

Remote monitoring of skidder Ecotrac 140V as a tool for collecting measurement data for scientific purposes



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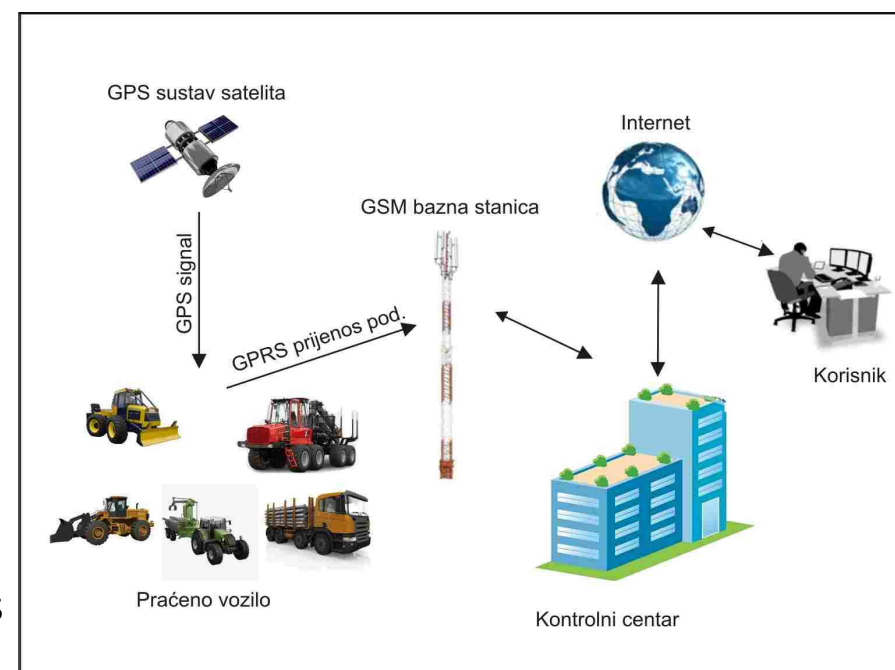
Hrvoje Korseak, mag. ing. silv.

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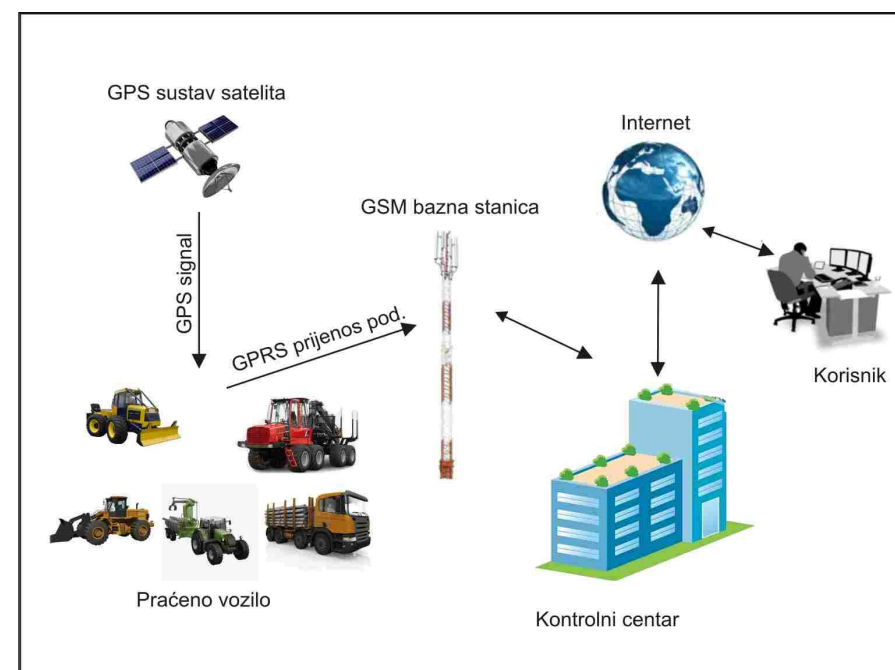
Remote monitoring of vehicles

- FMS – Fleet Management System
- Intelligent system for control, optimization, monitoring, and administration of vehicles fleet
- Use of FMS:
 - determining the position of the vehicle in real time
 - performing remote control of the vehicle and performing various measurements
 - monitoring the driver's working hours
 - monitoring vehicle costs
 - archiving collected data for their subsequent search, analysis and creation of various reports



Remote monitoring of vehicles

- Recording of certain parameters on the vehicle and wireless sending of the recorded data via GPRS or SMS via the monitoring center to the end user.
- The end user has insight into the vehicle's parameters by connecting to the Internet using a computer or mobile phone.





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PREVIOUS RESEARCH - Data transmission via cables

Sever (1980) - skidder



Horvat (1993) - forvarder



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PREVIOUS RESEARCH - Data transmission via radio connection

Šušnjar (2005) – skidder Ecotrac 120V



Tomašić (2007) – skidder Ecotrac 55V



PREVIOUS RESEARCH - Data collection on the investigated vehicle

Marenče (2005) – skider Woody 110 i APT AGT 835





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RESEARCH AIM

- The possibility of using a commercial vehicle remote monitoring system (FMS) for the purpose of scientific research and its upgrade with additional measuring transducers
- Determination of the energy consumption of the skidder at different operating tasks and under different field conditions



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Skidder type

- Ecotrac 140 V, manufactured by Hittner d.o.o

| | |
|-----------------------|----------------------------------|
| Engine | Cummins Inc; QSB4.5 |
| Engine cooling | Water cooling |
| Number of cylinders | 4 in-line cylinders |
| Working volume | 4500 cm ³ |
| Rated power | 104 kW at 2000 min ⁻¹ |
| Torque | 622 Nm at 1500 min ⁻¹ |
| Exhaust gas standards | EPA/COM IIIB Tier 4(I) |
| Weight | 8060 kg |
| Winch | 2 – drums; 2 × 100 kN |



Research area

- Bjelovar – Bilogora County – timber skidding from final fellings on hilly terrains
- Lika – Senj County – timber skidding from selective fellings on mountainous terrains



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MEASUREMENTS

- Mobilisis – measuring equipment (installation)
- WIGO-E (Telematic Data collector) gateway
 - collecting and storing data from sensors and motor computer via CANBUS
 - integrated GPS system
 - data transfer of WLAN, LAN and GSM communication to Web platforms (Cloud).
- Differential fuel flow meters – DFM 100 D
 - measurement precision = 0,001 L





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MEASUREMENTS

Remote measurements:

- Fuel consumption (mL)
- position (travelling route) of skidder (lat, lon)
- Detection of winch work (0, 1)
- Engine rpm (min-1)
- Engine torque (% od max)
- Throttle position (%)
- Engine temperature

sampling frequency – 3-5 s



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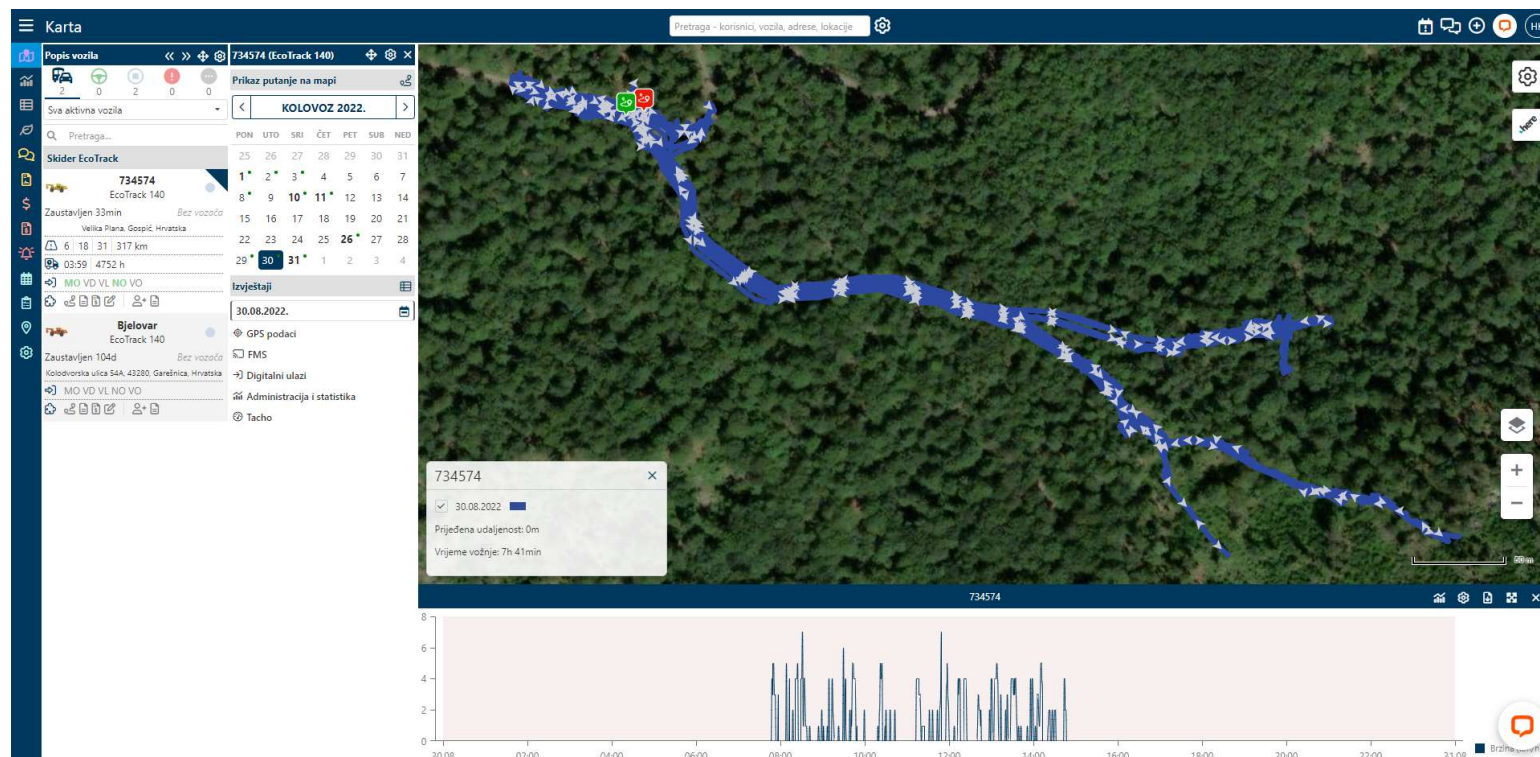
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DATA COLLECTION

Mobilis web platform

- list of tracked vehicles
- all available data
- map with all vehicles
- real-time vehicle tracking



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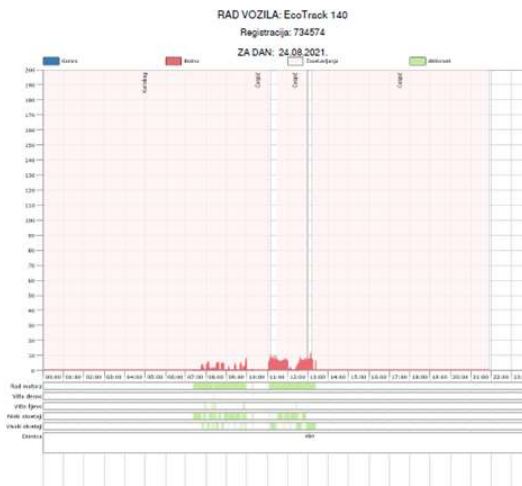


DATA COLLECTION

Mobilisis web platform

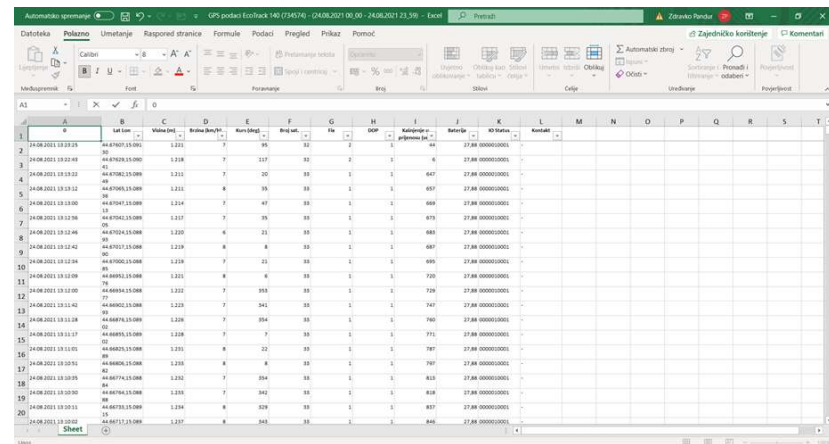
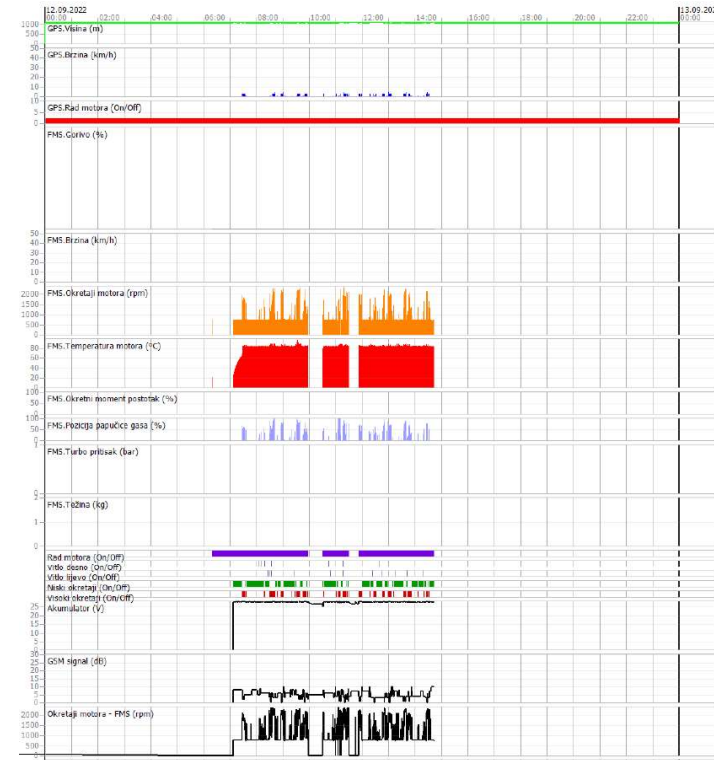
- Vehicle operation reports (graphic and tabular display, .xlsx, .pdf)

MOBILISIS®



Rad

| | Početak | Kraj | Radni sati | Angažirano vrijeme | Udaljenost |
|-----------------|---------|-------|------------|--------------------|------------|
| Voznja | 09:47 | 13:13 | 00:37 | 03:16 | 8 km |
| Rad motora | 07:22 | 13:23 | 06:00 | 06:01 | 8 km |
| Vrlo sporo | 08:22 | 10:17 | 00:00 | 01:55 | 0 km |
| Vrlo sporo | 07:52 | 12:26 | 00:00 | 04:32 | 0 km |
| Niski okretaji | 07:22 | 12:54 | 03:23 | 05:32 | 0 km |
| Vapori okretaji | 07:47 | 13:23 | 01:36 | 05:36 | 4 km |



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DATA PROCESSING

- merging all data into a database
- data processing and analysis

Mjerač protoka goriva | Bjelovar (EcoTrack 140) | 10.02.2022

MOBILISIS

Mobilisis d.o.o.
Varaždinska ul. 8, 42000, Jarkovci
042 311 777
www.mobilisis.hr

| Datum | Temperatura goriva [°C] | Mjerna brzina [l/min] | Ukupno isporučeno gorivo [l] | Potrošnja goriva u radu na motoru [l/min] | Potrošnja goriva u radu na agregatu [l/min] | Potrošnja goriva u radu na ventilatoru [l/min] | Potrošnja goriva u radu na ostalim agregatima [l/min] | Vrijeme rada motora [min] | Vrijeme rada agregata [min] | Vrijeme rada ventilatora [min] | Vrijeme rada ostalih agregata [min] | Vrijeme rada motora u pripremi [min] | Vrijeme rada agregata u pripremi [min] | Vrijeme rada ventilatora u pripremi [min] | Vrijeme rada ostalih agregata u pripremi [min] |
|-----------------|-------------------------|-----------------------|------------------------------|---|---|--|---|---------------------------|-----------------------------|--------------------------------|-------------------------------------|--------------------------------------|--|---|--|
| 10.02.2022 0:56 | 47 | 0 | 0,02 | 510,728 | 67,978 | 430,545 | 12,195 | 4,015 | 56:04 | 32:14 | 23:35 | 00:00 | 00:02 | 00:08 | |
| 10.02.2022 0:56 | 42 | 1 | 0,03 | 510,838 | 68,028 | 430,615 | 12,195 | 4,015 | 56:05 | 32:17 | 23:35 | 00:00 | 00:02 | 00:08 | |
| 10.02.2022 0:56 | 42 | 0 | 0,04 | 510,858 | 68,043 | 430,62 | 12,195 | 4,015 | 56:06 | 32:18 | 23:35 | 00:00 | 00:02 | 00:08 | |
| 10.02.2022 0:56 | 41 | 1 | 0,16 | 510,908 | 68,078 | 430,635 | 12,195 | 4,015 | 56:06 | 32:18 | 23:35 | 00:00 | 00:02 | 00:08 | |

FMS podaci | Bjelovar (EcoTrack 140) | 10.02.2022 00:00 - 23:59

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Mobilisis d.o.o.
Varaždinska ul. 8, 42000, Jarkovci
042 311 777
www.mobilisis.hr

| Vrijeme [h:m:s] | Ukupna potrošnja goriva [l] | Količina goriva spremena [l] | Radnja [l/min] | Radni sati [h:m:s] | Broj ciklusa motora [broj] | Obrtni moment [Nm] | Posljednja potrošnja [l/min] | Temperatura motora [°C] | Stanje u pripremi motora [h:m:s] | Broj priprema [broj] | Broj priprema [h:m:s] |
|---------------------|-----------------------------|------------------------------|----------------|--------------------|----------------------------|--------------------|------------------------------|-------------------------|----------------------------------|----------------------|-----------------------|
| 10.02.2022 14:44:58 | 7.651,0 | | | 785,30 | 748 | 14 | | | 00:00 | | |
| 10.02.2022 14:44:59 | 7.651,0 | | | 785,30 | 1.024 | 0 | | | 00:00 | | |
| 10.02.2022 14:44:48 | 7.651,0 | | | 785,30 | 1.900 | 15 | 14 | | 00:00 | | |
| 10.02.2022 14:44:45 | 7.651,0 | | | 785,30 | 1.285 | 72 | 48 | | 00:00 | | |
| 10.02.2022 14:44:39 | 7.651,0 | | | 785,30 | 1.127 | 0 | 4 | | 00:00 | | |

| Datum | Turnus | Radni zahvat | Potrošnja goriva, L | Potrošnja energije, kWh | Potrošnja goriva po turnusu, L | Potrošnja energije po turnusu, kWh | Privučeni tovar, m³ |
|-----------|--------|---------------|---------------------|-------------------------|--------------------------------|------------------------------------|---------------------|
| 28.4.2022 | 1 | Prazan | 2,66 | 29,15 | | | |
| 28.4.2022 | 1 | Privitlavanje | 0,83 | 9,10 | 5,94 | 65,048 | 1,82 |
| 28.4.2022 | 1 | Pun | 1,87 | 20,50 | | | |
| 28.4.2022 | 1 | Stovarište | 0,575 | 6,30 | | | |
| 28.4.2022 | 2 | Prazan | 2,87 | 31,46 | | | |
| 28.4.2022 | 2 | Privitlavanje | 1,275 | 13,97 | 5,85 | 64,171 | 3,91 |
| 28.4.2022 | 2 | Pun | 1,005 | 11,01 | | | |
| 28.4.2022 | 2 | Stovarište | 0,705 | 7,73 | | | |
| 28.4.2022 | 3 | Prazan | 2,915 | 31,95 | | | |
| 28.4.2022 | 3 | Privitlavanje | 1,43 | 15,67 | 5,85 | 64,116 | 2,28 |
| 28.4.2022 | 3 | Pun | 0,95 | 10,41 | | | |
| 28.4.2022 | 3 | Stovarište | 0,555 | 6,08 | | | |
| 28.4.2022 | 4 | Prazan | 2,74 | 30,03 | | | |
| 28.4.2022 | 4 | Privitlavanje | 0,995 | 10,91 | 6,32 | 69,322 | 2,46 |
| 28.4.2022 | 4 | Pun | 1,545 | 16,93 | | | |
| 28.4.2022 | 4 | Stovarište | 1,045 | 11,45 | | | |
| 28.4.2022 | 5 | Prazan | 3,195 | 35,02 | | | |
| 28.4.2022 | 5 | Privitlavanje | 0,565 | 6,19 | 5,11 | 56,006 | 1,98 |
| 28.4.2022 | 5 | Pun | 0,445 | 4,88 | | | |
| 28.4.2022 | 5 | Stovarište | 0,905 | 9,92 | | | |
| 28.4.2022 | 6 | Prazan | 2,075 | 22,74 | | | |
| 28.4.2022 | 6 | Privitlavanje | 0,72 | 7,89 | 4,19 | 45,977 | 2,57 |
| 28.4.2022 | 6 | Pun | 0,98 | 10,74 | | | |
| 28.4.2022 | 6 | Stovarište | 0,42 | 4,60 | | | |
| 28.4.2022 | 7 | Prazan | 2,17 | 23,78 | | | |
| 28.4.2022 | 7 | Privitlavanje | 1,22 | 13,37 | 5,19 | 56,937 | 2,5 |
| 28.4.2022 | 7 | Pun | 0,92 | 10,08 | | | |
| 28.4.2022 | 7 | Stovarište | 0,885 | 9,70 | | | |



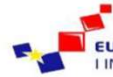
Skid trail length: 896 m
Skid trail average slope: + 8 %



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CONCLUSIONS

- The new measurement method indicates the high accuracy of measuring data and could be considered a favorable tool for remote monitoring of operational characteristics of skidder in uncontrolled conditions for scientific research.
- The commercial FMS met the expectations set at the beginning of the research and with certain adjustments it is considered a favorable tool for remote monitoring and data collection.
- Determination of the energy consumption of different types of forest vehicles performing different work tasks under different terrain conditions is a very important topic of scientific research in the field of forestry engineering. These data could be used as a basis for the development of hybrid and electric forest vehicles.



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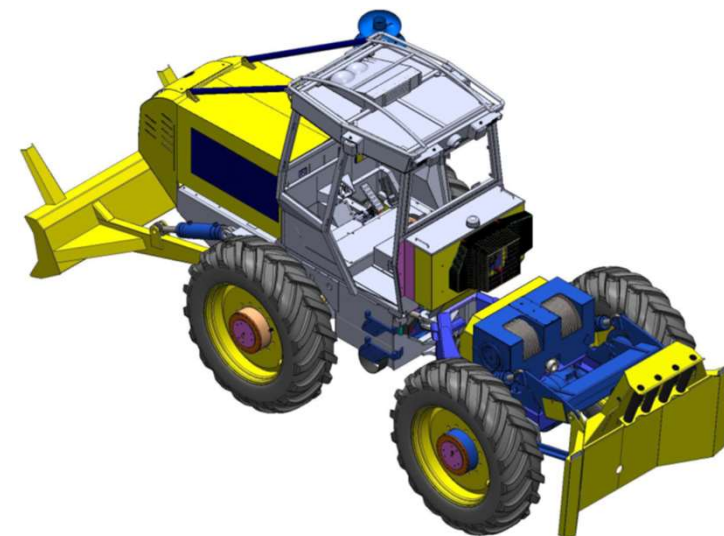
HiSkid

ACKNOWLEDGEMENTS

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The project is implemented in partnership between the Faculty of Forestry and Wood Technology and the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb.

The final outcome of the project is the conceptual design of a hybrid skidder that will be the basis for the prototype.



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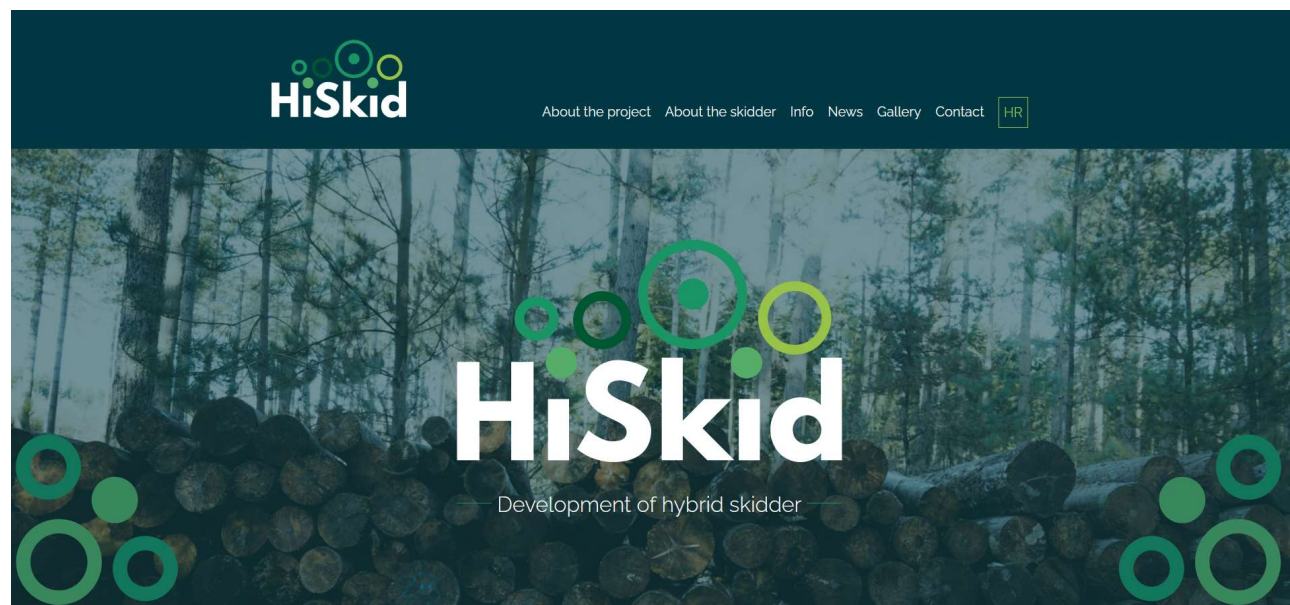
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