just sown cotton is one field and preparing another one for cotton. In winter season we grow vegetables like Green Chilli, Brinjal, Cabbage, Cauliflower. Other crops are castor, Jwar, Bajra, and Okra.

Q: How much is the area that you farm on?

A: 17 acres. But the land is distributed into small fields.

Q: What is the type of soil?

A: There are two types of soil here. Black soil and semi black (‘gurado’). Black soil requires less water as compared to semi black. So black soil is good during when the rainfall is less but not good during heavy rains.

Q: How long have you been farming on this land?

A: It has been 15 years.

Q: What changes have you observed during this time?

A: The yield has gone down drastically.

Q: What are the reasons that the yield is poorer now?

A: Erratic and less rainfall, pollution in the environment, diesel prices have gown up, pests that affect the crops have increased and now using insecticides and pesticides cost us higher.

Q: You said that diesel prices have gown up. Since when have you been using tractors?

A: We are using tractors from day 1. Earlier bullocks were used more frequently but now it is only used only for ‘gudai’ after the first shoot appears.

Q: For what purposes do you use the tractor?

A: First we implant the cultivator and run it on the field. After that Ploughing is done. After ploughing levelling is done. The we make furrows using ‘chariya’.
Q: How do you sow seeds?
A: Sowing is done by hand. We measure the depth to be sown by fingers and then make a hole by finger and put the seed in that hole. For some seeds holes are not required and we just throw the seeds on the field randomly.

Q: Does everyone in this village do it the same way?
A: Yes. Not in this village only. In many villages around the same practices are followed. They sow seeds by hand. No one uses the seed drill.

Q: How much does the labour cost you since you are planting the seeds by hand?
A: Today no labour is ready to come. We don’t get labour very easily therefore we have to pay them higher on daily wage basis. We give them Rs170 per day which is higher as compared to other farms.

Q: Why don’t you use the tractor with a seed drill for sowing seeds instead of doing it manually?
A: Tractor cannot be used for cotton seeds but it can be used for Bajra and Jwar which we do sometimes by bullock. We don’t use tractor because we do not know if the seed has fallen or not. Sometimes many seeds fall in a single place. Also the level at which the seed is sown is not perfect.

Q: Why is the level of seed not perfect?
A: The entire field is not flat. There are variations in the terrain.

Q: What is the depth of sowing different seeds?
A: Cotton: 0.5-1 inch, Lady finger: 0.5-1 inch, Bitter Gourd (‘karela’): 3 inch, Castor: 3 inch

Q: What do you think, how can we solve the problem of sowing with tractor?
A: “Uska meter honachahiye kibeej gayakin higaya. Agar gayohitnage hragaya.” There should be a meter to monitor whether the seed was sown or not. If yes, at what depth it was sown.

Q: We are working on the same problem. We are building a sensor that will tell you how deep is the seed sown and how many seeds were sown. Can we have a look at the field where cotton is sown?

Then the team had a look at the field where cotton was sown just a day before. It was planted on the sides of the canal. The team also saw the cultivator, plough, leveller, rotavator and manual plough used with bullocks.

Q: What crops give you the maximum profits?
A: There is no such crop. We have to grow all the seasonal crops because we don’t have greenhouse shelter. Otherwise castor gives maximum profits.

Q: What are other problems that you face?

A: Can you do something for the thresher? There is a lot of waste collected along with the useful grains. Saw dust and pebbles of the size of grain are not properly removed. Also during winnowing the saw dust is blown away by the thresher. This gets collected on the farm then labour has to be called to collect it from ground.

Q: Can’t you just block its opening by some sort of sack?

A: We tried doing it but then most saw dust waste came along with the grain. So blocking the opening is not an option.

The team then saw the working of the thresher.

Q: Is there any machine available in the market that does this?

A: Harvester has less waste. But is cannot be used on small distributed farms like ours. It is also expensive. When we take the grains to the market to get is separated from pebbles and saw dust it costs us 70Rs for 100Kg.

Q: How much does the thresher cost you?

A: 2.5 Lakhs

**Story:**

The farmer was very sensitive towards deteriorating conditions of farmers in India. He said that they are not getting the prices which they should get. He started talking to the team about suicides that are being committed by farmers and how this rate of committing suicides has increased drastically. He was saying that today no one tries to find out what is the real reason why farmers are resorting to such extreme steps. This becomes front page headline for a day in the newspapers and is forgotten by everybody after a day or two. No one takes a step to help solve problems faced by farmers. He suggested that there should be an association of farmers who should decide the prices of the agricultural products not the middlemen who do not give them fair value for their produce.
Photos from Field Visit 1
Field Visit 2: Mubarakpur

Person met: Hasmuk Prajapati (9723535527)

Q: How much is the area that you farm on?
A: We have 10 acres of area out of which we farm on 4 acres and the rest is given on rent.

Q: What crops do you grow?
A: Jwar, Bajra and wheat

Q: Do you grow any vegetable?
A: Yes, but not in this season.

Q: What is the type of soil here?
A: Red soil

Q: Which soil is good for Bajra & Jwar, red soil or black?
A: Red soil has higher yield and the crops grow much bigger and faster in this soil.

Q: Since how many years are you into farming?
A: Our family has been into farming since generations. I was doing a job earlier so quit it and now doing farming.

Q: What changes have you observed since these years?
A: New machines have come. Pest infestation has increased.

Q: Since when are you using tractors?
A: It has been 10 years.

Q: What all tools do you use?
A: We have a cultivator, Plough, ‘chariyuka’ (for making furrows) and a seed drill.

Q: For what seeds do you use seed drill?
A: Cotton is done by hand. For Jwar and Bajra seed drill is used. But this seed drill is not the automatic one. It has to be operated by a person.

Q: How many seed drills are there is this village?
A: 3-4

Q: How do the others sow these seeds if not by a seed drill?
A: They borrow the seed drill from us.

Q: Can the seed drill be operated by anybody?

A: No. An experienced farmer can only use it as he knows how much seed to put in the opening on top otherwise sowing may not be proper. Also the land has to be made flat before the seed can be sown using the machine.

Q: Why is the sowing not proper?

A: If there is a lot of grass on the farm, it gets stuck and seeds are not implanted on the right place. Also if there are lumps of soil at one place and hollow at some other place then the seed may remain on top and eaten by birds.

Q: Can you show us the working?

A: On the tractor seed drill is connected behind the cultivator at about 1 feet distance. Then seeds are put manually by a person on the top opening. Then the seeds are distributed in all the 7 pipes uniformly. The seeds come out of the bottom opening. There is also a provision to sow different types of seeds on the same land.

Q: Are the seed drill and cultivator at the same level?

A: Seed drill is 3 inch above the cultivator.

Q: At how much depth do you sow Bajra?

A: 3 inch

Q: What if it is deeper than 3 inch?

A: It does not yield good. The first shoot takes a longer time to appear. Tillering takes time.

Q: How much does the manual drill and the automatic drill cost?

A: Manual drill cost about Rs 10000 and Automatic is Rs 90000. No one in this or nearby village uses the automatic drill.

Q: If there exists a meter that tells how many seeds were sown and where they were sown would it help?

A: Yes that would be good.
Field Visit 3: Mubarakpur

First the team saw the working of the cultivator with the seed drill the video of which is shown below. Then measurements were made of the depth of ploughing to find out the variation in depth. The following plot was obtained. The data has a resolution of 1ft.
Person met: Kanti Bhai Gangaram Prajapati (8980863843)

Q: How much is the farming area?
A: 2 Bhiga

Q: What crops do you sow?
A: Jwar, Wheat

Q: Why only these two?
A: These two are cheap and do not require machines. Rest of the seeds like Bajra have to sown with precision. We throw Jwar and wheat by hand randomly on the farm so its costs us less as compared to using a tractor. We can sow 40 Kg wheat on 1 Bhigal land but only 2 kg Bajra can be sown on 1 Bhiga land. Earlier we used bullock for ploughing but we haven’t used it for the past 10 years.

Q: What is the most expensive seed?
A: Bajra, Tuar and Moong are expensive.

Q: What seeds did you sow using the bullock earlier?
A: Moong

Q: How do you adjust the pressure on the bullock drive sowing instrument so that seeds fall on the right place?
A: Angle of the beam is set for the required depth and the person pouring the seeds has to put pressure by hands.

Q: How many people in the village use the bullock now?
A: very few

Q: What are problems with the bullock driven plough?
A: For rotating it has to be lifted and then rotated. 3 people are required for this purpose.

Q: How do you do the ploughing of the land if you don’t own a tractor?
A: We take the tractor on rent. It costs us 300Rs for 1 Bhiga land.
Connecting the seed drill and cultivator to the tractor

Seed sowing using manual seed drill; later we measured the spatial variation of depth
The team then saw the bullock driven ploughing and sowing
Field Visit 4: Pinnada

Person met: Rajendra Singh R Bihola (9924876672)
Sarpanch of the village. He had an automatic seed sowing machine that did not require any person for its operation.

Q: Q: How much is the farming area?
A: 20 Bhiga. Earlier we had 50 Bhiga of land but sold 30 Bhiga in girl’s marriage.

Q: What crops do you sow using the seed drilling machine?
A: Jwar, Wheat and Bajra

Q: How much did the machine cost?
A: Rs 50000

Q: How old is the machine?
A: 3-4 years.

Q: What is the advantage of using this machine over doing it by hand?
A: It makes sowing fast. It only takes 0.5 hrs to sow this land and also reduces the labour cost. Seed wastage is also minimised.

Q: What is the rod behind the machine?
A: It is the leveller. After sowing wheat levelling is done. Jwar and Bajra do not require levelling.

Q: Are there any problems associated with the machine?
A: No, it is perfectly fine.

Q: Does it occur that sometimes the seeds do not germinate?
A: Yes, at some places this occurs.

Q: How do you control how many seeds to be sown on a given land area?
A: It is controlled by the driver of tractor. 12Km per hour is the optimum speed for sowing 2-3 Kg seed on 1 Bhigaland. The driver has to be very careful in adjusting the level for plough depending on the terrain.

Q: How many people in this village own this machine?
A: There is only one machine of this kind in our village. This machine is given on rent at the charge of 400Rs for 1Bhiga land.
Automatic Seed Drill
Insights, Problems and Observations

Observations from field visit:

- The villages near Grambharti farmers sow cotton, Bajra, Jwar, Wheat and seasonal vegetables.
- The area of land farmed by them ranges from 0.5 acres to as big as 17 acres.
- All of them used tractors for ploughing and preparation of land for sowing. First they use a cultivator, then plough the land and then seeding is done. The method of sowing seeds varies depending on the crop.
- Some seeds like cotton have to be sown by hand because they require precision. Others like wheat and jwar are thrown randomly by hand and do not require any machine. But some expensive seeds like Bajra have to be sown by the seed drill.
- Those who don’t own it do it manually by finger measurements for 3inch depth and some of them do not sow Bajra at all for the reason mentioned above.
- The population owning seed drill for sowing Bajra is less (3-4 in one village). The reason is that they cannot afford it. They generally borrow it from others and use it.
- A very few people today use the bullock for farming operations. Bullock is only used for doing ‘gudai’ (removing weeds) after sowing.

Problems faced by farmers:

Yields are affected when the seeds are not sown properly because tillering is delayed. The seeds may not fall in the right number and right depth when using the machine for sowing. The reason that depth is not proper is because the cultivator does not dig at equal depth throughout. To ensure that seeds are sown properly an experienced person is required who may not be always available. And if they don’t use a machine then labour cost for manual operations is high because of unavailability of labour (because they prefer working in factories which pay higher as compared to farms). So they want some meter which tells them that seeds are not going at the right depth or in right number. Something which alarms them so that they can adjust the operations to correct for it.

Another problem faced by farmers is during the threshing and winnowing operations. Saw dust waste and pebbles are not completely removed in the thresher. They cannot afford the harvester which is efficient in removing this waste. During winnowing they want the saw dust to be collected in one single place instead of blowing it away.

Design Factors:

1. When the terrain is uneven (for ex. when tyres of the tractor encounter a bump), there is a variation in the distance between the ground level (where sowing is done) and a reference point on the tractor (the distance increases in case of bump) thus leading to change in the depth (reduction) of sowing as the entire implement (plough) lifts along with the tractor when it lifts.
2. Though the tractors have automatic depth and draft control system (ADDC) which is generally adjusted by the operators before starting the operation. The system senses
the draft required through spring mounted with top link and the hydraulic system adjusts the depth and draft power available. If the soil profile is tight (high draft) then the load on the top link would increase. The actuator raises the lower-link. Conversely if the soil profile is loose (low draft) then the load on the top link would decrease. The actuator then lowers the lower-link.
Ideation

Problem:

The problem of finding the depth of the plough or any other implant behind the tractor/bullock has been reduced to finding out the distance between the tractor/bullock frame and the soil surface as shown in the figure attached below where a sudden change in the terrain changes the distance from d to d' (figure 1 and figure 2).

Solutions:

The team thought of three possible solutions which would be inexpensive:

1. Using an ultrasonic sensor mounted on the tractor frame (on the top link). Since the soil surface might cause uneven reflection of the wave we are putting a metal plate below the sensor such that the metal plate should always remain in contact with the soil surface (figure 1).
2. Using a mechanical arm attached to the tractor with a wheel rotating on the soil surface. The rotation of the wheel would change the angle of its arm which can be related to the change in plough depth. The angle of the arm can be measured by a rotary potentiometer (figure 3).
3. Using a camera fitted on the plough that takes the image of the plough from the side. This image can be processed to find what part of the plough is above the ground and subtracting it from the total length to find the part of the plough under the ground thus giving depth of ploughing. This image processing can be done in the android phone of the tractor driver.
4. Using a Time of Flight sensor. ToF sensor works by calculating the time required by light to travel to the obstacle are reach back. ToF sensor works fine on uneven surfaces like fabrics and soil.

Alarm will be in form of sound of varying intensity.

Figure 1
Experimentation and Mentor Inputs

The first idea of using an ultrasonic sensor was tried. After coding on the Arduino, the team found that the ultrasonic sensor didn’t work on soil surface. The reflections of the ultrasonic wave could not be received by the receiver. Also, another problem with using ultrasonic sensor is that in the farm, the sensor would require regular cleaning so that dust particles are not accumulated on the transmitter. This would be difficult for the farmer to do on a regular basis hence this solution is not feasible.

For the solution with image processing, the problem is that image processing would require special app on the farmer’s phone. Also, the image wouldn’t be clear on the moving tractor dust to dust and soil spreading everywhere.

Prof Anil Gupta also suggested a solution where a spring loaded arm would be used to find the distance between the tractor/plough frame to the ground.

Discussion with a farmer

The team discussed the possible solutions with a farmer Achal Patel (9601098063). He also faced the problem of improper sowing of seeds with a seed drill. He agreed that such a type of sensor for plough depth will prevent the wastage of seeds which are expensive. He said that the tractor driver has to be trained before he can really go for sowing and other farming operation because adjustment of lever is very important and not everyone can do that because it requires expertise in judging when the land is suddenly compact or the terrain is uneven. Right now in case of abrupt changes the tractor has to be stopped and the lever has to be reset. He said that the sensor should be low cost and should be resistant to the dust and soil. He didn’t have any problem in adding any attachment behind the tractor which can sense the depth of seed sown and alarm him when it goes wrong.
Prototype 1: Electromechanical Solution

The team went on to prototype the solution which prof Gupta suggested. Having a spring loaded arm which moves up and down, compressing and extending the spring. There would be an initial compression in the spring, when the depth of sowing is more the spring would be further compressed giving an alarm. When the seed is sown at shallow depth, the tension in spring would be released giving another alarm.

When this solution was thought upon further, problem was that having a spring would create a force on the soil thus changing the depth of seed and giving improper readings. In order to eliminate the spring, simply a rod was used with a wheel attached on one end which would roll on the soil behind the tractor just before the implant.

Other end of the rod of clamped to the tractor in such a way that the rod always remains vertical. Changes in terrain would lead to up and down motion of the rod. Thus the changes in the seed depth can be detected by measuring this vertical motion of the rod.

In order to measure the vertical motion and give an alarm when this movement is out of some pre-set range, the rod was divided in three parts: top and bottom are covered with an insulating material (paint) and middle part is metal(conducting). A circuit is connected to the insulating part at position such that when the rod moves and the circuit comes in contact with metal the alarm rings.

Carbon brushes were used to make electrical contact of the circuit with the rod. The circuit has a battery (9V) and alarm.

*Given below is the diagram of the rod with a wheel and circuit:*

![Diagram of the rod with a wheel and circuit]
CAD of Main Frame Structure
Pros:

- Visible motion of the rod corresponding to changes in terrain (can be explained to the farmer easily)
- No calibration required
- Low cost

Cons:

- Very heavy in weight
- Design is such that it can only be fitted on tractor and not the implant; does not account for motion of top link hence soil compactness is not accounted for.
- Improper electrical contacts leading to poor accuracy
- Improper insulation of the pipe
- Small wheel diameter therefore does not move freely on soil
- No provision of setting the optimum depth of operation and allowable variation, which user may adjust according to type of crop

Possible change in design:

Using a linear potentiometer to eliminate the need of electrical contacts. Although this would accurately measure depth variation but linear potentiometer is very expensive.
Prototype 2: Time of flight sensor (ToF)

The team then used a time of flight sensor (vl53l0x) with an Arduino. This was suggested Mr. Ankur Bal from STMicroelectronics. Time-of-Flight (ToF) laser-ranging module provides accurate distance measurement irrespective of the target reflectances unlike conventional technologies like ultrasonic sensor used before. It can measure absolute distances up to 2m which is well above the distance measurement required for this application. The VL53L0X uses 940nm VCSEL emitter (Vertical Cavity Surface-Emitting Laser), is totally invisible to the human eye, coupled with internal physical infrared filters, it enables longer ranging distance and higher immunity to ambient.

![Circuit on breadboard](image)

Reflections of the time of flight sensor from the soil surface are perfect and it gives an accurate reading of the variations in depth. Casing for the sensor and Arduino was made with Acrylic sheets. The sensor along with Arduino is implanted on the lower link just before the point where cultivator is connected to the tractor as shown in figure below. Alarm rings when the depth is out of pre-set range.

![Prototype 2](image)
Matching the variations in sensor values with variations in depth of ploughing (NIF farm):

The sensor with alarm system was fitted behind tractor on the bottom link, just before cultivator. Tractor was then made to run with the cultivator for 26 meters. The sensor data was saved on laptop for this distance and values of ploughing depth were measured manually with scale for the entire distance at a gap of 5 cm. Below are the graphs for sensor data and ploughing depth. For comparison between sensor data and measured depth, sensor data was subtracted from 600 to give values proportional to depth.

![Sensor data graph](image1)

**Graph 1: data from sensor**

![Measured Depth graph](image2)

**Graph 2: manual depth measurements**
Interpretation of above graphs: The position where peaks appear in graphs 1 and 2 are offset by a constant distant. This offset appears due to difference in the resolution sensor readings and hand measurements. But it is clearly visible that the patterns of the peaks and troughs is the same in both the graphs. Hence the initial assumption that ploughing depth is related to the readings of the height of the plough frame above the ground (ground clearance) is validated. From graph 3 it is clear that there are periodic variations in the ploughing depth (due to movement of top link tracking the soil profile) and aperiodic variations due to changes in terrain. Therefore, sensor accounts for both the factors: soil compactness and terrain. For field testing and taking feedback from farmers, the error range was set to ± 6 cm.
Manual measurement of ploughing depth (NIF Farm)

Sensor fitted on the lower link on which the plough is attached

Pros:

• Non contact sensor works on soil surface
• No moving parts
• Directly gives distance values, no calibration required
• High precision: Upto 1 mm
• Light weight and compact
• Can be easily mounted on any tillage implant (cultivator, plough, seed drill, harrow etc)
• Has provision of setting the optimum depth of operation and allowable variation, which user may adjust according to type of crop
• Very high sampling rate and gives real time data

Cons:

• Slightly expensive
• Requires proper casing to prevent contact with dust
Field Visit for User feedback

Field Visit 1:

Farmer1: Rathod Dharmendra Singh, Amrapur (9904152076)
Farmer2: Surendra Singh Rathod, Amrapur (9924510631)

The two farmers were happy with the prototype for depth sensing and gave valuable inputs to improving user interface and functionality.

- They suggested that the sensor should have a display along with the alarm. This display should be with the other displays in the tractor (diesel, speed etc.) They wanted this display to show the exact number that by how much is the depth actually changing.
- They also said that this should come embedded with the tractor and should not be an external attachment.
- The sensor should be resistant to water and should work during rains. Rice is sown in water so they said that this device couldn’t be implanted like this behind the tractor during rice cultivation.
- They said that instead of just an alarm there should be a control system along with hydraulic itself that automatically adjusts when depth changes.
Field Visit 2:

Farmer 1: Rathod Kehuji Babaji, Amrapur (7622804622)

Farmer 2: Narayansingh Balthuji Rathod, Amrapur (9904151863)

Farmer 3: Rathod Bikaji Babaji, Amrapur

In the second field visit for user feedback the sensor was tested with a bullock driven plough. It was pretty accurately sensing non uniform ploughing and buzzing wherever the depth changed. Farmers got very excited looking at the product and requested to leave the sensor with them. They said that this device would tell the farmers when to add pressure and when to release pressure from the plough while plough and while sowing. They found this sensor useful and said it would be a grate help during sowing. They don’t require it for ploughing.
Field Visit for User feedback, Amrapur
Limitations

- The ToF sensor IC vl53l0x costs around Rs 1000. Therefore the entire product cost is slightly on a higher side.
- Sensor is not water resistant therefore cannot be used during rains and with crops like rice.
- Since the sensor works in 940nm infrared range, there can be delays in initial calibration due to interference with sunlight.
- Right now there is no display panel that tells the farmer how much is the change in depth, there is just a sound that alarms him about the pre-set limits. The sound is not loud enough to be heard with tractor.
- The user cannot input the error range, it is hardcoded in Arduino right now.
- No clamp for attaching to tractor or bullock, fixed by tape right now.

Road Ahead

- The cost of the sensor can be reduced by replacing the Arduino with circuit elements on an IC.
- Interference with sunlight can be minimised by designing a casing around the sensor such that the soil surface where the sensor is pointing to always remains in shadow.
- A display panel can be incorporated on the dashboard of the tractor that gives numerical values corresponding to change in depth.
- The error range can be taken as an input from the user by having a keypad with the device where the farmer can enter the range of allowable depth change.
- The above keypad can also be replaced by a potentiometer which can be used to set the limits.
- With the bullock driven plough, after the alarm rings depth can be corrected by applying or releasing pressure from hand. But this is not possible real time with tractor. Therefore either there can be a mechanism such that the hydraulic automatically adjusts itself whenever the alarm rings or there can be a mark on the soil where the alarm rang so that the farmer can manually correct afterwards.
- A universal clamp has to be designed which can be used for both the tractor and bullock driven plough.
## Bill of materials

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<th>S No.</th>
<th>Item</th>
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